

# BOOK OF ABSTRACTS

30th Annual Congress of the
**EUROPEAN COLLEGE OF SPORT SCIENCE**

1 - 4 July 2025 | Rimini, Italy
Jointly hosted by
University of Bologna | University of Padova

Edited by:
Marcora, S., Narici, M., Paoli, A., De Vito, G., Tsolakidis, E.,
Thompson, J.L., Ferrauti, A., Piacentini, M.F.

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# Welcome to ECSS Rimini 2025

It is with great pleasure that we announce our hosting of the 30th ECSS Annual Congress in 2025 in the charming city of Rimini, through a collaboration between the Universities of Bologna and Padova. Above all, we are thrilled to bring the ECSS Annual Congress back to Italy after a span of 26 years, following the ECSS Congress held in Rome in 1999. At that time, there were no sport and exercise science programmes in Italian universities. Since then, sport science has developed quickly in Italy and we look forward to promoting it further by welcoming our colleagues across Europe and the rest of the world.

ECSS Rimini 2025 will take place at the Palacongressi di Rimini, a modern and attractive convention centre capable of accommodating over 9,000 attendees. This venue is conveniently located within walking distance of the city centre, hotels and the picturesque Adriatic seafront.

Rimini, with its origins dating back to 268 BC as the Roman Ariminum, boasts a captivating historic centre adorned with ancient Roman monuments, renaissance squares and architectural wonders. The city is home to churches embellished with treasures and works of art, allowing visitors to immerse themselves in its rich history. Additionally, Rimini proudly hosts the Federico Fellini Museum, dedicated to the world-famous film director who was born in the city.

The city's seafront stretches over 15 kilometres, offering access to 250 seaside resorts, cycle paths and sports facilities. Rimini is also renowned for its vibrant nightlife, featuring some of Italy's most famous venues. Rimini also serves as the nucleus of the Wellness Valley, established in 2003. This initiative aims to transform the Romagna region into a leading hub for knowledge and culture related to wellness and the quality of life. This mission aligns seamlessly with the ECSS's objective of disseminating high-quality, innovative science that makes a meaningful impact within the sports science community and society at large.

The Universities of Bologna and Padova have collaborated closely with the ECSS Scientific Board to deliver an outstanding scientific programme. This programme will encompass recent advancements in muscle biology, physiology and biophysics, as well as topics such as inactivity and aging, motor control, nutrition, physical activity and health, performance in extreme environments, exercise and sports medicine, psychology and social sciences. In addition, applied sports sciences, including Olympic winter sports, motorsports, football, cycling and other endurance sports, will also be addressed, along with physical performance of military personnel. A particular emphasis will be given to promote a multidisciplinary and interdisciplinary approach within sport science to break the barriers that often divide the biomedical and the psychosocial sciences applied to sport and physical activity.

We eagerly anticipate welcoming you to Rimini, where we can exchange knowledge within the ECSS scientific community in the vibrant, joyful and lively backdrop of this beautiful city along the Adriatic riviera.

Yours in Sport Science,

The ECSS Rimini 2025 Organising Team

Prof Samuele Marcora (Congress President)
*University of Bologna*

Prof Marco Narici (Congress Vice President)
*University of Padova*

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## 12:00 - 13:15

### Oral Presentations

### OP-PN17 Physiology and Methodology of Muscle Adaptation to Exercise

**HISTAMINE MEDIATES FOOD INTAKE, BUT NOT MUSCLE ADAPTATIONS, FOLLOWING 10 WEEKS OF RESISTANCE TRAINING IN HUMANS**

VAN DE LOOCK, A., VANDECAUTER, J., LIEVENS, E., SCHROÉ, H., MORENO JUSTICIA, R., WEYNS, A., VAN THIENEN, R., DESHMUKH ATUL, S., BLEMKER, S., VAN DER STEDE, T., DERAVE, W.

*GHENT UNIVERSITY*

INTRODUCTION: Antihistamine medication blocks the functioning of the histamine system and is widely used to treat allergies. Intake of antihistamines during a six-week cycling training period results in marked impairments in training adaptations (1), likely due to an impaired intercellular histaminergic cross-talk initiated by mast cells in muscle (2). However, it remains unclear whether this is a universal mechanism of muscle adaptation. Therefore, we investigated the impact of antihistamine medication on resistance training adaptations.

METHODS: Eighteen men were randomly assigned to either a placebo (n=9) or antihistamine (n=9, 180mg fexofenadine) group and performed 10 weeks of resistance training. Dietary intake was monitored using self-reported three-day food diaries (baseline, week 4, and week 6) and a dietitian ensured sufficient protein intake. Before and after the training program, maximal strength, muscle volume, fat mass, fat free mass, whole-body insulin sensitivity and vascular function were determined. Training-induced changes between groups were evaluated with two-way ANOVA tests or linear mixed models.

RESULTS: Both the placebo and antihistamine groups showed similar increases in muscle volume (+6% and +7%, p=0.316) and maximal strength (+14% and +20%, p=0.083). Unexpectedly, the antihistamine group gained fat mass (+0.6kg), while the placebo group did not (-0.3kg, p=0.011). This result is reflected by the rise in total caloric and carbohydrate intake in the antihistamine, but not the placebo group (+34% vs +7%, p=0.064 and +29% vs -7%, p=0.005). Both groups showed reductions in mean arterial blood pressure (-2.5 mmHg, p=0.047) and diastolic blood pressure (-4.4 mmHg, p=0.004), as well as a decrease in total glucose level during the oral glucose tolerance test (-81 mM, p=0.001). Surprisingly, fasting glucose and insulin concentrations increased following training (+4%, p=0.041 and +25%, p=0.013, respectively), in both groups.

CONCLUSION: Antihistamine intake did not alter resistance training adaptations, indicating that the intercellular histaminergic cross-talk initiated by mast cells is not a universal mechanism across training modalities. Unexpectedly, antihistamine intake led to increased food intake and fat mass following 10 weeks of resistance training, likely linked to the well-known role of histamine in appetite regulation.

References: 1. Van der Stede et al. (2021). Science Advances, 7(16).; 2. Van der Stede et al. (2025). Cell Metabolism, 37(1-15).

**REGIONAL DIFFERENCES IN INTRAMUSCULAR BLOOD FLOW AND MUSCLE DEOXYGENATION OF THE QUADRICEPS FEMORIS DURING INCREMENTAL ISOMETRIC KNEE EXTENSION**

IZUMI, K., KATAYAMA, K., TANAKA, N., KANO, Y., AKIMA, H.

*NAGOYA UNIVERSITY, UNIVERSITY OF ELECTRO-COMMUNICATIONS*

INTRODUCTION: Blood flow plays an important role in supplying oxygen to the exercising muscles. The impairment of oxygen supply via blood flow profoundly impacts exercise performance. Previous studies have shown a heterogeneity of the metabolic responses among the quadriceps muscle. For example, intramuscular blood flow measured by positron emission tomography is heterogeneous within the quadriceps muscle. Moreover, the kinetics of muscle deoxygenation during incremental exercise differ among muscles in the quadriceps. However, it is unknown the dynamics of intramuscular blood flow and its relationship to muscle deoxygenation within the quadriceps femoris. Therefore, the purpose of this study was to evaluate the changes in intramuscular blood flow, muscle deoxygenation, and their relationship in different muscles of the quadriceps femoris.

METHODS: Thirteen healthy young men (19.4 ± 1.0 years) performed intermittent (5-second contraction, 5-second relaxation) and incremental isometric knee extensions. The exercise began at 30% of maximal voluntary contraction (MVC) and increased by 10% for every five contractions to 70% of MVC until task failure. Intramuscular blood flow using power Doppler ultrasonography and muscle deoxygenation using near-infrared spectroscopy (NIRS) were simultaneously measured from the vastus lateralis (VL), rectus femoris (RF) and vastus medialis (VM) in randomized order over 3 days. All variables were measured up to 5 minutes after task failure and averaged every 30 seconds. NIRS measurement provided muscle oxygen saturation (StO2) and deoxy-hemoglobin/myoglobin (deoxy-Hb/Mb).

RESULTS: There were no significant differences in ΔIntramuscular blood flow, ΔStO2, and the ratio between intramuscular blood flow and deoxy-Hb/Mb among three muscles during exercise. However, significant regional differences were observed for all parameters after exercise. ΔIntramuscular blood flow was significantly higher in the RF (3 minutes; 1698.5 ± 1038.1 a.u., 4 minutes; 1573.9 ± 950.0 a.u.) than in the VL after 3 minutes post-exercise (824.6 ± 855.5 a.u., P = 0.009) and in the VM after 4 minutes post-exercise (713.7 ± 529.3 a.u., P = 0.037). ΔStO2 was significantly higher in the RF (3 minutes; 12.08 ± 5.36 %, 3.5 minutes; 11.78 ± 5.70 %) than in the VL after 3 minutes post-exercise (6.87 ± 3.11 %, P = 0.025) and in the VM after 3.5 minutes post-exercise (7.18 ± 5.88 %, P = 0.044). The ratio between intramuscular blood flow and deoxy-Hb/Mb was significantly higher in the RF (1.5 minutes; 15.10 ± 7.77 a.u. × 10^4, 3.5 minutes; 15.31 ± 9.74 a.u. × 10^4) than in the VL after 1.5 minutes post-exercise (9.31 ± 6.45 a.u. × 10^4, P = 0.044) and in the VM after 3.5 minutes post-exercise (4.94 ± 4.15 a.u. × 10^4, P = 0.016).

CONCLUSION: These results suggest that the metabolic requirements in the RF are different from other quadriceps femoris during fatiguing knee extension.

**THE HIGHEST POWER OUTPUT AT WHICH THERE IS A PREDOMINANTLY AEROBIC CONTRIBUTION REPRESENTS THE UPPER BOUNDARY OF THE SEVERE EXERCISE INTENSITY DOMAIN**

PEKER, A., AS, H., JONES, A.M., OZKAYA, O.

*FACULTY OF SPORTS SCIENCES*

INTRODUCTION: It has recently been identified that the highest power output at which energy supply is derived predominantly from the aerobic energy system, i.e., aerobic limit power (ALP), coincides with the upper boundary of the severe exercise intensity domain, defined as the highest power output that elicits maximal VO2 (i.e., PUPPERBOUND) (1). ALP is assessed based on VO2 dynamics during exercise, peak blood lactate concentration, and the fast phase of recovery VO2 kinetics, representing the contributions of aerobic, lactic, and phosphagen energy systems, respectively. A non-invasive alternative for estimating relative energy contribution rates is the maximal accumulated oxygen deficit (MAOD), which is defined as the difference between the estimated total oxygen cost of exercise and the accumulated oxygen uptake (2). Since the energy contribution rates derived from these two methodologies are often considered interchangeable (3), it is important to indicate that ALP as derived from MAOD still represents PUPPERBOUND. The aim of this study was to evaluate whether ALP, as determined by MAOD, coincides with PUPPERBOUND.

METHODS: Thirteen physically active male individuals underwent a ramp incremental exercise test, followed by four submaximal, 6-7 maximal and at least one supramaximal constant-work-rate test to estimate PUPPERBOUND and MAOD-derived ALP. A linear regression line was plotted using data points from the relationship between VO2 responses and power outputs obtained from submaximal exercise tests and then extrapolated to target power outputs to calculate MAOD. The PUPPERBOUND was estimated based on the linear relationship between the time to achieve VO2max and the time to task failure. The ALP was estimated by MAOD, based on the difference between the predicted VO2 demand and the accumulated O2 uptake.

RESULTS: The ALP derived from MAOD and PUPPERBOUND were not significantly different (p= 0.16; ES: 0.42) and they were interchangeable (r: 0.99; Bias: 3±7 W; SEE: 7 W; LoA: −11 to 17 W). Pulmonary VO2 just above ALP was significantly different from VO2max (Δ: 4±3 mL/min/kg; p<0.001). When ALP was exceeded, relative contribution rates obtained from the energy systems shifted and anaerobic contribution rate above ALP was significantly higher than that of ALP (51% vs 46%; p<0.001).

CONCLUSION: This study demonstrated that ALP, as derived from the MAOD method, provides a simple, cost-effective, and non-invasive approach to accurately determine the PUPPERBOUND.

1. Peker et al (2024)

2. Medbø et al (1988)

3. Bertuzzi et al (2010)

**DOES HUMAN MUSCLE VOLUME HOMEOSTATICALLY ADAPT TO BONE VOLUME?**

DHOE, B., VAN DE LOOCK, A., VAN VOSSEL, K., BLEMKER, S., LIEVENS, E., DERAVE, W.

*GHENT UNIVERSITY*

INTRODUCTION: The 'adipostat' is a homeostatic framework that keeps fat storage levels around an internal setpoint. Similarly, the 'myostat' would encompass homeostatic mechanisms that maintain muscle volume in a dynamic equilibrium around an optimal bone-scaled setpoint (myostatic setpoint). The primary function of skeletal muscles is to move bones. Therefore, one might expect a relationship between a particular muscle volume and the associated bone volume (e.g., biceps brachii vs. humerus), as a larger bone could support more muscle. The current study explores whether there is a normative ratio of muscle volume relative to its associated bone volume, indicating a setpoint, independent of human stature. Moreover, we hypothesize that resistance training (RT) would increase muscle volume more and easier when starting below the myostatic setpoint and increasing muscle volume towards the setpoint, as opposed to increasing muscle volume beyond the myostatic setpoint.

METHODS: Previously untrained males (n=29) and females (n=10), aged 23±4 years, underwent whole-body MRI scanning before and after 12 weeks of whole-body RT. An extensive set of individual skeletal muscle volumes (n=57) and their anatomically associated bone volumes were determined through AI-based automated segmentation analysis (Springbok

Analytics) and height-corrected, followed by Z-score extraction. The linear relationship between the mean Z-score across all muscle volumes and their associated bone volumes was assessed at baseline using linear regression, and residuals were derived from subject positioning relative to the corresponding regression line (myostatic setpoint). Positive residuals indicate a muscle volume above the setpoint relative to bone volume, and vice versa. Mean muscle volume Z-score changes from baseline were calculated after 12 weeks of RT.

RESULTS: At baseline, mean muscle volume Z-scores across all muscles showed a strong positive correlation with the mean associated bone volume Z-scores ($R^2$=0.58, p=2.59×10-8). This means that a major portion of the inter-individual variation in muscle volume can be explained by the volume of their associated bones. The RT-induced increase in mean muscle volume Z-scores exhibits a negative correlation with the baseline residual Z-scores ($R^2$=0.11, p=0.0067). This indicates that individuals who start below the myostatic setpoint experience greater hypertrophy than those who are already above the myostatic setpoint before RT.

CONCLUSION: In untrained individuals, muscle volume is strongly associated with bone volume, after adjusting for height. The resulting linear regression line could be considered a myostatic setpoint. RT-induced increases in muscle volume tend to be inversely related to initial bone-scaled muscle volume in previously untrained males and females, supporting the myostat theory. This model could be used to predict normative muscle volume and RT effects based on bone volume, potentially defining upper and lower limits of muscle volume.

**NO PERFECT FIT: EVALUATING THE ACCURACY OF RMR PREDICTION EQUATIONS IN MASTERS ENDURANCE ATHLETES**

DEVRIM LANPIR, A., DEVENNEY, S., EGAN, B.

*DUBLIN CITY UNIVERSITY*

INTRODUCTION: Accurate RMR assessment is crucial for evaluating energy balance in masters endurance athletes, who experience age-related metabolic changes (1). While indirect calorimetry is the gold standard, its limited practicality makes predictive equations a common alternative (2). This study evaluates the validity of existing RMR equations and develops a new regression model tailored for masters endurance athletes.

METHODS: One hundred masters endurance athletes (70 males; 46.2 ± 7.1 years (40–65), 30 females; 48.5 ± 8.3 years (40–72)) underwent RMR assessment via indirect calorimetry. The accuracy of nine commonly used RMR prediction equations was evaluated using mean bias, limits of agreement, intraclass correlation coefficients (ICC), and root mean square error (RMSE). Additionally, a multiple regression model incorporating fat-free mass (FFM), age, and sex was developed to enhance predictive accuracy.

RESULTS: Among male athletes, the De Lorenzo (3) and Cunningham (1991) (4) equations demonstrated the highest accuracy, with ICC values of 0.557 and 0.607, respectively. In females, Cunningham (1991) showed the best predictive performance (ICC = 0.557), but substantial under- and overpredictions were observed across equations. Regression analysis identified FFM as the strongest predictor of RMR, explaining 63% of the variance. The newly developed regression model, which included FFM, age, and sex as predictors, demonstrated improved predictive power, explaining 74% of the variance in measured RMR ($R^2$ = 0.74). The model exhibited moderate agreement with measured RMR (ICC = 0.531 for males, 0.612 for females), with lower RMSE values (184 kcal/day for males, 168 kcal/day for females) compared to commonly used equations. However, it still displayed wide limits of agreement, suggesting variability in individual predictions.

CONCLUSION: No single predictive equation demonstrated consistently high accuracy in masters endurance athletes. While Cunningham (1991) and De Lorenzo provided moderate agreement with measured RMR, their errors remain significant for individual assessments. The newly developed regression model outperformed existing equations in predictive accuracy but requires further refinement to improve individual-level precision. Future research may integrate additional physiological parameters, such as somatotype and metabolic adaptations, to enhance RMR estimation in endurance athletes.

## Invited Symposium

### IS-BM01 Neuromotor stability control and inter-task generalisation in irregular human gait

**STABILITY REGULATION MECHANISMS OF THE WHOLE-BODY DURING GAIT ON UNEVEN GROUND**

NIKOLAIDOU, M.

*NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS*

Leg posture and muscle activation patterns are important mechanisms that control two important measures of stability, namely margin of stability (MoS) and whole-body angular momentum, for maintaining dynamic balance during stable and unstable locomotion (1,2). Leg posture adjustments and muscle activation influence the base of support and the moment arm from the centre of mass (CoM) to the ground reaction force (GRF) vector, affecting stance phase dynamics. Experience-based and visually guided anticipatory adjustments in leg posture and activation patterns provide the opportunity to proactively plan movement initiation and modify subsequent responses, facilitating robust and stable gait on uneven ground. Therefore, understanding the neuromuscular and biomechanical mechanisms that control the translational and rotational behaviour of the whole-body during movement on uneven ground will provide important knowledge for effec-

tive stability control and fall prevention. During hole negotiation, we found a decrease in MoS and an increase in the peak-to-peak range of the whole-body angular momentum compared to level walking, especially in the frontal plane, indicating an increased challenge to body stability. As a result, the rate of the angular momentum, which is similar to the external moment of the GRF around the CoM, was increased during the negotiation of the hole predicting a higher demand in the muscles of the ipsilateral leg to control body stability. On the other hand, the decrease in the medio-lateral moment arm of the GRF at touchdown indicated an anticipatory foot displacement strategy to control the angular momentum towards the contralateral leg. Furthermore, the muscle activation patterns and the resulting kinematics of the contralateral leg before touchdown also showed proactive adjustments to regulate the kinetic CoM energy and to reduce the contribution of gravity to the angular momentum rate. Nevertheless, the high activation of the soleus, gastrocnemii and vastii muscles of the ipsilateral leg required to manage the total CoM energy during hole negotiation dominated the aforementioned anticipatory adaptations and resulted in the increased range and rate of angular momentum. We argue that the high activation of the plantar flexors and knee extensors during the stance phase in the hole suggests that the regulation of total CoM energy at the expense of an increase in whole-body angular momentum is a reasonable trade-off in the regulatory stability mechanisms, and demonstrates the challenge of moving on uneven ground. The presentation will address (i) the translational and rotational behaviour of the whole-body, (ii) the functional diversity in activation between the ipsilateral and contralateral leg muscles and (iii) how humans regulate MoS and whole-body angular momentum to maintain stability during hole negotiation. REFERENCES: 1) Hof et al. 2010, J Exp Biol 213, 2655-2664 2) Neptune and Vistamehr 2019, J Biomech Eng 141, 0708011–07080

**GENERALIZABILITY OF BALANCE RECOVERY RESPONSE ADAPTATIONS FROM MECHANICAL- AND VIRTUAL-BASED GAIT PERTURBATION EXERCISES**

KARAMANIDIS, K.

*LONDON SOUTH BANK UNIVERSITY*

Human bipedal locomotion faces various perturbations to stability that require neuromotor adjustments and adaptations to maintain postural integrity and avoid falls. Previous research suggests that the central nervous system monitors and corrects motor responses by predicting sensory consequences of perturbations (1). However, these predictions must accurately reflect the nature of the perturbation, and hence, motor control is continuously refined based on error-feedback information. This ability of the neuromotor system to adapt suggests that enhanced balance recovery responses developed through exposure to specific perturbations may improve coping with altered forms of the exercised task (2). Understanding the factors that enable the neuromotor system to improve and transfer balance recovery mechanisms across diverse perturbation tasks and environmental conditions is essential for enhancing fall resilience in both healthy and pathological conditions. Using unpredictable mechanical-based perturbations during walking, our recent findings support the hypothesis that the neuromotor system can facilitate improved reactive balance responses by enhancing neuromuscular coordination, along with retaining balance improvements over several years, potentially reducing fall risk. Acquiring and retaining fall-resistance skills appear to rely more on neural rather than muscle-tendon capacities, emphasizing the neural system's critical role in maintaining stability under challenging conditions. In addition to perturbations in physical environments, visual-based gait perturbations in virtual environments stimulate motor skill learning that can be retained for several weeks. Our data further indicate that the neuromotor system can partly transfer those balance recovery adaptations from virtual to physical environments. However, the generalizability and transfer of stability recovery mechanisms from one task to another and from the virtual to physical environments seem to depend on perturbation direction and the degree of similarity in neuromuscular control patterns between tasks. Furthermore, balance recovery performance of an individual affects the responsiveness to perturbation exercises and therefore task demand should be considered when accessing transfer potential, particularly for studies on populations with varying locomotor capacities. The current presentation will focus on our recent findings about (i) how gait stability and adaptability during unpredictable mechanical-based gait perturbations are affected by age, and (ii) whether transfer of enhanced stability recovery responses to novel perturbation tasks is impacted by neuromuscular function, and (iii) whether visual-based gait perturbation exercises in a virtual environment benefit dynamic stability in physically challenging environments. References 1. Shadmehr 2017, J. Neurosci.37, 1663-1671 2. Harper et al. 2021, Brain Sci. 11, 402

**ACTIVATION PATTERNS AND BIARTICULAR MECHANISMS OF POWER SHARING BETWEEN THE SYNERGISTIC MUSCLES OF THE TRICEPS SURAE DURING HUMAN GAIT PERTURBATIONS**

ARAMPATZIS, A.

*HUMBOLDT-UNIVERSITY BERLIN*

There is evidence for a critical role of the ankle joint in human locomotion and indications for muscle-specific functional relevance of the plantar flexors during perturbations (1). The soleus (Sol), gastrocnemius medialis (GM) and gastrocnemius lateralis (GL) form the triceps surae muscle and operate together as ankle extensors to generate moments and perform power at the ankle joint. Although the three muscles work synergistically, they have important differences in function, geometry and size. The Sol, as monoarticular muscle, acts around the ankle joint, while the GM and GL are biarticular and act across the ankle and knee joints. The biarticular gastrocnemii may transfer power and energy between the two joints (2) increasing intrinsic stability by reducing the effort required for neural control. Recently, we found a significant increase in the energy transfer potential between the ankle and knee joint via the biarticular gastrocnemii in both trip-like (1.6-fold) and drop-like (2.5-fold) perturbations compared to unperturbed walking. This modulation was consistent during the un-

predictable and adapted walking perturbations and was accompanied by a high activation of the gastrocnemii, indicating a crucial involvement of biarticular mechanisms to counteract locomotor disturbances. Subsequently, Achilles tendon (AT) force and AT elastic energy storage and recoil were quantified during drop-like perturbations. Based on the AT force as a proxy for triceps surae muscle force, the generated moment and the performed power and work of the monoarticular Sol at the ankle joint and the biarticular gastrocnemii at the ankle and knee joints were calculated. We found that the biarticular mechanisms of the gastrocnemii significantly affect the mechanical power and work through an ankle-to-knee joint in the first part and a knee-to-ankle joint energy transfer in the second part of the stance phase after the perturbations. The transfer of energy from the ankle to the knee joint via the biarticular gastrocnemii provides evidence of an important contribution of biarticular mechanisms to the absorption of body energy during unpredictable trials, where beneficial mechanisms to control stability modulated by prediction are not available. The presentation will focus on (i) the consequences of unpredictable and predictable gait perturbations on the translational and rotational behaviour of the whole-body, (ii) the functional diversity of activation and power sharing between the synergistic Sol, GM and GL muscles with a special focus on biarticular mechanisms to control gait stability, and (iii) how improvements in gait stability through prior experience and motor learning are related to the interplay between activation and biarticular mechanisms for power and energy transfer between the ankle and knee joints. REFERENCES: 1) Dick et al. 2021, Proc Biol Sci, 31, 288(1947):20210201 2) van Ingen Schenau 1989, Hum Mov Sci 8, 301-337

## Invited Symposium

### IS-MH01 REDs Prevention: Navigating Barriers and Harnessing Opportunities

**NAVIGATING BODY COMPOSITION AND WEIGHT ISSUES IN REDS MANAGEMENT**

MELIN, A.
*SPORTS SCIENCE*

A higher power-to-weight ratio can enhance performance outcomes across various sports disciplines and is typically achieved through modifications in body composition, such as increased lean mass and/or reduced fat mass Additionally, there is a widespread belief within the sports community that reduced body weight or maintaining a low body weight contributes to improved athletic performance. However, an excessive focus on maintaining a low body weight and specific body composition for performance, coupled with frequent anthropometric assessments, can lead to body dissatisfaction, body image disturbances, and disordered eating and training behaviors. These behaviors can result in problematic low energy availability (LEA) and Relative Energy Deficiency in Sport (REDs). Moreover, the fear of undesired weight gain may deter athletes experiencing REDs symptoms from optimizing their energy availability. This presentation will address strategies for managing body composition and weight issues within the sporting environment to prevent REDs and eating disorders.

**TRANSLATING REDS BIOMARKERS: ENHANCING PRACTITIONER UNDERSTANDING AND INTERPRETATION**

HACKNEY, A.
*UNIVERSITY OF NORTH CAROLINA*

The 2023 IOC Consensus statement on REDs presented a revision of the clinical assessment tool (CAT) to appraise the severity/risk of REDs syndrome development. The new tool is referred to as the 'REDs CAT2' which utilizes a number of primary and secondary indicators (biomarkers) to assess athlete severity and risk status using a stoplight model – green = none, yellow = mild, orange = moderate to high, red = very high/extreme (i.e., with multiple levels of biomarkers used for classification). These biomarkers are essential for secondary prevention strategies. However, assessing and interpreting the various biomarkers can be challenging for the practitioner as many of these markers require research or clinical backgrounds to understand fully. To that end, this presentation will: 1) provide an overview of what are the biomarkers utilized in the REDs CAT2, 2) discuss the importance of standardized methodology for measuring the biomarkers, and 3) explain translationally what changes in such biomarkers mean or denote for the athlete relative to performance and health. The overarching theme herein will be to focus on discussing these topics in a clear and useful approach for the practitioners.

**THE MIND AND REDS. OVERCOMING PSYCHOLOGICAL HURDLES IN PREVENTION**

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Although the physical harm caused by problematic low energy availability (LEA) in athletes has been extensively researched and documented, the psychological risk factors and the subsequent consequences related to psychological problems and psychological health are less understood. In order to prevent REDs, it is crucial to understand the different attitudes, habits, and behaviours associated with problematic LEA, and whether they are intentional or unintentional. The psychological indicators associated with problematic LEA and REDs include cognitive dietary restraint, perfectionistic tendencies, drive for thinness, mood disturbances, and reduced sleep quality. Other adverse psychological health outcomes associated with problematic LEA and REDs are affective disorders, depressive symptoms, reduced well-being,

anxiety related to injury and/or recovery, exercise dependence or addiction, and sport-specific issues such as coping with weight requirements and developing eating disorders. Moreover, under-fuelling may be driven by distorted thoughts, cognitive restraint, perfectionism, disordered body image, body dysmorphia, unregulated emotions, compulsive drive for thinness, and/or compulsive exercise. Thus, it is of utmost importance to increase our understanding of these psychological factors in order to prevent and manage athletes with problematic LEA and REDs. This presentation will therefore focus on 1) How to reduce psychological risk factors and improve psychological protective factors in order to prevent REDs from developing (primary prevention), 2) How to early identify symptoms of psychological problems related to REDs and prevent them from evolving to more serious psychological health problems (secondary prevention), and 3) How to manage athletes with more severe psychological health problems related to REDs (tertiary prevention).

## Invited Symposium

### IS-EX01 CSSS-ECSS Exchange Symposium – Technology support in Football youth performance progression in the Millennium Era

**FROM THE PAST TO THE MILLENNIUM ERA - REFINED INNOVATION PROCESS OF THE PERFORMANCE EVALUATION OF FOOTBALL YOUTH TRAINING**

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The football youth training system has undergone profound changes from being extensive to refined, and this has been especially notable in aspects like physical fitness, technical and tactical skills, and the evaluation of comprehensive sports performance. In the past, football youth training was still in its initial stage. Physical training mainly encompassed simple running and strength training, while technical and tactical skills depended on the traditional method of being passed down from masters to apprentices. After entering the 20th century, more scientific physical training methods started to be incorporated into football youth training as the sports science developed. For instance, interval training, strength training, and aerobic training were integrated organically, and technical and tactical training also gradually became systematic, emphasizing team cooperation and tactical implementation. By the Millennium Era, the evaluation of physical fitness, technical and tactical skills, and comprehensive sports performance in football youth training had reached a climax of refined innovation, and there are also a growing number of relevant research papers. Physical training emphasizes analyzing the physical characteristics of different ages and on-field positions. Scientific and reasonable training plans are designed by combining these physical characteristics with athletes' physiological features and competition requirements. High-tech means such as big data analysis and video analysis also increase their investment in football youth training. Consequently, precisely evaluating and adjusting footballers' technical movements and competition performance has gradually become a hot research topic. This refined training innovation process has not only enhanced the sports performance of young footballers but also energized the development of the global football youth training system. For example, it has cultivated many young talents such as Kylian Mbappé, Jude Bellingham, and Lamine Yamal. In the future, as technology and training theories continuously progress, the evaluation of physical fitness, technical and tactical skills, and comprehensive sports performance in football youth training will be further deepened, contributing more wisdom and strength to the prosperous development of the global football industry.

**DATA-INFORMED DIAGNOSTIC AND TRAINING PROCEDURES OF YOUTH FOOTBALL PLAYERS IN THE MILLENIUM ERA**

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In the Millennium Era, different technologies which promise to support coaches regarding personalization of training procedures with the aim to enhance performance and/or reduce the likelihood of injuries in football youth training are increasingly available. Technological developments can be rapid, and among the most currently discussed technologies are wearable technologies and forms of Artificial Intelligence (AI). While it can be argued that technologies provide benefits to coaches and (youth) football players, not all available technologies are equally beneficial. Stakeholders must cautiously evaluate if, when, and how to employ different technologies (and by whom), in order to select and deploy them effectively to achieve desired, and avoid undesired outcomes. In this presentation, an overview of various technologies and their applications in sports, with a particular focus on youth football players, including selected examples of how wearable technologies and forms of AI can inform diagnostics and training procedures will be given. For example, the talk will focus on using wearable technologies in diagnostic procedures for youth football players, specifically comparing the assessment of VO2max with smartwatches or portable seismographic devices to established methodologies. Additionally, this talk will provide an example of how machine learning can be employed to reveal relationships between internal and external load parameters and its potential for planning of training procedures. The contribution will conclude by highlighting key factors needed to enhance the development and implementation of scientifically trustworthy technologies, partly derived from a global survey, for youth football players and stimulate future (interdisciplinary) ideas for research in this field.

Oral **P**resentations

GSSI

**DOES DEHYDRATION IMPAIR EXOGENOUS CARBOHYDRATE OXIDATION DURING PROLONGED RUNNING IN A HOT ENVIRONMENT?**

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INTRODUCTION: Exogenous carbohydrate oxidation (i.e., from drinks) is reduced in hot conditions (1,2). Increased thermal and cardiovascular strain and reduced gastrointestinal (GI) integrity (3) may impair glucose uptake and transport, gastric emptying, and intestinal absorption. However, dehydration, often resulting from heat exposure, may also contribute to these impairments by reducing blood volume and altering blood flow distribution. As previous studies in hot conditions have not controlled hydration status, the impact of dehydration on reduced exogenous carbohydrate oxidation is unclear. Therefore, this study aimed to investigate the effect of hydration status on exogenous carbohydrate oxidation during running in a hot environment.

METHODS: Ten trained male runners (21 ± 2 y; 68.9 ± 7.6 kg; VO2peak: 67 ± 6 mL/kg/min) completed a preliminary session (VO2peak and sweat rate testing) and two experimental trials [100 min of steady state running at ~65% VO2peak in hot conditions (32°C) with hydration (water intake to replace 90% of mass losses; HYD) or to induce dehydration (minimal fluid provided; DEH)]. In each trial, participants consumed 60 g/h (bolus every 20 min) of a 35% dextrose solution enriched with [U-13C] glucose (145 ± 2 δ‰ enrichment). Expired breath (analysed for 13C:12C ratio using GC-IRMS), venous blood samples and subjective scales of GI comfort were collected at rest and every 20 min during exercise. Data were analysed using linear mixed models with significance at $P < 0.05$. Results presented as mean ± SD.

RESULTS: Average (40-100 min) and peak exogenous carbohydrate oxidation rates were 29% (DEH: 0.35 ± 0.15 vs. HYD: 0.50 ± 0.13 g/min; $P = 0.016$) and 24% (DEH: 0.54 ± 0.19 vs. HYD: 0.71 ± 0.13 g/min; $P = 0.017$) lower in DEH than HYD, respectively. Total (DEH: 2.52 ± 0.47 vs. HYD: 2.56 ± 0.26 g/min; $P = 0.737$) and endogenous carbohydrate oxidation (DEH: 2.17 ± 0.36 vs. HYD: 2.06 ± 0.30 g/min; $P = 0.188$) were not different between trials. GI temperature (DEH: 39.4 ± 0.5°C; HYD: 39.2 ± 0.4°C; $P = 0.380$) and heart rate (DEH: 173 ± 11 bpm; HYD: 169 ± 12 bpm; $P = 0.124$) at the end of trials were not different between conditions. Body mass loss (-2.7 ± 0.5% vs. -0.4 ± 0.5%; $P < 0.001$) and changes in plasma volume from baseline (-9.3 ± 4.1% vs.-2.5 ± 5.1%; $P < 0.001$) were greater in DEH. No differences in GI symptoms, including stomach bloatedness, were observed between conditions ($P > 0.05$).

CONCLUSION: Prolonged exercise in the heat, with minimal fluid intake leading to dehydration, impaired exogenous carbohydrate oxidation. These findings underscore the importance of hydration and fluid delivery for optimising exogenous carbohydrate utilisation, particularly for athletes aiming to sustain endurance performance in hot conditions.

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**CO-INGESTING WHEY PROTEIN WITH DUAL SOURCE CARBOHYDRATE ENHANCES AMINO ACID AVAILABILITY WITHOUT COMPROMISING POST-EXERCISE LIVER GLYCOGEN RESYNTHESIS**

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INTRODUCTION: Carbohydrates (CHO) are crucial for prolonged moderate- to high-intensity exercise, although storage within the liver and skeletal muscle is relatively limited. The development of practical strategies to optimize glycogen resynthesis with athletes is thereby essential for enhancing recovery and performance. In addition to CHO, protein consumption during recovery supports muscle protein synthesis and enhances muscle glycogen storage, particularly when carbohydrate intake is suboptimal. While protein may aid liver glycogen repletion by promoting hepatic glucose storage and providing glucogenic amino acids, protein stimulates glucagon secretion - potentially impairing liver glycogen synthesis. Therefore, the present study examined the effects of co-ingesting whey protein with dual source carbohydrates on post-exercise liver and muscle glycogen resynthesis.

METHODS: Following glycogen-depleting exercise, ten well-trained male cyclists (mean ± SD: age 29 ± 7 years; body mass 78.5 ± 6.4 kg; stature 181.9 ± 4.7 cm; VO2max 57.5 ± 5.8 ml·kg−1·min−1) ingested 60 g.h-1 CHO from either maltodextrin (MAL), fructose (FRU), maltodextrin + fructose (MF) or maltodextrin + fructose plus 30 g whey protein (PRO) at 0 and 180 min during a 5-h recovery period. 13C magnetic resonance spectroscopy and imaging were performed at 0-, 120- and 300-min post-exercise to determine liver and muscle glycogen concentrations and liver volume.

RESULTS: Protein co-ingestion resulted in elevated serum insulin and plasma glucagon compared with FRU and MF ($P <$ 0.001 for all). Similarly, serum insulin and plasma glucagon concentrations were markedly higher with MAL when compared with both FRU and MF ($P < 0.05$ for all), although plasma glucagon concentrations were also higher when com-

pared with PRO (P < 0.001). Liver glycogen concentrations were significantly higher with FRU (276 ± 70 mmol·L-1), MF (257 ± 65 mmol·L-1) and PRO (285 ± 49 mmol·L-1) compared with MAL (198 ± 41 mmol·L-1) (P < 0.05 for all) following 5 hours of recovery. However, muscle glycogen concentrations (MAL, 166 ± 39; FRU, 145 ± 51; MF, 153 ± 39; PRO 154 ± 36, mmol·L-1) were not different between trials (P > 0.05).

CONCLUSION: In summary, ingesting dual-source carbohydrates enhances liver glycogen repletion whilst maintaining comparable rates of muscle glycogen resynthesis when compared to maltodextrin only. Notably, despite enhancing glucagonemia, co-ingestion of whey protein (with a 1:1 combination of maltodextrin and fructose) does not compromise post-exercise liver glycogen resynthesis, allowing for increased aminoacidemia alongside rapid glycogen resynthesis. Considering the importance of post-exercise protein intake for muscle reconditioning and the dietary habits of elite endurance athletes, our findings suggest that combining dual-source carbohydrates (a 1:1 ratio of maltodextrin and fructose) with whey protein offers a practical strategy to optimize both amino acid availability and endogenous glycogen resynthesis.

**THE IMPACT OF SEX, MENSTRUAL PHASE, AND ORAL CONTRACEPTIVE USE ON THE ANABOLIC SENSITIVITY TO DIETARY LEUCINE AT REST AND AFTER RESISTANCE EXERCISE**

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INTRODUCTION: Dietary amino acids (AA), such as the essential AA leucine (Leu), are used for building new body proteins (i.e. protein synthesis) or as a source of energy (i.e., oxidation). Our laboratory has developed an oral [13C]Leu 'breath-test' that measures the leucine retention (Leu Ret) for protein synthesis as a marker of the body's 'anabolic sensitivity' to dietary AAs. However, the effect of biological sex (i.e., males vs. females) or female hormonal milieu (i.e., naturally cycling eumenorrheic females vs. oral contraceptive (OC) use) on whole-body dietary Leu Ret at rest and following resistance exercise (RE) remains unknown. Thus, the purpose of the study was to determine Leu Ret (i.e., 'anabolic sensitivity') in equal groups of n=8 males (26.4±4.8 y, 78.3±7.7 kg body mass (BM), 13.8±5.9% body fat (BF)), eumenorrheic females in the follicular (21.4±3.1 y, 65.1± 0.5 kg BM, 26.4 ± 6.9% BF) and luteal (24.4 ± 4.3 y, 64.7 ± 10.2 kg BM, 28.2±5.1% BF) phases and monophasic OC users (23.3 ± 2.4 y, 59.3±10.0 kg BM, 24.9±4.9% BF) during the active pill phase (days 10-21) upon consuming a [13C]Leu-enriched beverage at rest (FED) and after a bout of full-body RE (EXFED).

METHODS: Using a counterbalanced, crossover design, participants ingested a mixed macronutrient beverage containing carbohydrate and crystalline AAs (0.75 and 0.25 g/kg BM, respectively) in both FED and EXFED, enriched to ~5% with [13C]Leu, which is preferentially metabolized in peripheral (e.g. muscle) lean tissues. The oxidation of ingested Leu (Exo Ox) was assessed using 13CO2 enrichment (via isotope ratio mass spectrometry) and CO2 production (via indirect calorimetry) over 6 h. Leu Ret relative to fat-free mass (FFM) was determined by the algebraic difference between total Leu intake and the area-under-the-curve for Exo Ox.

RESULTS: Over the 6 h post-prandial period, Leu Ret at rest was greater ($p<0.01$) in males (16.27 mg/kg FFM) compared to females in the follicular (12.70 mg/kg FFM) but not luteal (14.39 mg/kg FFM) phase or active pill OC users (14.08 mg/kg FFM), with no further group differences ($p\geq0.05$). Although Leu Ret after exercise was ~11.2% greater in males than females in the follicular phase, there were no significant differences between groups ($F(3, 28)= 2.65$, $p= 0.07$, $f2= 0.39$).

CONCLUSION: The greater anabolic sensitivity to dietary leucine in males compared to females during the follicular phase at rest is attenuated during recovery from RE. The impact of these differences in whole-body leucine retention on muscle protein metabolism and/or dietary protein requirements at rest or during recovery from RE warrants further investigation. This study is supported by a New Frontiers in Research Fund Grant to D.R.M.

**CO-INGESTION OF A KETONE ESTER SUPPRESSES EXOGENOUS CARBOHYDRATE OXIDATION IN MALE CYCLISTS WHEN FEEDING 120 G.H-1 CARBOHYDRATE COMPARED WITH CARBOHYDRATE ALONE.**

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INTRODUCTION: Ketone esters are purported to improve endurance exercise performance via alterations in substrate metabolism, including a sparing of muscle glycogen (1). However, recent evidence suggests ketone ester ingestion could alter glucose metabolism, which in turn could impair exercise performance (2). Such studies have not been completed under conditions of best nutritional practice, including CHO loading, pre-exercise feeding and high rates of CHO ingestion during exercise. In this regard, it is unclear whether ketone esters are ergogenic to performance when consumed with optimal CHO. Accordingly, we aimed to test the hypothesis that co-ingestion of ketone esters during exercise suppresses exogenous CHO oxidation rates without affecting exercise capacity when compared to CHO alone.

METHODS: In a randomised, crossover design seven male trained cyclists (VO2max 64.6 ± 6.1 ml.kg-1.min-1) completed four 180-min cycling experimental trials at 95% of lactate threshold (LT) followed by an exercise capacity test to exhaustion at 150% LT. Each trial was commenced following 36 h of high CHO loading (11.6 g.kg-1) and 2 h after a high CHO breakfast (2 g.kg-1). Participants consumed 0 g.h-1 during a familiarisation trial (FAM), 0 g.h-1 (PLA), 120 g.h-1 CHO (CHO) or 120 g.h-1 CHO co-ingested with 75 g of ketone monoester (CHO + KE) ((R)-3-hydroxybutyl (R)-3-hydroxybutyrate) delivered in 3 boluses (25 g) at -60, 0 and 90 min during the protocol. Carbohydrate (exogenous and whole body) and lipid oxidation, subjective GI symptoms, blood lactate, glucose and ß-hydroxybutyrate (ßHB) were measured throughout exercise.

RESULTS: KE ingestion increased blood ßHB to a peak concentration of 2.8 ± 0.8 mM at 30 min during exercise and mean concentrations were higher following KE ingestion vs CHO and PLA (both P = 0.002). There was no difference in mean whole body CHO oxidation rates between CHO + KE and CHO (2.40 ± 0.11, 2.31 ± 0.13 g.min-1, P > 0.99). However, whole body CHO oxidation rates in PLA (1.78 ± 0.12 g.min-1) were lower than CHO + KE (P = 0.008) and CHO (P = 0.013). Mean rates of exogenous CHO oxidation were significantly reduced during exercise in CHO + KE vs CHO alone (1.37 ± 0.05, 1.51 ± 0.05 g.min-1, P = 0.029) (assessed via stable isotope methodology). Exercise capacity was not increased by CHO + KE compared with CHO (334 ± 239, 365 ± 198 s, P = 0.986), though both trials (CHO + KE vs FAM, P = 0.034, CHO + KE vs PLA, P = 0.053, CHO vs FAM, P = 0.016, CHO vs PLA, P = 0.025) resulted in greater exercise capacity than PLA (85 ± 109 s) and FAM (67 ± 89 s).

CONCLUSION: Data demonstrate that ketone ester and CHO co-ingestion suppresses exogenous CHO oxidation during exercise and does not enhance exercise capacity when compared to CHO ingestion alone. Such data provide further evidence that ketone esters are unlikely ergogenic for exercise performance.

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**INGESTION OF A VARIETY OF PROTEIN-RICH WHOLE-FOODS RESULTS IN SIMILAR POST-EXERCISE WHOLE-BODY AND MYOFIBRILLAR PROTEIN SYNTHESIS RATES COMPARED WITH A PROTEIN ISOLATED FROM WHOLE-FOOD IN YOUNG ADULTS**

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INTRODUCTION: The ingestion of protein-rich whole-foods may stimulate (post-exercise) whole-body (WB) and myofibrillar protein synthesis (MyoPS) rates to a greater extent than protein isolated from whole-foods. However, to date, few (mostly animal-derived) foods have been investigated with regard to their potential to augment post-exercise anabolism. We assessed WB phenylalanine kinetics (to calculate indices of WB protein turnover) and MyoPS rates following a single bout of resistance exercise and ingestion of a variety of protein-rich whole-foods (from animal and non-animal derived sources) and egg whites (protein isolated from whole-food) in resistance trained young adults.

METHODS: In a randomised parallel design, sixty-five healthy young males and females received primed, continuous infusions of L-[ring-2H5]phenylalanine and L-[3,3–2H2]tyrosine and completed a bout of bilateral lower body resistance exercise before ingesting 0.25g protein per kg body mass[bm] from: egg whites (n=11; 7f, age 22±2 y, bm 77.4±4.7 kg), whole egg (n=11; 7f, age 24±2 y, bm 77.0±2.7 kg), salmon (n=10; 6f, age 24±2 y, bm 75.2±3.8 kg), pork (n=11; 7f, age 24±2 y, bm 74.7±3.6 kg) lentils (n=11; 7f, age 26±2 y, bm 77.9±3.0 kg) or mycoprotein (n=11; 7f, age 24±2 y, bm 77.4±3.5 kg). Blood and muscle samples (vastus lateralis) were taken pre- and (2 and 5 h) post-exercise/protein ingestion to assess postabsorptive and postprandial WB phenylalanine kinetics and MyoPS rates (as fractional synthetic rates; FSRs). Calculated WB protein metabolism parameters and FSRs were analysed using 2-way (condition x time) ANOVAs.

RESULTS: WB protein synthesis and breakdown rates increased and decreased, respectively, post-exercise/food ingestion in all conditions, with both effects being most pronounced following egg white ingestion. This resulted in the shift from postabsorptive negative to post-exercise postprandial positive WB net protein balance being most pronounced following egg white ingestion (postprandial net balance [0-5h]; egg whites, 256.6±15.4 vs; whole egg, 161.0±6.1; pork, 166.8±7.2; salmon, 195.4±7.1; lentils, 175.8±8.1; mycoprotein, 189.7±8.4µmol·kg-1·min-1 [P<0.0001, all]). FSRs increased following exercise/food ingestion with no (temporal) differences between conditions despite divergent plasma amino acid responses (Δ change in FSRs [0-5 h]; egg whites, 0.050±0.013; whole egg, 0.051±0.009; pork, 0.008±0.008; salmon, 0.021±0.014; lentils, 0.029±0.012; mycoprotein, 0.041±0.012%·h-1 [P=0.077]).

CONCLUSION: The ingestion of a variety of protein-rich whole-foods or a protein isolated from whole-foods (egg whites) immediately following lower body exercise results in comparable MyoPS rates, though a greater WB net protein anabolism was achieved with egg whites. These data demonstrate that a variety of commonly consumed protein-rich foods from different origins may be selected to support acute post-exercise reconditioning, though a potentiation due to consuming protein within its whole-food form does not necessarily occur.

## Oral Presentations

### OP-AP01 Cycling I

**RELAXATION TECHNIQUES TO IMPROVE SLEEP AND TIME-TO-EXHAUSTION TASK: PRELIMINARY FINDINGS**

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INTRODUCTION: Relaxation techniques have been shown to improve both sleep quality and quantity, potentially playing a critical role in increasing the individual coping ability when facing high stressor (1). However, their role in performance improvement is understudied, especially in the endurance context. Thus, the aim of this study is to determine whether relaxation techniques may improve a cycle-ergometer time-to-exhaustion task. Moreover, we explored the effects of two

relaxation techniques with different mechanisms: Yoga Nidra (YN), a guided relaxation technique that induces a hypnagogic state blending deep rest with conscious awareness (1), and Body Scan (BS), a progressive muscle relaxation (PMR) technique that enhances bodily awareness while reducing muscular tension (2). Their influence on both performance and sleep parameters were assessed.

METHODS: Thirty-six participants performed four cycling sessions until exhaustion on a cycle-ergometer. The first two sessions aimed to determine the heart rate deflection point to ensure a comparable load across participants, while the third and fourth sessions worked as baseline (T0) and post-intervention (T1) tests, respectively. Participants were randomly assigned to either a relaxation technique group (YN; BS) or a Control (C) group. In each case, they underwent five days of their respective intervention between T0 and T1. From the second session onward, sleep was monitored using actigraphy-based monitoring for a total of 10 - 12 nights, depending on weekend presence.

RESULTS: First, we analyzed performance outcomes in the TTE test through a within-between-subjects RM-ANOVA to compare the time to complete the task associated with groups. The analysis showed improvements for both YN and BS groups when compared to the C group with a small effect ($F = 1.07$, $n^2 = 0.04$): YN: T0=15,2±1,5min; T1=16,3±1,7min. BS: T0=14,9±1,4min; T1=16,5±1,5min. C: T0=17±1,3min; T1=15±1,3min.

A RM MANOVA was performed for sleep variables and significant differences for groups were noted ($p=0.04$). Particularly, differences in the number of awakenings were found per group ($F=3.48$, $p=0.03$, $n2=0.02$) and time ($F=4.90$, $p=0.02$; $n2=0.02$): YN: T0=16±4; T1=14±4. BS: T0=17±6; T1=16±5. C: T0=16±5; T1=16±5.

Moreover, a trend was found in the interaction group*time for sleep latency ($F=2.41$; $p=0.09$; $\eta2=0.01$): YN: T0=26±21min; T1=19±18min. BS: T0=15±15min; T1=20±19min. C: T0=18±19 min; T1=17±17min.

CONCLUSION: In this study, relaxation techniques seem to be a promising approach to improve sleep quality and endurance performance. Regarding the two adopted techniques, YN yielded the most positive sleep effects, decreasing both the time to fall asleep and the number of awakenings after sleep onset, two crucial indicators for sleep quality.

References

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2 di Fronso et al., 2024 (doi: 10.1016/j.heliyon.2024.e24180)

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**BEYOND CURVATURE 'CONSTANT': INTENSITY-DEPENDENT VARIATIONS IN WORK ABOVE CRITICAL POWER**

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INTRODUCTION: The Critical Power (CP) model describes the link between power and exercise duration and rests on two key assumptions: (i) the existence of a CP, representing the asymptote of the power-duration curve, and (ii) a fixed amount of work that can be performed above CP, referred to as the curvature constant (W). Previous research shows that test duration affects CP and W', with shorter trials yielding lower W'; however, it is unclear if this is due to the higher CP estimates or a true reduction in W'. Additionally, W exhibits a consistently large standard error of estimation, and its physiological significance remains unclear (1). Therefore we examine the difference between W and the actual work above CP (W>CP) at different intensities using different CP models and explore associations between W', W>CP, and well-established anaerobic markers.

METHODS: Nineteen cyclists completed a ramp test to determine the power at peak oxygen uptake (MAP). Then, they performed five trials to exhaustion (Tlim) at 130%, 115%, 100%, 85%, and 80% of MAP, and a Wingate test. Accumulated oxygen deficit (AOD) for each Tlim was calculated. CP and W, were computed by the 2- and 3-parameter hyperbolic models (2HYP and 3HYP), the Work-Time model (W-T), and the inverse-time model (1/T). Actual W>CP during all Tlim were calculated. Pearson correlations were conducted to evaluate associations among variables and repeated measures ANOVA followed by Bonferroni post-hoc procedures to detect significant differences among conditions. Significance was set at $P<.05$. All data are expressed as mean ± SD.

RESULTS: W derived from 2HYP and 3HYP were significantly higher than W>CP at 130, 115, and 100% MAP ($P<.01$). For both models, the W>CP was higher at 85 and 80% compared with 130 and 115% MAP ($P<.05$). W derived from W-T and 1/T were significantly higher than the actual W>CP at 80% MAP ($P<.05$). Notably, the W>CP predicted by W-T was lower at 130% and 115% MAP compared to 100% and 85% MAP ($P<.05$). A positive association was found between peak and mean power of the Wingate test, and the W>CP during Tlim at or above 100% MAP, regardless of the model used ($P<.05$). No significant correlations were observed between W (irrespective of the model) and maximal AOD. However, the W>CP during the 130% MAP trial was correlated with the corresponding AOD for all models ($P<.05$). Additionally, for the two hyperbolic models, this relationship also appeared for the W>CP at 115% MAP ($P<.05$).

CONCLUSION: Our findings highlight that W' may not be constant as previously assumed. Indeed, W>CP shows an intensity-dependent behaviour, with lower values for shorter efforts, increasing for longer efforts until reaching a plateau at intensities between CP and MAP. Furthermore, W shows weak correlations with AOD and Wingate test results, reinforcing that W alone cannot fully capture an athlete's anaerobic capacity.

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**THE INFLUENCE OF MENSTRUAL CYCLE AND ORAL CONTRACEPTIVES ON PSYCHOLOGICAL AND PHYSIOLOGICAL PARAMETERS AT REST AND DURING SUBMAXIMAL CYCLING**

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INTRODUCTION: Menstrual cycle (MC) and oral contraceptives (OC) create distinct hormonal environments. While MC phases are characterized by dynamic fluctuations of endogenous estrogen and progesterone, OC use suppresses these hormones, replacing them synthetically. Despite evidence suggesting phase-dependent variations in performance during the MC (1) and potential impairments under OC use due to hormonal suppression (2), findings remain inconsistent. To further address uncertainties, we conducted standardized testing across MC and OC cycles focusing on within-group changes and potential between group differences.

METHODS: Twenty-two eumenorrheic women (age: 30±5y, VO2peak: 43±6ml/min/kg) and six women using OC (age: 29±5y, VO2peak: 46±6ml/min/kg) performed standardized tests in specified phases (MC: early follicular (EFP), ovulatory (OP), midluteal phase (MLP); OC: early inactive pill (EIPP), late inactive pill (LIPP), mid active pill phase (MAPP)) for one (n=6), two (n=22) or three test cycles (n=1). Testing included the Short Recovery and Stress Scale (SRSS), assessment of heart rate measures (RR, HR, RMSSD, SDNN, DFAa1) at rest (pre- and post-exercise), and during a 15-minute submaximal incremental cycling test (SCT) with intensities set at 90% of first ventilatory threshold (VT) 1, 110% VT1, and 100% VT2. SCT included blood lactate concentration (BLC) testing and rating of perceived exertion (RPE). Linear mixed-effects models and Cohens d were used to analyze data for MC, while descriptive analyses and Cohens d were applied for OC due to the small sample size.

RESULTS: Pre-exercise SDNN showed MC effects (p=0.037), particularly between MLP with EFP (p=0.083, d=0.58) and OP (p=0.052, d=0.44). SRSS subscales emotional balance (EB; p=0.038) and emotional imbalance (EI; p=0.031) were significantly affected, notably between EFP and OP in MC (EB: 4.23 vs. 5.08, p=0.034, d=-0.55; EI: 3.66 vs. 2.70, p=0.039, d=0.57). In OC, all subscales except from EB, showed a substantial change between EIPP and LIPP or EIPP and MAPP (d>0.80). During SCT, most parameters were unaffected by MC and OC, except RPE, which showed significant MC effects (p<0.001) with moderate changes between EFP and OP for the first (11.9 vs. 11.3, p=0.024, d=0.59) and second intensity stage (15.1 vs. 14.6, p=0.073, d=0.50), and substantial changes for OC between EIPP and LIPP for the first stage (11.0 vs. 10.4, d=1.55).

CONCLUSION: MC and OC phases had limited physiological but notable psychological effects . EFP (MC) and EIPP (OC) were associated with higher perceived stress and lower recovery. A closer examination of the SRSS subscales exhibited primarily emotional changes for MC, while OC showed substantial alterations in other facets like lack of activation or physical performance capacity. These findings emphasize the role of hormonal variability in psychological outcomes, even when physiological parameters remain largely unaffected.

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**SEX DIFFERENCES IN DURABILITY DURING CYCLING EXERCISE**

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INTRODUCTION: In cycling, a rider's capacity to maintain high power outputs (PO) after accumulating a certain amount of work represents a key determinant of elite performance [1]. Indeed, the most successful competitive male (M) road cyclists have shown lesser reductions in the power output profile that occurs as exercise proceeds, also called "durability" [2]. However, while females (F) are well reported to be more fatigue-resistant than M during various tasks [3], no research has compared durability between sexes. Therefore, this study aimed to investigate durability (measured as changes in submaximal and maximal markers of performance) and the underpinning physiological mechanisms in both sexes following 90 minutes of heavy intensity cycling.

METHODS: 32 cyclists (16M, age 29±6 years, VO2peak 58±6 ml.kg-1.min-1 and 16F, age 26±3 years, VO2peak 51±3 ml.kg-1.min-1) visited the laboratory on two occasions. In visit 1, participants performed an incremental exercise test to exhaustion. In visit 2, they performed 90 minutes of heavy intensity cycling (HVY) at 110% of gas exchange threshold (GET), followed by the same incremental test performed in visit 1. During HVY, pulmonary ventilation (VE), oxygen uptake (VO2), carbon dioxide production (VCO2), heart rate (HR), and rating of perceived exertion (RPE) were recorded, and blood lactate (bLa) was collected. Before (PRE) and immediately after (POST) HVY, maximal voluntary isometric contraction force (MVIC), voluntary activation (VA) and potentiated twitches (100Hz, 10Hz, Qtw) of the knee extensors were assessed.

RESULTS: Peak PO (M 410±56 vs F 269±34 W), PO at GET (M 226±42 vs F 135±20 W), and at respiratory compensation point (RCP, M 331±51 vs F 221±35 W) were higher in M vs F (all p<0.001). During HVY, VE, HR, gross efficiency and RPE increased over time (all p<0.001) without sex differences. Time × sex interactions were detected for HR (p=0.008) demonstrating greater increases in M, and RER (p<0.001) with greater decreases in F. A sex effect was found for bLa (p=0.029) and VO2 (%peak, p=0.012), which were greater in M compared to F. After HVY, PO at GET (M -16±15% vs F -3±12%) and at RCP (M -13±10% vs F -6±9%) decreased more in M than F (p=0.013 and p=0.048, respectively). Peak PO (M -13±9% and F -8±7%, p=0.073) and VO2peak (M -8±9% and F -6±6%, p=0.884) decreased similarly in both sexes. MVIC (-17±10%), po-

tentiated twitches at 100Hz (-15±13%), 10Hz (-34±15%), Qtw (-27±12%), and VA (-6±6%), decreased from PRE to POST (all $p<0.001$), without sex differences ($p\geq0.096$).

CONCLUSION: Females exhibited lesser reductions in submaximal thresholds, whereas data recorded at peak exercise decreased similarly in both sexes, and no sex differences were observed in the changes in neuromuscular function. These results highlight the need to consider sex-specific training prescription and pacing strategies for long duration events.

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**THE ACUTE RESPONSES TO REPEAT-SPRINT TRAINING IN HYPOXIA IN ELITE TRACK ENDURANCE CYCLISTS**

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INTRODUCTION: Repeat-sprint training in hypoxia (RSH) is increasingly used by elite athletes to improve repeat-sprint ability under normoxic conditions [1]. RSH involves performing a series of "all-out" sprints (3-10s) with brief recovery periods (<60s) [2] in a hypoxic environment (i.e., simulated altitude of ~3000m) [3]. However, the physiological responses to varying sprint durations, particularly in elite cyclists, remain unclear. This study aimed to determine how different RSH sprint durations affect acute physiological responses in elite track endurance cyclists.

METHODS: Nineteen elite track endurance cyclists completed a two-week RSH training block, incorporating four repeat-sprint sessions into their regular training and racing. RSH sessions were prescribed at simulated altitude of ~3000m (FiO2: 14.5%) in a normobaric hypoxic chamber using three protocols: RSH-6 (4 x 5 sprints, 6s sprint:24s rest), RSH-10 (3 x 5 sprints, 10s sprint:20s rest), and RSH-6/10 (4 x 5 sprints, sets 1 and 3 – 6s sprint:24s rest; sets 2 and 4 – 10s sprint:20s rest). Athletes performed all sprints seated, starting with a cadence of 40rpm for 6s sprints and 70rpm for 10s sprints, aiming to exceed 120rpm during all sprints. A fixed effects linear mixed model (LMM) was used to assess differences between sprint durations (6s vs 10s sprints) and protocols (RSH-6, RSH-10 and RSH-6/10).

RESULTS: Mean and peak sprint power output ($p=0.006$), mean and peak sprint torque ($p=0.001$) and vastus lateralis re-oxygenation between sprints ($p=0.001$) were greater in 6s sprints compared to 10s sprints. The 10s sprints resulted in higher work per sprint and peak cadence ($p=0.001$), larger decrements in mean power across a set ($p=0.001$), higher blood lactate accumulation with each set ($p=0.001$), and greater vastus lateralis de-oxygenation during sprints ($p=0.001$). Between session analyses demonstrated that RSH-6 had significantly higher mean and peak power outputs and torque outputs compared to RSH-10 ($p<0.001$) and RSH-6/10 ($p<0.001$). RSH-10 elicited higher heart rate and blood lactate accumulation across the session, along with lower vastus lateralis de-oxygenation during sprints compared to RSH-6 ($p=0.001$) and RSH-6/10 ($p=0.001$).

CONCLUSION: In elite cyclist undertaking RSH, 6s sprints durations elicited a stronger neuromuscular response (i.e. greater torque) while sets of 10s sprints resulted in larger decrements in power and torque, and higher blood lactate accumulation and oxygen extraction. Using 6s sprints or 10s sprints during RSH in elite track cyclists therefore could be used to target both neuromuscular and metabolic adaptations respectively.

## Oral Presentations

### OP-BM13 Sports Technology Marker less

**DEVELOPMENT AND APPLICATION OF ROTATIONAL SHOT PUT TECHNIQUE ANALYSIS SYSTEM**

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INTRODUCTION: The development of the rotational shot put technique analysis system aimed to enhance athletes performance through advanced artificial intelligence technologies. The system was designed to quickly capture and analyze biomechanical data of human motion, providing coaches and athletes with technical evaluations, thereby optimizing training effects.

METHODS: System Architecture and Key Technologies

The system primarily consists of two parts: the client and the server. Client includes a human-computer interaction module and a data acquisition and processing module, responsible for data input, display, and user interaction. Server includes a model invocation module and an offline training module, responsible for invoking deep learning models for pose estimation and data processing. Key technologies include a 3D human pose estimation algorithm, which utilizes an adaptive fusion method, combining epipolar expansion and triangulation techniques based on epipolar geometry constraints, improving adaptability to complex scenarios such as occlusion and enhancing pose estimation accuracy, a smoothing model, which improves the stability of pose sequences and reduces noise interference through smoothing processing,

and a heartbeat mechanism, ensuring smooth communication between the client and server, guaranteeing real-time and accurate data processing.

Specialized Action Technique Diagnosis

The system is specifically designed for the rotational shot put athletes, providing detailed technical evaluation. Users can input training or competition data to generate diagnostic reports containing speed, amplitude, angle, time, and et al. Reports offer detailed technical analysis and feedback, helping coaches and athletes identify technical shortcomings.

System Validation

To verify the accuracy and reliability of the system, we set up the rotational shot put technique analysis system alongside the qualisys motion capture system in an experimental setting. Six athletes performed three rotational shot put throws, with both systems capturing the entire motion and analyzing kinematic parameters. Bland-Altman plot and ICC analysis were used to assess the consistency and correlation of measuring results between the two systems, respectively.

RESULTS: Validation RESULTS: The Bland-Altman plot showed high consistency in measuring results between the two systems. ICC analysis indicated a high correlation between the two systems. These results demonstrate that the rotational shot put technique analysis system has high accuracy and reliability, providing precise technical analysis outcomes for athletes and coaches.

CONCLUSION: The rotational shot put technique analysis system is an accurate and reliable technical analysis tool, offering new methods and approaches for rotational shot put technique analysis. Through this system, coaches and athletes can conduct detailed technical evaluations and training optimizations, thereby improving athletic performance.

**THEIA 3D MARKERLESS VS. MARKER-BASED MOTION CAPTURE: COMPARING SHOULDER KINEMATICS IN OVERHEAD MOVEMENTS**

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INTRODUCTION: The analysis of shoulder kinematics during overhead movements can reveal important information for performance optimization and injury prevention in sports such as handball and tennis. Marker-based motion capture systems provide highly accurate joint angle measurements and are commonly used in sports science and clinical research. However, their use in field environments is limited due to long preparation and post-processing times. While markerless motion capture, like Theia 3D, presents a promising alternative, its accuracy for overhead shoulder kinematics remains unclear. Therefore, we aimed to compare shoulder kinematics during overhead movement tasks between Theia 3D and a marker-based motion capture system.

METHODS: Twenty participants performed overhead movements including full arm scaption, abduction and flexion while synchronized markerless (Theia 3D, v2023.1) and marker-based (Qualisys) motion capture data were collected. Reflective markers were placed on landmarks of the upper extremities and trunk according to the International Society of Biomechanics (ISB) guidelines [1]. For both approaches data were processed with a low-pass Butterworth filter at 6 Hz cut-off and shoulder kinematics were reconstructed using the X-Z-Y sequence for scaption and abduction tasks and the Z-X-Y sequence for flexion tasks [2]. Coefficients of multiple correlation (CMCs) and root mean square errors (RMSEs) were calculated for the kinematic waveforms for each angle and movement task.

RESULTS: In general, markerless and marker-based trajectories showed similar patterns for all movements, indicated by good to excellent CMCs (>0.75) for all angles and movement tasks. However, larger differences between systems were observed near the turning point of the movement, when the arms reached the maximum overhead position. Mean RMSEs were smallest for the abduction angle, ranging from 5.9° to 9.1°, followed by the flexion angle ranging from 8.7° to 12.1° and the internal rotation from 16.5° to 24.1°.

CONCLUSION: While Theia3D v2023.1 showed general agreement in movement patterns compared to the marker-based system, notable differences in absolute joint angles were observed, particularly for the internal rotation angle. This suggests that Theia3D, in the tested version v2023.1, is not suitable for use in performance analysis and injury prevention in sports, where accurate measurements of overhead shoulder kinematics across three dimensions are essential. However, further refinement and training of the model on overhead movement tasks may enhance the accuracy of Theia3D for these tasks, making it a potent alternative for assessing shoulder kinematics in the future.

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**LIGHTS, CAMERA, ACTION: THE IMPACT OF LIGHTING AND CAMERA POSITIONING ON THREE-DIMENSIONAL GAIT KINEMATICS USING MARKERLESS MOTION CAPTURE**

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INTRODUCTION: Markerless motion capture (MMC) has emerged as a potential solution to motion capture in logistically challenging environments (e.g., outside a motion capture laboratory). As such, many studies compare MMC (e.g., Theia3D [1]) with conventional marker-based methods to understand agreement between systems. These studies often take

place in a laboratory environment, where factors like lighting and camera position can be optimised for 3D coverage. However, many environments where MMC might be employed have suboptimal lighting or limited space for ideal camera placement (e.g., hospital or gymnasium). This study aimed to understand the effects of lighting and camera positioning on MMC performance, by synchronously comparing with a marker-based system.

METHODS: Fifteen adults walked (3 km/h) and ran (12 km/h) on an instrumented treadmill (Gaitway3D; h/p/cosmos), whilst a 14-camera optoelectronic motion capture system (Oqus 7+, Qualisys) collected retroreflective marker trajectories [2]. Video data were collected synchronously with 12 high-speed cameras (100 Hz; Miqus, Qualisys). To compare the effect of lighting, data were collected under four randomised lighting conditions (1069, 692, 455, and 289 lux). Video cameras evenly surrounded the capture volume (SURR), but to compare the effect of camera position some cameras were removed post-collection to replicate a corridor (CORR) setup, and a setup with bias towards anterior views (FRONT) under one lighting condition (1069 lux). Videos were processed using Theia3D. Hip, knee, and ankle joint range of motion (ROM) was computed in all three planes with Visual3D and compared between lighting conditions and camera setups using marker data as a reference system.

RESULTS: Significant interactions were found for all joints when lighting was changed, with less lighting leading to lower hip frontal ROM, higher knee and ankle frontal ROM, and higher ROM in all transverse angles ($p < 0.05$). Despite systematic differences between marker data and MMC, there were generally no interactions with lighting in the sagittal plane. There were significant differences between camera setups, particularly in frontal and transverse planes ($p < 0.05$). SURR and FRONT underestimated ROM compared with marker data, where CORR was in some cases more similar ($p \geq 0.05$).

CONCLUSION: Lighting and camera positioning need to be considered when using MMC, especially if kinematics in the frontal or transverse planes are of interest (e.g., in injury "screening" assessments). Equally, the translation of system comparison studies into the field-based adoption of MMC needs to be approached with caution, as external factors like lighting and camera position affect the difference between systems. Finally, if a motion capture environment has compromised lighting or limited space for camera setup, the accuracy of MMC might be limited.

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**VALIDATION OF COMPUTER VISION BASED KINEMATIC ANALYSIS USING LATERAL VIEW VIDEOS IN ERGOMETER ROWING**

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INTRODUCTION: Kinematic analysis in rowing is critical for optimizing performance and technique and difficult to realize in everyday training due to the high effort involved. Computer vision (CV) offers automated solutions [1], yet validation remains essential [2]. This study compared the results of CV-derived joint angles at key rowing phases (catch/end position) with manual digitization of three different evaluators using an open-source analysis software in elite rowing.

METHODS: Eighteen healthy Austrian national rowers (age: 23.1 ± 3.5 years; experience: 6.2 ± 2.1 years) performed a 2000 m all-out test on a rowing ergometer. Lateral-view videos (4k@120 fps) were recorded with an action camara (GoPro 12 Black) at linear optic settings and 5 consecutive strokes after 500 m rowing distance were chosen for the later analysis. A commercially available analysis tool (RowerUp 2025) was used for the automated detection of joint centers and angle calculations while two experienced evaluators (both rowing experts) performed a manual analysis using Kinovea software (2024.1). The calculated joint angles (hip, knee, ankle) at catch and end positions have been compared using paired t-tests, intraclass correlation coefficient (ICC) was used to assess agreement between the methods.

RESULTS: High agreement was observed for the angles in the knee (ICC = 0.87) and ankle joint (ICC = 0.92). Shoulder and hip joint center detection showed slight discrepancies impacting the absolute hip angle accuracy (4.21 ± 5.89°, p = 0.020). However, the intraindividual variability was acceptable (ICC > 0.80) for all joint angles. Regarding the automatic detection of the catch/end position (timing), the CV system demonstrated robust temporal synchronization (mean difference: < 0.05 s). Critical background and contrast situations (e.g. dark background & black rowing suite) resulted in a slightly larger deviation in the detection of joint centers.

CONCLUSION: CV-based kinematic analysis provides valid intraindividual comparisons despite minor absolute inaccuracies in shoulder/hip joint localization. This supports its utility for training feedback and longitudinal monitoring in elite rowing, also thanks to a very well-designed operating concept and user interface (GUI). Next step would be the validation against marker-based 3D-kinematic data under laboratory conditions but also in practical training environment with different camera alignments (position & orientation) [3] and varying clothing situations (e.g. long vs. short rowing suites, different color combinations).

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**FRONTAL PLANE ANALYSIS OF GOLF SWINGS: DETECTING INDIVIDUAL AND PROFICIENCY DIFFERENCES USING COMPUTER VISION**

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INTRODUCTION: Golf swings involve complex, multi-degree-of-freedom movements, and understanding individual and expertise-related variations is crucial for optimizing performance. Previous studies, such as Yamamoto et al. (2023), have shown that sagittal plane markerless motion analysis can successfully identify proficiency differences and individual swing characteristics, but its applicability to frontal plane motion remains unexplored. In golf, the analysis of movements in the frontal plane is crucial for understanding body sway, including head sway, which contain essential information for making fast and accurate contact between the club and the ball. Additionally, this study aims to conduct this investigation using a low-cost and simplified method.

METHODS: Twenty-eight golfers (beginner to expert) hit 20 shots using a 7-iron. High-speed video (240 Hz) was utilized to record frontal plane movements. Pose estimation via HRNet extracted joint positions, and key swing events were identified. Head and pelvis coordination patterns were analyzed via ear and hip joint midpoints.

RESULTS: Three distinct coordination patterns were identified: (a) The head and pelvis moved backward together (opposite to the shot direction). (b) The pelvis moved backward while the head remained stable. (c) The head moved forward (toward the shot direction) while the pelvis moved backward.

The distribution of these coordination patterns showed no significant correlation with expertise level, suggesting that these variations represent individually acquired movement patterns rather than universally expertise-dependent characteristics.

CONCLUSION: This study analyzed golf swing patterns in the frontal plane using a simple method (high-speed video data and pose estimation with computer vision). As a result, the coordination between the head and body could be broadly classified into three distinct movement patterns. Furthermore, these movements could be more broadly divided into a translational swing (a) and rotational swings (b, c), where the head movement differed.

This difference may correspond to allocentric, and egocentric movements as described by Swinnen et al. (1997), suggesting that in complex motor tasks, strategies for generating large forces or achieving precise movements are not limited to a single approach.

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## Oral Presentations



**COMBINED EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING AND SODIUM NITRITE SUPPLEMENTATION ON METABOLIC AND INFLAMMATORY BIOMARKERS IN TYPE 2 DIABETIC RATS**

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INTRODUCTION: Type 2 diabetes mellitus is a chronic, progressive metabolic disorder marked by insulin resistance, increased inflammation, and oxidative stress (1). While high-intensity interval training (HIIT) has shown substantial benefits in modulating angiogenesis and flogosis (2), sodium nitrite (NaNO2) supplementation has emerged as a promising agent for enhancing insulin sensitivity and reducing oxidative stress (3). Thus, our study was conducted to elucidate the effects of sodium NaNO2 and HIIT on metabolic and vascular dysfunction biomarkers of subclinical chronic inflammation.

METHODS: To this aim diabetic rats, obtained by applying the nicotinamide-streptozotocin method, were used as experimental animal model. An overall sample of 25 male rats was assigned to one of 5 groups: control animals, diabetic animals, diabetic+NaNO2 supplementation, diabetic+HIIT, and diabetic+HIIT+NaNO2 supplementation. Exercise intervention consisted of an 8-week HIIT protocol with increasing intensity and duration, adjusted every 2 weeks based on reassessed maximum running speed. NaNO2 was administered in 3 doses via tail injection (12 nmol/kg each), with a one-week interval among doses. Specific biomarkers (i.e., TNF-alpha, MuRF1, PI3K, Klotho, and Resistin were measured in rat cardiomyocytes by ELISA). One-way ANOVA and Kruskal-Wallis tests were used for between-group comparisons, followed by Dunnett's T3 and Dunn-Bonferroni post-hoc tests.

RESULTS: As compared to control animals, diabetic animals displayed higher MURF-1 and TNF-alpha levels (p=0.047 and p=0.002, respectively), while greater Resistin levels were apparent both in diabetic (p=0.007) and HIIT animals p=0.008).

Finally, increased Klotho levels emerged in the NaNO2+HIIT and NaNO2 groups (p=0.001 and p=0.044, respectively) compared to diabetic animals whereas significantly higher PI3K levels were apparent both in control (p<0.001) and NaNO2+HIIT (p=0.017) rats.

CONCLUSION: In conclusion our results show that while combined intervention (NaNO2+HIIT) effectively increased both Klotho and PI3K levels, isolated NaNO2 supplementation selectively ameliorated Klotho levels at the cardiomyocyte level of diabetic rats. When administered alone, HIIT was not effective in contrasting diabetes-induced alterations in inflammatory and metabolic biomarkers in an experimental diabetic animal model.

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**EFFECTS OF DIGITALLY MONITORED TIME-RESTRICTED EATING AND HIGH-INTENSITY INTERVAL TRAINING IN ADULTS WITH OVERWEIGHT OR OBESITY: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Time-restricted eating (TRE) and high-intensity interval training (HIIT) have emerged as two promising alternatives to the current diet and physical activity recommendations for improving cardiometabolic health. In our previous study, 7 weeks of TRE combined with supervised HIIT (TREHIIT) reduced fat mass, visceral fat, and HbA1c and improved cardiorespiratory fitness (CRF) in women with overweight/obesity (1). The effects of TREHIIT in free-living conditions with minimal follow-up remain unclear. We investigated the effects of a digitally monitored TREHIIT intervention completed outside the laboratory on fat mass and secondary cardiometabolic health outcomes in men and women with overweight/obesity.

METHODS: We randomized 52 adults (50% female, 37.5 ± 6.9 years, body mass index (BMI) 33.0 ± 4.1 kg/m2) 1:1 to a 7-week TREHIIT intervention or a control group (CON). The intervention included 3 weekly HIIT sessions performed as the participants' preferred aerobic activity at ≥ 90% maximal heart rate, and a ≤ 10-h/day TRE window with ad libitum energy intake. All HIIT sessions were performed in free-living conditions after one supervised introductory session. Participants in TREHIIT received one weekly follow-up via telephone. Participants in CON received no intervention nor weekly follow-up. The primary outcome was fat mass change. We measured secondary body composition outcomes, CRF, and cardiometabolic health markers in fasting blood samples. We analyzed between-group differences using linear mixed models and considered p <.01 statistically significant for secondary outcomes.

RESULTS: Forty-two participants completed the study. We found no statistically significant difference in fat mass (-1.0 kg, 95%CI -2.3 to 0.4, p=.146). Participants in TREHIIT had reduced body mass (-2.1 kg, 95%CI -3.4 to -0.8, p=.002) and tendencies of reduced muscle mass (-0.7 kg, 95%CI -1.3 to -0.2, p =.013). CRF, measured as absolute and relative peak oxygen uptake, increased after TREHIIT (0.4 L/min, 95%CI 0.1 to 0.6, p=.008 and 3.4 mL/min/kg, 95%CI: 0.9 to 5.9, p=.010, respectively). There were no statistically significant between-group differences in remaining secondary outcomes.

CONCLUSION: TREHIIT in a real-world setting with digital follow-up did not reduce fat mass among adults with overweight/obesity. However, CRF significantly increased after TREHIIT, and the improvement was similar to that observed in our previous study of 7 weeks supervised TREHIIT. These findings suggest that a thrice weekly HIIT intervention is feasible without extensive supervision and can induce important improvements in cardiovascular health, but additional support may be required for effective fat mass reduction.

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**EFFECTS OF ONCE-WEEKLY AND THRICE-WEEKLY HIGH-INTENSITY INTERVAL TRAINING ON LEAN MASS IN ADULTS WITH CENTRAL OBESITY: A PRELIMINARY SECONDARY ANALYSIS OF A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Preservation of lean mass is critical to maintain good health, especially in individuals with obesity. In the obese population, the loss of lean mass can lead to sarcopenic obesity and impose significant detriment in functional independence, quality of life, and even the management of obesity and its comorbid conditions, such as diabetes. Although resistance training is well-established as an exercise strategy to mitigate the loss of lean mass, its implementation at the public health level is limited due to barriers such as access to equipment and knowledge on how to perform the movements correctly. High-intensity interval training (HIIT) is a popular exercise strategy in the general and obese popula-

tion with robust benefits on cardiorespiratory and adiposity health. However, its effects on lean mass are inconclusive, as evidence in the literature is mainly derived from studies employing cycling HIIT with small sample sizes (e.g., 10 participants per group). Thus, limiting its interpretation and application to the broader community. This study presents the secondary findings of a randomized controlled trial that examined the effects of once-weekly and thrice-weekly walking/jogging HIIT on lean mass in adults with central obesity.

METHODS: In this three-arm, assessor-blinded, randomized controlled trial, 315 adults (Age: 48±13; BMI: 28.7±3.8) with central obesity (waist circumference ≥80cm for women and ≥90cm for men) were randomized in a 1:1:1 ratio to once-weekly HIIT (H1: n=105), thrice-weekly HIIT (H3: n=105) and usual care (CON: n=105). Usual care participants attended a 150-minute health education class every 2 weeks for 16 weeks. HIIT participants received 75 minutes of supervised HIIT per week for 16 weeks. Training was conducted on a treadmill using the 4×4-min protocol, which consists of four 4-min intervals at 85-95% peak heart rate with a 3-min active recovery between each interval. Outcome assessments were conducted before and after the 16-week intervention. Appendicular lean mass (ALM), lower limb lean mass (LLM) and upper limb lean mass (ULM) was assessed using dual-energy x-ray absorptiometry. Generalized estimating equations was used to assess the treatment effects, with baseline values used as covariates.

RESULTS: After 16 weeks of intervention, ALM, LLM and ULM was significantly greater in the once-weekly (ALM: H1 vs CON: +0.58kg; P<0.0001) and thrice-weekly HIIT group (ALM: H3 vs CON: +0.66kg; P<0.0001) compared to the CON group. No significant difference was found between once-weekly and thrice-weekly HIIT for all outcomes (ALM: H3 vs H1: +0.08kg; P=0.49).

CONCLUSION: Walking/jogging HIIT performed for 75 minutes a week (regardless of once-weekly or thrice-weekly) can induce modest improvements in lean mass relative to control in adults with central obesity. These findings enhance the role of HIIT as a public health exercise strategy to provide holistic health benefits ranging from cardiorespiratory health to lean mass.

**EFFECTS OF DIFFERENT INTENSITIES OF HIGH-INTENSITY INTERVAL TRAINING ON CARDIAC FUNCTION IN OBESE WOMEN**

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INTRODUCTION: Obesity is a major global public health issue, particularly among women, increasing the risk of cardiovascular diseases, diabetes, and metabolic disorders. According to the World Health Organization, approximately 39% of adults are overweight or obese, with a higher prevalence among women. High-intensity interval training (HIIT) has emerged as an effective exercise intervention for reducing fat mass and improving cardiovascular health. Compared to moderate-intensity continuous training (MICT), HIIT is more time-efficient while inducing significant physiological adaptations. However, the effects of different HIIT volumes remain unclear, especially in obese women. This study investigates the effects of high-volume (HV-HIIT) and low-volume (LV-HIIT) HIIT on body composition and cardiac function in obese women.

METHODS: A randomized controlled trial was conducted with 40 obese women (BMI ≥30) aged 18–40 years. Participants were randomly assigned to HV-HIIT, LV-HIIT, MICT, or a control group. All training sessions were conducted on a Wattbike. HV-HIIT sessions lasted more than 15 minutes with interval periods of 4–6 minutes, whereas LV-HIIT sessions were under 15 minutes with 30-second to 1-minute intervals. MICT sessions lasted 45 minutes at 60–75% of maximum heart rate, while the control group received no exercise intervention.

Body composition was assessed using bioelectrical impedance analysis (BIA). Cardiac function was measured via echocardiography, including ejection fraction (EF), mitral valve inflow velocities (E/A ratio), stroke volume, and cardiac output. One-way ANOVA was used to analyze group differences, with LSD post-hoc testing.

RESULTS: Baseline characteristics showed no significant differences between groups ($p > 0.05$). After intervention, HV-HIIT reduced body fat percentage from 35.22% to 33.82% and BMI from 24.84 kg/m² to 24.44 kg/m². LV-HIIT showed a reduction in body fat percentage from 37.38% to 36.25% and BMI from 25.49 kg/m² to 24.94 kg/m². MICT also induced positive changes ($p < 0.01$) but was less effective than HIIT. HV-HIIT increased EF from 70.16% to 74.86% and improved the E/A ratio from 2.01 to 2.55 ($p < 0.05$). LV-HIIT increased EF from 67.71% to 76.04%, but E/A ratio changes were not significant. Cardiac output and stroke volume improved across all intervention groups, with no significant inter-group differences.

CONCLUSION: Both HV-HIIT and LV-HIIT effectively improved body composition and cardiac function in obese women. The minimal differences between the two suggest that LV-HIIT could serve as a time-efficient training alternative for improving cardiovascular health and reducing obesity-related risks.

**HIIT VS. MICT: OPTIMAL EXERCISE DOSE FOR MAXIMIZING CARDIRESPIRATORY FITNESS IN HEALTHY AND CV RISK POPULATIONS - A DOSE RESPONSE META-ANALYSIS**

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INTRODUCTION: High-intensity interval training (HIIT) is a time-efficient and effective exercise modality, offering comparable or superior benefits to moderate-intensity continuous training (MICT) across various populations. However, variations in HIIT session durations limit insight into the optimal dose-response relationship. Indeed, some protocols last nearly as long as typical aerobic exercise training. This study aimed to determine the optimal HIIT and MICT doses for improving cardi-

orespiratory fitness in healthy individuals and those with elevated cardiovascular risk factors (CVRF) using a dose-response meta-analysis.

METHODS: A one-stage random effects dose-response meta-analysis was conducted to examine the nonlinear relationship between exercise dose (min/session) and changes in maximal oxygen uptake (ΔVO2max). Optimal exercise dose was identified as the effect doses corresponding to 50%, 80%, and 100% of the maximal observed effect.

RESULTS: The dose-response meta-analysis revealed that HIIT achieved 80% and 100% of its maximal effect (ΔVO2max = 3.45 and 4.31 mL/kg/min) in 11.4 minutes and 23.2 minutes, respectively. In comparison, MICT required 52.4 and 63.0 minutes to achieve 80% and 100%, ΔVO2max = 3.30 and 4.13 mL/kg/min. In healthy individuals, time-efficiency of HIIT was particularly pronounced, where it showed a strong non-linear response (second spline term = -5.439, $p < 0.001$), with optimal dose of 5.2 min (50%), 10.1 min (80%), and 20.0 min (100%). In contrast, MICT followed a linear response, with doses of 13.2 min, 26.2 min, and 63.0 min for equivalent effects. In individuals with elevated cardio-metabolic risk, HIIT showed a weaker non-linearity (second spline term = -0.764, $p = 0.025$), with optimal doses of 6.6 min (50%), 12.9 min (80%), and 28.2 min (100% of maximal effort), while MICT required similar doses as the overall analysis (39.6 min, 53.7 min, and 63.0 min for 50%, 80% and 100% of maximal effort).

CONCLUSION: This meta-analysis identifies a nonlinear relationship between HIIT session duration and VO2max improvements, with optimal adaptations occurring within 20 minutes per session. HIIT provides comparable or greater benefits than MICT in a fraction of the time – MICT required 2.7- to 6.2-fold longer duration than HIIT, with the greatest differences observed at lower percentages of maximal effect (i.e., lower ΔVO2max), supporting its use as a time-efficient training strategy to improve cardiorespiratory fitness across populations

## Oral Presentations

### OP-MH20 Aerobic Exercise and Cancer

**CARDIORESPIRATORY FITNESS, FUNCTIONAL FITNESS AND BODY COMPOSITION AMONG BREAST CANCER SURVIVORS: A RANDOMISED, CONTROLLED NON-INFERIORITY TRIAL COMPARING REMOTE VERSUS PARTLY-SUPERVISED EXERCISE**

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INTRODUCTION: There were ~2.3 million cases of female breast cancer diagnosed worldwide in 2022 (1). Exercise training has a positive effect on survival, disease recurrence and all-cause mortality. Barriers that hinder employing supervised exercise programmes in oncology settings, include staff training and capacity, resources and facilities, accessibility and costs. Remotely-supported exercise training is an alternative that can bring about beneficial health effects. This randomised, controlled non-inferiority trial investigated whether 8 weeks of remotely-supported exercise training changes cardiorespiratory fitness, functional fitness and body composition by a magnitude that is not meaningfully inferior to changes caused by partly-supervised exercise training among female breast cancer survivors.

METHODS: After randomisation, n=30 (57 ± 6 years, VO2max 28.9 ± 6.1 ml·kg-1·min-1, BMI 25.3 ± 3.3 kg·m-2) female breast cancer survivors completed 8 weeks of partly-supervised (n=15) or remotely-supported (n=15) exercise training. The partly-supervised group undertook two supervised and one unsupervised session per week progressing from 55-70% VO2max and 35-50 min. The remotely-supported group were prescribed the same total duration of exercise per week progressing from 105-150 min. Intensity was prescribed using heart rate targets corresponding to 55-70% VO2max. VO2max, functional fitness measurements, body composition (via dual-energy x-ray absorptiometry) and blood pressure was assessed pre- and post-intervention.

RESULTS: Adherence was higher in the partly-supervised group (87 ± 7%) compared to the remotely-supported group (64 ± 25%; p=0.01). The remotely-supported group exhibited changes in one functional fitness measurement (timed up and go, difference to partly-supervised; 95% CI –0.8 to 0.4 s) and one measure of body composition (percentage body fat, difference to partly-supervised; 95%CI –0.6 to 0.5 kg·m-2) that were non-inferior in magnitude to the partly-supervised group. It was inconclusive whether changes among the remotely-supported group for VO2 max (difference to partly-supervised; 95% CI –3.3 to 1.1 ml·kg-1·min-1), blood pressure (difference to partly-supervised; 95% CI systolic; –3 to 12 mmHg, diastolic; –5 to 6 mmHg), 6 minute walk (difference to partly-supervised; 95% CI –54.0 to 0.4 m), or sit to stand (difference to partly-supervised; 95% CI –3 to 2 repetitions), were non-inferior in magnitude compared to the partly-supervised group.

CONCLUSION: 8 weeks of remotely-supported exercise may be an alternative to 8 weeks of partly-supervised exercise for influencing functional fitness (assessed by timed up and go) and percentage body fat. It remains inconclusive whether remotely-supported exercise is an alternative to 8 weeks of partly-supervised exercise for influencing cardiorespiratory fitness, functional fitness (assessed by 6-minute walk, sit to stand) and blood pressure.

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**ROWING AND ADAPTED PHYSICAL ACTIVITY FOR BREAST CANCER SURVIVORS: EFFECTS ON LYMPHEDEMA, MOBILITY, STRENGTH AND PSYCHOLOGICAL WELL-BEING**

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INTRODUCTION: In women with breast cancer, the most common complications after surgery include the development of lymphedema and a reduction in mobility and strength in the operated limb, leading to a negative impact on psychological well-being1. Studies suggest that rowing or an adapted physical activity (APA) program may be a viable strategy to mitigate the negative effects of breast cancer and its treatment2,3. The purpose of the study was to examine the effects of rowing on arm lymphedema, mobility, strength and psychological well-being in breast cancer survivors participating in a 6-month APA program.

METHODS: The project Effect and efficacy of RowIng in breast CancEr survivors (ERICE) involved 27 women with breast cancer (age: 56.6±6.5 yrs; BMI: 23.9±3.0 kg/m2; stages I, II, or III; surgery at least 6 months to a maximum of 20 years ago), who trained 3 times a week for 6 months with sculling (a form of sliding-seat rowing moving the boat with two oars per rower), online APA sessions and walking. The analysis conducted at baseline (T0) and at the end of the training program (T1) included arm lymphedema (Arm Volume_AV), mobility (Back Scratch_BS) and strength (Hand Grip_HG) evaluation. Additionally, Functional Assessment of Cancer Therapy – Lymphedema (FACT-B+4) and Rosenberg Self-Esteem Scale (RSES, Italian version) were administered. A minimum adherence of 75% to the program was required.

RESULTS: During the 6-month intervention, 19 women completed the program and 13 of them achieved the required adherence (N: 6_NAD vs N: 13_AD). No variation in AV of both operated (OA) and non-operated (NOA) arms was observed (OA: T0, 1566.7±274.6 vs T1, 1567.8±279.3; NOA: T0, 1513.1±254.3 vs T1, 1557.5±265.4 cm3). Despite this, an improvement in both operated and non-operated arms BS (OA: T0, 2.0±7.6 vs T1, 3.0±7.8; NOA: T0, 3.3±7.3 vs T1, 4.1±7.2 cm) was noticed, with a greater improvement in HG performance in women who achieved the required adherence (OA: ΔAD, 1.2±2.4 vs ΔNAD, -3±1.4 kg, p=0.0029; NOA: ΔAD, 1±1.7 vs ΔNAD, -2.6±2.2 kg, p=0.0044). Psychological well-being (FACT-B+4: T0, 123.0±15.1 vs T1, 122.3±14.8 score) and self-esteem (RSES: T0, 20.0±5.1 vs T1, 20.74±5.87 score) remained stable.

CONCLUSION: An APA program combined with sculling revealed to have a positive impact on flexibility and strength. It is important to emphasize that improvements in physical parameters were observed only among participants achieving at least 75% of adherence.

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**HIGH-INTENSITY EXERCISE DURING CHEMOTHERAPY IMPROVES MUSCLE STRENGTH AND PRESERVES CARDIORESPIRATORY FITNESS 12 MONTHS AFTER COMPLETION OF TREATMENT IN BREAST CANCER PATIENTS.**

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INTRODUCTION: Physical exercise during treatment may counteract some of the adverse effects following (neo-)adjuvant chemotherapy for breast cancer. However, the optimal exercise intensity and whether the benefits of exercise during chemotherapy continue into survivorship is not well-known (1,2). The aim of the current study was to examine the effects of high (HIT) vs. moderate (MIT) intensity exercise during chemotherapy on cardiorespiratory fitness, muscular endurance, body composition and muscle strength in patients with breast cancer 12 months following completion of chemotherapy.

METHODS: Women diagnosed with stage I-III breast cancer (n=80) was randomized to either a HIT or MIT training group. Both groups performed home-based endurance training and supervised strength training twice a week over the course of chemotherapy (approximately 12-24 weeks) at an intensity of 80-90% of heart rate reserve (HRR) and 1RM (HIT) or 40-50% of HRR and 1RM (MIT). Measures of VO2max, muscle strength, body composition and muscular endurance were performed before (T0), immediately after (T1) and 12 months after the completion of chemotherapy and training (T2). In total, 55 participants (HIT, n=26, MIT, n=29) completed follow up measures.

RESULTS: VO2max decreased in both groups during chemotherapy (T0-T1, HIT: -19%, p<0.01, MIT: -14%, p<0.01), but were not different from baseline values 12 months later (T0-T2) HIT: -4%, p=0.07 MIT: -3%, p=0.80). There was no significant difference between the groups.

HIT increased chest press strength at T1 (8%, p=0.03) and tended to have an increase at T2 (7%, p=0.06). There was no change in the MIT group (T1: 4%, p=0.24, T2: 5%, p=0.27) and no significant difference between the groups.

Leg press strength increased in HIT at T1 by 5% (p<0.05) and at T2 by 32% (p<0.01) and in MIT at T2 by 13% (p=0.03) but not at T1 (0%, p=0.93). There was a significant difference between the groups at T2 (p=0.04) but not at T1.

Leg extension strength increased in the HIT group at T2 (11%, p=0.04) but not at T1 (1%, p=1.00). There was no change in the MIT group (T1: -1%, p=0.39, T2: 6%, p=0.43) and no significant difference between the groups.

Muscular endurance did not change in either group.

Lean body mass increased in both groups at T1 (HIT: 2%, p<0.01, MIT: 3%, p<0.01) but not at T2 (HIT: 0%, p=0.91, MIT: 0%, p=0.23). There was no significant difference between the groups.

Fat mass increased in the HIT group at both T1 (4%, p<0.05) and T2 (10% (p<0.01) with no change in the MIT group (T1: 2%, p=0.92, T2: 4% (p=0.14).

CONCLUSION: Both high and moderate intensity exercise was effective in preserving cardiorespiratory fitness 12 months after completion of chemotherapy for breast cancer, but HIT improved muscle strength more than MIT.

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**EFFECTS OF LAND- AND WATER-BASED AEROBIC EXERCISE ON CANCER-RELATED FATIGUE IN BREAST CANCER SURVIVORS: PRELIMINARY FINDINGS FROM THE WATERMAMA RANDOMIZED CLINICAL TRIAL**

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INTRODUCTION: Cancer-related fatigue is one of the most substantial challenges faced by breast cancer survivors, underscoring the importance of developing effective strategies to mitigate its impact on this population. This study aimed to evaluate the effects of land- or water-based aerobic exercise programs, compared to a health education program, on cancer-related fatigue in breast cancer survivors.

METHODS: The WaterMama trial is a randomized, single-blinded, three-arm, parallel, superiority trial (NCT05520515) [1]. It enrolled women aged ≥18 years who had completed primary treatment for stage I–III breast cancer. Participants were randomly allocated (1:1:1) into one of three groups: 1) water-based aerobic exercise (WG), 2) land-based aerobic exercise (LG), and active control (CG). The WG and LG completed two weekly 45-minute sessions in the corresponding environments, plus a weekly health education session (45 minutes) for 12 weeks. The CG received only the weekly health education program (45 minutes) for 12 weeks. Cancer-related fatigue was assessed at baseline and post-intervention using the Piper Fatigue Scale. Post-intervention data are presented as mean [95% CI] and analyzed using Generalized Estimated Equations ($\alpha$ = 5%).

RESULTS: A total of 49 participants were randomized into WG (n = 17; 53.1 ± 12.4 years), LG (n = 16; 51.1 ± 10.6 years), and CG (n = 16; 59.5 ± 11.2 years) and included in an intention-to-treat analysis. Preliminary data showed a significant post-intervention reduction in total fatigue (p=0.047) and behavioral/severity scores (p<0.001) across all groups, with no differences among them and no significant group × time interaction. Mean post-intervention values for total fatigue and behavioral/severity scores corresponded to 3.3 [2.3-4.7] and 2.5 [1.5-4.0] points for WG, 3.1 [2.3-4.2] and 2.3 [1.4-3.8] points for LG, and 2.4 [1.5-4.0] and 2.1 [1.2-3.9] points for CG, respectively. The affective meaning, sensory, and cognitive/mood domains remained unchanged across all groups, with no significant group × time interaction.

CONCLUSION: Water- and land-based aerobic exercise programs did not demonstrate superiority over health education alone in reducing cancer-related fatigue among breast cancer survivors. This result may be attributed to the baseline fatigue levels being classified as mild, potentially limiting the magnitude of improvement. Nevertheless, significant improvements in total fatigue and behavioral/severity scores were observed post-intervention across all groups. These preliminary findings suggest that while all interventions contributed to reducing total fatigue, the additional benefits of aerobic exercise beyond health education alone may be limited in this population.

Funding: CNPq, CAPES and FAPERGS, Brazil.

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**PROSTATE CANCER CELL SPHEROID FORMATION CAPACITY IS REDUCED BY RUNNING RACE-CONDITIONED HUMAN SERA.**

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INTRODUCTION: Prostate cancer is one of the most commonly diagnosed cancers in men worldwide. The advances in diagnostic and therapeutic options associated with a usually moderate intrinsic biological aggressiveness have led to an increase in survival rate. To date, more than 90% of patients are alive at five years, but the high prevalence of the disease needs effective strategies to reduce the recurrence risk. In this sense, epidemiological evidence suggests that physical activity is associated with a lower cancer incidence and recurrence. Nevertheless, the underlying mechanisms of action are poorly understood. This study aimed to evaluate the effects of two different running races (5 Km and 10 Km) in the modulation of spheroids formation capacity of prostate cancer cells.

METHODS: 13 healthy subjects (mean age 47.7 ± 16.1 years; body mass index 24.6 ± 2.3 kg/cm2) performed two running races, 5km- and 10 km-long, interspersed by 2 weeks of wash-out time. The tumorigenic potential of prostate cancer cell line LNCaP was assessed through the 3D in vitro culture technique (soft agar assay), stimulating cells with sera collected

before (PRE), immediately after (POST), and 3 hours after (POST 3h) running races. The spheroid formation ability was evaluated after 3 weeks of incubation, using GelCount (Oxford Optronix), an automated high throughput imaging and analysis system that optimizes the measurement of the spheroid number.

RESULTS: Overall, 11 and 7 subjects performed the 5km and 10km races predominantly above the anaerobic threshold. In both running races, the spheroids formation analysis showed a significant average reduction in the tumorigenic capacity of LNCaP cells when stimulated with POST and POST 3h sera, compared to PRE sera. POST versus PRE sera analysis revealed that after the 5 km race, 10 out of 13 exercise-conditioned sera induced a reduction > 5% (-24.51 ± 13.21%) in the number of spheroids; a similar degree (-22.44 ± 11.85%) was observed after the 10 km race, in 9 out of 13 participants. This effect further improved when considering the POST 3h sera. In this case, all the sera from the 5 km and 12 out of 13 of those collected in the 10km race induced a reduction > 5% in spheroids number in comparison with PRE sera (-38.96 ± 17.89 and 39.92 ± 17.12%, respectively). Interestingly, no significant differences have been found in the effects of sera comparing the two running distances.

CONCLUSION: These preliminary results suggest that acute training sessions reduce the spheroid formation of prostate cancer cells. This finding allows interesting speculations about the potential mechanisms underlying the impact of physical exercise in reducing the risk of prostate cancer recurrence to be further validated and explored. Moreover, the present work offers suggestions concerning the prescription, indicating that even a relatively short running distance may produce similar effects to a long one, with important implications for the real-world setting.

## Oral Presentations

### OP-PN11 Nutrition I - Amino Acids and Protein II

**A VEGAN DIET PROVIDING THE RDA FOR PROTEIN SUPPORTS FREE-LIVING DAILY MYOFIBRILLAR PROTEIN SYNTHESIS RATES COMPARABLY TO AN ISONITROGENOUS OMNIVOROUS DIET IN HEALTHY OLDER ADULTS**

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INTRODUCTION: A mycoprotein-rich high-protein vegan diet supports daily myofibrillar protein synthesis (MyoPS) rates to a similar extent as an isonitrogenous omnivorous diet in older adults. However, it remains unclear if vegan diets compromise daily MyoPS and, thus, muscle adaptive responses to exercise at lower protein intakes, especially when consisting of a more diverse array of non-animal-derived foods. We assessed the impact of a vegan diet providing the RDA for protein on daily free-living MyoPS rates over one week, in rested and exercised muscle, compared to a high-quality isonitrogenous omnivorous diet in older adults.

METHODS: Twenty-two healthy older adults (male [m]/female [f]; 12/10; age: 67±4 y; BMI: 25±3 kg/m^2) participated in a randomised, parallel-group trial. Following 3 days of consuming their habitual diets, participants consumed a 7-day vegan diet (VEGAN; n=11; m/f, 5/6), providing 0.8 g/kg bm/day of protein (predominantly from mycoprotein, pea, oat, rice, and spirulina-containing foods), or an isonitrogenous omnivorous diet (OMNI; n=11; m/f, 5/6) containing 69% animal-derived protein. On days 1, 3, and 5 of the dietary intervention period participants performed a bout of unilateral resistance exercise. Skeletal muscle and saliva samples were collected during the habitual and dietary intervention periods to assess daily MyoPS in rested and exercised tissue using deuterated water.

RESULTS: Dietary protein intake during the intervention period decreased by 26% compared to habitual intakes (P<0.001). Despite this, daily MyoPS rates in rested muscle remained unchanged between the habitual and intervention periods (OMNI: 1.56±0.32 to 1.37±0.24 %/d; VEGAN: 1.53±0.41 to 1.43±0.24 %/d; P=0.81). Resistance exercise increased MyoPS rates by 18% from habitual levels (OMNI: 1.74±0.26 %/d; VEGAN: 1.88±0.28 %/d; P<0.001), resulting in 29% higher MyoPS rates in exercised compared to rested muscle during the intervention (P<0.0001). MyoPS rates were similar between OMNI and VEGAN groups at all time points, in both rested and exercised muscle (all P>0.05).

CONCLUSION: A feasible vegan diet incorporating high-quality protein sources, while providing less protein than habitual intakes yet meeting the RDA, supports daily MyoPS rates to a similar extent as an isonitrogenous omnivorous diet. This demonstrates the utility of vegan diets to support skeletal muscle remodelling in older adults.

**THE BIOAVAILABILITY OF INSECT COMPARED TO ANIMAL PROTEIN IN YOUNGER, MIDDLE-AGED AND OLDER ADULTS**

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INTRODUCTION: A global shift towards sustainable food sources is now emerging, largely due to the damaging environmental impact from producing animal foods. Insects are a novel source of sustainable protein due to their high protein content and lower drain on natural resources [1]. This is particularly relevant for older adults, as protein becomes increasingly more important in later life to maintain muscle as we age, which is crucial for reducing frailty, falls and early mortality [2]. We aimed to investigate the digestibility via gastric emptying (GE) of an insect-derived protein compared to whey protein to find out if insects could present a bioavailable source of protein to support human skeletal muscle. A secondary aim was to identify any impact of ageing on the digestibility of insect protein.

METHODS: In a randomised double-blind crossover design, 30 healthy adults were separated into three age groups: younger (n=10, 25.9±5.5 yrs), middle (n=10, 46.7±4.9 yrs), and older age (n=10, 76.5±4.2 yrs). After overnight fasting, baseline breath and blood samples were collected. Participants then consumed a cricket or whey protein muffin (20g protein) containing a carbon-13 (13C) octanoic acid tracer to measure GE via expired air as 13CO2. Breath samples were collected at regular intervals for 4-hours postprandially. Blood samples were also collected at the same timepoints to measure plasma amino acid concentration. A week later, the process was repeated with the opposite muffin. Modelling was used to analyse and interpret GE data, determining the time to peak 13C release from the stomach (t lag) and the time for 50% of 13C to empty into the small intestine (t half). One-way and two-way ANOVAs and paired t-tests assessed differences in means between protein sources and age groups, with statistical significance set at $p<0.05$.

RESULTS: Both protein sources resulted in a similar excretion of 13CO2 in all age groups, with ~28% of the 13C recovered at 240 minutes after ingestion for cricket and whey, with no differences between protein sources in t lag or t half ($p>0.05$). There were also no differences between age groups in t lag or t half for either protein source ($p>0.05$).

CONCLUSION: GE does not appear to differ between cricket and whey protein and is not impacted by ageing. This indicates that the digestibility of an insect protein is similar to that of a well-characterised animal protein in healthy humans.

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**THE EFFECT OF HMB SUPPLEMENTATION AND HIGH-INTENSITY FUNCTIONAL EXERCISE ON BODY COMPOSITION, TESTOSTERONE AND CORTISOL CONCENTRATION, AND ISOMETRIC KNEE EXTENSION IN TRAINED AND UNTRAINED MALES**

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INTRODUCTION: The study verified the hypothesis that 3-week supplementation with a free liquid form of beta-hydroxy-beta-methylbutyrate (HMB; 90 mgHMB/kgFat-free mass[FFM]) would result in the improvement in body composition, selected hormones, and indices of isometric knee extension, and the magnitude of these changes will be amplified after introducing high-intensity functional training (HIFT) units as an adjunctive stimulus.

METHODS: The randomized double-blind placebo-controlled parallel study was performed in 30 trained (TR; 28.6±9.4 yrs) and 30 untrained (UTR; 33.9±8.0 yrs) males. After the baseline (BAS) visit, participants were randomly allocated into the HMB (TR_HMB, n=15; UTR_HMB, n=15) or the placebo (TR_PLA, n=15; UTR _PLA, n=15) group. There were two 3-week treatment periods: 1) SUP – ingestion of either HMB or PLA and performing the usual training cycle (TR) or lack of training (UTR), and 2) SUP+FGB – ingestion of either HMB or PLA and implementing the additional exercise stimuli (TR and UTR) in the form of two Fight Gone Bad (FGB) workouts per week. The following procedures were performed: body composition (FFM and fat mass [FM]) content using the BodPod®; Cosmed, Italy), total body water content (TBW) using electrical bioimpedance (BIA-101 BIVA Pro ASE, Akern Srl. Italy), blood analysis (cortisol [COR], total and free testosterone [TT and FT]), and maximal voluntary isometric contraction knee extension (Biodex Medical System Inc., New York, USA; peak [PT] and average torque [AT]).

RESULTS: BM, FM, or FFM did not change across the study visits in the studied groups. In TR_PLA percentage of TBW was significantly higher at SUP+FGB (63.9±4.3%) compared to BAS (61.4±3.4%) and SUP (63.1±2.9%) visits ($p=0.022$); TBW in L was significantly higher at SUP (55.4±9.0 L; $p=0.041$) and SUP+FGB (56.0±9.0 L; $p=0.004$) compared to BAS (53.7±8.8 L) visit. The concentration of COR and TT did not change in any of the treatment groups. In the TR_PLA group, the concentration of FT was significantly lower at SUP (13.4±3.2 pg/mL) compared to BAS (17.5±7.4 pg/mL; p=0,024). TT/COR or FT/COR did not change in any of the groups. In UTR_PLA absolute and relative PT was significantly higher at SUP+FGB compared to BAS (296±39 vs 281±35 Nm, $p=0.003$ and 323±56 vs 292±46 Nm/kg, $p=0.008$); while AT absolute and relative AT were significantly higher at SUP and SUP+FGB compared to BAS (SUP: 279±43 vs 267±31 Nm, $p=0.014$; SUP+FGB: 286±37 vs 267±31 Nm, $p<0.001$ and SUP: 304±55 vs 292±46 Nm/kg, $p=0.029$; SUP+FGB: 312±54 vs 292±46 Nm/kg, $p<0.001$).

CONCLUSION: Regardless of training status, HMB supplementation did not affect body composition, COR, TT, FT concentration, TT/COR, FT/COR, or PT and AT. Surprisingly, PLA supplementation had a favorable effect on TBW content. Moreover, PLA supplementation in combination with HIFT stimuli increased PT and AT. The content of glycerin and the bitter taste of PLA preparation might evoke hydration and ergogenic effects in the studied groups.

**INCREASED PHYSICAL ACTIVITY AND PROTEIN INTAKE ARE ASSOCIATED WITH GREATER STRENGTH, BALANCE AND LEAN MASS, BUT NOT MUSCLE PROTEIN SYNTHESIS, ACROSS THE MENOPAUSE TRANSITION.**

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INTRODUCTION: Reduced sex hormone production during menopause is thought to accelerate age-related decline in muscle mass, strength, and balance. Dietary protein ingestion (PI) and physical activity (PA) are essential to stimulate skeletal muscle protein synthesis (MPS), facilitating muscle reconditioning, retention and function. This study aimed to

explore the role of PI and PA on changes in muscle mass, strength, balance, quality, MPS, and expression of genes involved in protein turnover across the menopause transition.

METHODS: Seventy-one, moderately active pre- (PRE; n=27; 46.1 ±3.2yrs), peri- (PERI; n=16; 51.5 ±2.0yrs) and post-(POST; n=28; 56.2 ±2.5yrs) menopausal females were included. Menopause status was determined by serum follicle-stimulating hormone (PRE<17, PERI<30, POST>30IU.L-1) and menstrual cycle history. 7-day PA was quantified by accelerometer and 3-day diet diaries analysed for PI. Peak torque of hip abduction (HA) and flexion (HF) was measured by isokinetic dynamometer. Balance was measured with the Y-balance test in anterior, posterolateral (PL) and posteromedial (PM) directions. Thickness (MT) and quality (MQ) of the rectus femoris (RF) were determined with B-mode ultrasound. Percentage lean (LM) and fat (FM) mass was analysed by DXA. Muscle biopsies were collected to measure 3-day free living MPS rates using 2H2O, and expression of 12 genes using RT-qPCR. One-way ANOVAs tested for differences in all variables between groups. Linear regression evaluated the relationship of PA and PI on outcome measures. ANCOVAs with PA and PI as covariates were performed on significant predictors.

RESULTS: HA and HF did not differ across menopause groups (P<0.05). Anterior (PRE 23.1±4.1, PERI 20.4±4.2, POST 20.9±4.1%; P=0.064) and PM (PRE 53.1±9.1, PERI 49.1±6.6, POST 47.9±9.2%; P=0.075) tended to be lower over menopause. PL was greater in PRE (43.3±7.9%) vs POST (37.6±7.5%) (P=0.024), but not PERI (41.2±7.4%). LM (PRE 64.2±6.3, PERI 59.8±7.3, POST 61.5±7.3%; P=0.269) and FM (PRE 31.7±6.6, PERI 36.3±7.2, POST 34.8±7.3%; P=0.244) did not differ across groups. MT was lower in POST (15.9±3.0mm) vs PRE (19.1±2.9mm, P<0.001) and PERI (18.8±3.2mm, P=0.006). MQ, MPS, and gene expression did not differ across menopause groups (P>0.05). PA positively correlated with HA (R2 0.098, P=0.009), PL (R2 0.058, P=0.043) and PM (R2 0.063, P=0.035), and 5 of the 12 genes (RPS6KB1 (R2 0.190, P=0.033), MTOR (R2 0.274, P=0.009), EIF4EBP1 (R2 0.208, P=0.025), FOXO3 (R2 0.249, P=0.013), FBXO32 (R2 0.244, P=0.014)). PI between 1.2–1.8g/kg/d positively correlated with LM (R2 0.246, P<0.001) and negatively with FM (R2 0.241, P<0.001). When covaried for PA and PI, only MT remained different across menopause (P=0.018).

CONCLUSION: Increased protein intake may ameliorate the reduction in muscle mass across the menopause transition. However, lower muscle strength and balance across the menopause is likely due to reduced physical activity, rather than hormonal changes.

**WHEY PROTEIN SUPPLEMENTATION REDUCES INFLAMMATION AND IMPROVES HIGH PHYSICAL PERFORMANCES IN WELL-TRAINED ENDURANCE AND POWERFUL ATHLETES**

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INTRODUCTION: Whey protein supplementation is mainly used in powerful athletes to enhance muscle mass and maximal power output. There are few studies on the effects of whey protein in endurance athletes. Thus, the aim was to evaluate the effects of 2 months of whey protein supplementation of 30 g/day on body composition, selected biochemical parameters and high-intensity physical performance in a group of well-trained endurance and power athletes.

METHODS: Each group (endurance or power) was randomly divided into 2 groups: a whey group (n = 20) and a control group (n = 9). In both groups, body composition, biochemical parameters, peak power (PP) and mean power (MP), as well as Wingate fatigue index (FI), and maximum aerobic speed (MAS) were assessed before and after the intervention. Both groups continued to follow their specific training programs during the two-month intervention.

RESULTS: For endurance subjects and after the intervention, body mass increased in the whey group (3.8%, $p < 0.001$), with a decrease in fat mass % ($p < 0.004$) and an increase in muscle mass of the lower limbs ($p < 0.001$). Resting plasma values of aspartate aminotransferase (AST) and alanine aminotransferase (ALT), creatine kinase (CK), C-reactive protein (CRP), total cholesterol, LDL-cholesterol (all at $p < 0.05$), and urea ($p < 0.01$) were reduced in the whey group after the intervention, with an increase in HDL-C. The control group showed no change. The whey group had increased PP, MP and fatigue index ($p < 0.001$, $p < 0.001$ and $p < 0.05$ respectively), as well as MAS ($p < 0.05$) after the 2-month intervention. The control group showed no significant changes in these measures.

For powerful subjects, the results are quite similar, with some differences, notably in terms of reduction in the % of fat which approaches statistical significance. We found no changes in ALT and AST, but a decrease in CK and CRP. In terms of performance, the intervention involved improvement in Wingate parameters (PP, MP and IF) but no changes were observed in MAS in the group of supplemented power athletes. On the other hand, we did not note any changes in the control group.

CONCLUSION: Whey protein supplementation combined with 2 months of endurance or resistance training results in reduction in body fat, but an increase in lower limb muscle mass. CK and CRP were reduced both similarly in endurance and powerful athletes. These changes were accompanied by improvements in PP and MP and FI. However, MAS was improved mainly in endurance athletes. These data suggest that protein supplementation is beneficial for endurance and powerful athletes with some differences related probably to the training process. Thus, the supplementation could be recommended to promote recovery and high-intensity physical performance.

Oral Presentations

OP-SH01 Athlete Psychology

**DISTANCE RUNNERS STORIES OF SPORT INJURY AND DISORDERED EATING**

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Objective

Sport injury and disordered eating are timely and impactful issues in distance running. Yet, despite growing recognition of the sociocultural complexity of these issues, the nexus between them has not yet been explored. Taking a sociocultural perspective, this study aims to critically explore the relationship between sport injury and disordered eating in distance runners across their athletic careers.

METHODS: Ten distance runners participated (M age: 25.7) who had endured a range of injuries throughout their career (e.g., acute, chronic, overuse, career-ending). Life story interviews (N=28) and visual methods (i.e., photographs) were used to assist the participants in telling their stories. Data were analysed using dialogical narrative analysis and represented through creative non-fiction. Methodological rigour was strengthened through member reflections, reflexivity, and critical friends.

RESULTS: Five creative non-fiction stories were constructed: Is it good for me?, I knew Id gone too far, Maybe it wasnt too late for me?, Is this what normal feels like?, and I love food too much. These stories illustrated how embodiment of sociocultural practices influenced the thoughts, feelings, and behaviours of athletes throughout their careers, revealing the complex interplay between sport injury and disordered eating.

Discussion: The ways in which this study extends literature is threefold: (1) by bridging the fields of the psychology of sport injury and disordered eating in sport, we have offered a nuanced and novel understanding of the sociocultural factors underpinning distance runners experiences, (2) the use of two methods of data collection enabled a more in-depth understanding of participant experiences rather than relying solely on verbal articulation, (3) the use of creative non-fiction provides an innovative approach to knowledge dissemination, enabling broader engagement and application in athlete education. To this end, the stories challenge the dominant performance narratives, highlighting their embodiment, resistance, and reimagining. Sharing these stories holds promise to promote interdisciplinary ways of working in research and practice.

**BASIC PSYCHOLOGICAL NEED SATISFACTION DURING THE DAY AS A PROTECTIVE FACTOR REGARDING ATHLETES' SLEEP QUALITY AND SLEEP DEFICIT**

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INTRODUCTION: Even though athletes need sufficient restorative sleep to cope with the demands of competitive sport, they often experience a sleep deficit due to late competitions, intense training sessions, and dual demands (Walsh et al., 2021). Behavioral strategies such as sleep hygiene, sleep extension and daytime naps are frequently employed to reduce this sleep deficit (Cunha et al., 2023). Besides these strategies, studies indicate that psychological determinants like the satisfaction of basic psychological needs (autonomy, competence, relatedness; Ryan & Deci, 2000) during the day may also improve sleep quality (Campbell et al., 2015). This study aims to investigate this relationship in a cohort of competitive athletes (N=66).

METHODS: At the beginning of the study, 66 competitive athletes (M=21.06 years, SD=5.05; 74.2% female) from individual and team sports answered one-time questionnaires on general sleep quality (PSQI) and satisfaction of needs in the sleep (BPNSS-S) and in the sports domain (PNSEG). Of those, 48 athletes (M=20.00 years, SD=4.44; 66.7% female) took then part in a two-week sleep tracking. The participants wore actigraphs (Motionwatch 8) for 14 nights to measure objective sleep parameters (e.g., sleep onset latency, sleep duration, sleep efficiency). Individual sleep deficit and subjective sleep quality were recorded via morning sleep logs. In daily evening logs, athletes reported their daily basic need satisfaction, pre-sleep arousal and training load.

RESULTS: The results showed that better general sleep quality (PSQI) was associated with the satisfaction of needs in sleep (autonomy: r=-.46, p<.001; competence: r=-.49, p<.001; relatedness: r=-.30, p=.013) and in sport (autonomy: r=-.246, p=.046 ; competence: r=-.266, p=.031). Multilevel analyses revealed that daily need satisfaction reduced cognitive pre-sleep arousal on the same evening (p=.001 – p<.001). A higher global need satisfaction led to higher subjective sleep quality and duration (p=.037 – p<.001) as well as lower individual sleep deficit and sleep onset latency (p=.032 – p=.001).

Discussion: The results indicate that general basic psychological need satisfaction can be interpreted as a protective factor regarding athletes' sleep quality and therefore support the assumptions of the "Basic Psychological Need Theory". This study helps to unravel the sleep dynamics of athletes and to highlight potential interventions for optimizing athletes sleep such as the adaptation of training and sleep schedules according to athletes' satisfaction of psychological needs.

**"NO ONE SEEMS TO KNOW WHAT WE SHOULD BE DOING": DEVELOPING A FRAMEWORK TO GUIDE THE IMPLEMENTATION OF MENSTRUAL CYCLE TRACKING IN APPLIED SETTINGS**

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INTRODUCTION: Calls for sex-specific athlete support have increased discussion and apparent uptake of menstrual cycle tracking (MCT), although there is limited guidance for its use in sport. This project explores athletes' and practitioners' perspectives and experiences of MCT and presents a user-informed framework to guide practitioners when implementing MCT.

METHODS: The framework is based on the outcomes of three conceptually related studies; 1) a survey of practitioners (n = 141) on current MCT and education practices in high performance sport, 2) semi-structured interviews with athletes (n = 6) and practitioners (n = 8) exploring factors influencing the implementation of MCT, and 3) an investigation into the efficacy of an education intervention for athletes (n = 45) as a strategy to support MCT.

RESULTS: The survey shows few practitioners require (9%), while some encourage (36%), athletes to track. Practitioners who educated athletes/staff on menstrual-related topics were more likely to encourage athletes to track (p=.004) and discuss menstrual health (MH) with support staff (p<.001).

Interviews with athletes and practitioners highlighted the barriers and challenges that prevent the uptake or limit the effectiveness of MCT. At a societal level, menstrual stigma and lack of MH knowledge create discomfort in MCT and related communication. At an organisational level, competing health and performance priorities and practical constraints (i.e., time, resources, expertise) prevent or disrupt MCT. Finally, at an individual level, athletes' attitudes towards MH and practitioners' ability to provide support to athletes may influence compliance with and effectiveness of MCT.

Following two education workshops athletes answered significantly more MH questions correctly, made less 'I am not sure' responses, and rated their knowledge higher (p<.001), with improvements retained 3 months post-intervention. Likelihood to communicate with teammates increased post-intervention (p=.01) and was maintained, while there was no change in their likelihood to communicate with support staff (p>0.05).

CONCLUSION: It is likely that education promotes opportunities for communication and helps athletes and staff understand why MCT is conducted. Addressing factors such as organisational priorities and individual attitudes should also be a priority, as is menstrual stigma, knowledge, and attitudes of both athletes and coaching staff. As such, the proposed framework highlights how social, organisational, and individual factors contribute to the implementation and effectiveness of MCT, and how promoting education and communication may assist across each of these factors.

**A NOVEL, FUTSAL-SPECIFIC DECISION-MAKING TASK ELICITS SIMILAR PSYCHOPHYSIOLOGICAL STRESS RESPONSES TO WELL-ESTABLISHED PSYCHOLOGICAL STRESS TASKS.**

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Introduction: Making decisions at crucial moments has been demonstrated to be a potential stressor in association football (soccer). However, the focus of research to examine the relationship between sporting decision-making and mental or physical stress is typically scant. To investigate the ubiquitous link between stress and decision making, we developed a novel task using video simulations in futsal, a 5-a-side derivative of football. Our novel study therefore aimed to assess the psychophysiological stress response to a novel futsal-specific decision-making task and compare this response to well-established psychophysiological stress tests from the literature.

Methods: 25 healthy males with a minimum 2 years playing experience in football/futsal completed a baseline rest period, followed by 4 separate stress tests interspersed with 15 minutes recovery. The tests were the Paced Auditory Serial Addition Test (PASAT), Stroop Colour Word Test (SCWT), Mirror Tracing Task (MTT) and a novel Futsal-Specific Decision-Making Task (FDMT) and were completed in a randomised order. Non-invasive beat-to-beat cardiovascular (CV) and self-report stress responses were assessed throughout the stress protocol. Generalised estimating equations (GEEs) were used to determine changes in CV markers in response to stress, with reactivity calculated as the difference between the prior resting period and the stress task.

Results: Across the entire stress protocol, there were main effects for time in systolic blood pressure (SBP), diastolic blood pressure (DBP), mean arterial pressure (MAP), heart rate (HR) and cardiac output (CO; p's < .001). Post hoc analysis demonstrated increased SBP, DBP and MAP to the FDMT compared to baseline (p's < .001). SBP, MAP, HR and CO decreased following the FDMT, during recovery (p's < .001). To compare changes in CV reactivity across the different stress tasks, there were significant differences in the CV reactivity to stress in SBP, DBP, MAP, HR and CO (p's < .001). Post-hoc tests indicated SBP, DBP, MAP, HR and CO reactivity were significantly lower in the FDMT compared to the PASAT (p's < .001). DBP, MAP and HR reactivity were also lower in the FDMT compared to the MTT (p's < .023). There were no differences in reactivity values between the FDMT and SCWT for SBP, DBP, MAP, HR and CO (p's >.182). There were increases in self-reported perceived stress for the FDMT (p < .001), but higher perceived stress was observed in the PASAT (p < .001) and MTT (p < .002). Finally, there were no differences in self-reported stress between the SCWT and FDMT (p = 1.000).

Conclusion: Our novel FDMT elicited increases in traditional CV stress response markers, which was comparable to other psychophysiological stress tasks such as the SCWT but lower than the PASAT and MTT. This suggests the FDMT could be used as a decision-making task to examine potential changes in CV markers of stress.

**EXPLORING ELITE SPORTS IN THE THEATER: A MIXED-METHOD ANALYSIS OF WORK AND PERFORMANCE ABILITY, AND WORKPLACE CHALLENGES IN PROFESSIONAL DANCE**

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INTRODUCTION: The definition of professional dance encompasses its classification as a performing art; however, it is characterized by physical and mental abilities comparable to elite sports. The training load of professional dancers ranges from 19.1 to 27.5 hours per week, with occasional increases to 35.5 hours. Additionally, the professional environment is marked by a lack of autonomy due to the presence of power structures, which introduces various cultural, interpersonal and situational stressors. In summary this results in mental concerns including depression, anxiety, and chronic fatigue. However, less is known about the interplay of these factors. The objective of this study is to explore the nature of elite sport within the context of occupational theater structures, examining potentials for enhancing performance and health.

METHODS: An exploratory sequential mixed-method approach was utilized. The qualitative part involved interviews with dancers and leaders in German theaters (n = 25). The focus was on the working conditions and to identify potential areas for enhancing performance and health. Collected data was analyzed using qualitative content analysis according to Mayring. The following quantitative part incorporated sociodemographic data, and the work ability index (WAI). Items for enhancing performance and health synthesized from the qualitative results were asked to be ranked with respect to individual preferences/requirements. A total N of 75 theater dancers participated (28.76 ± 7.74 years; 62.7% female, 36% male, 1.3% as non-binary). Statistical analysis included Kruskal-Wallis rank sum test.

RESULTS: The qualitative analysis demonstrated that the prevailing working conditions exhibited a preservation of tradition. Additionally, no specific focus on relevant exercise physiology aspects including planning and controlling of the training load was identified. This accompanied with knowledge deficits in sport science topics among the dancers and leaders. The mean WAI score was 37.19 (SD ± 7.18) from 49 points, with a majority of participants demonstrating moderate (36%) to good (33.3%) work ability. Demi-soloists demonstrated a significantly lower WAI score of 25.8 (Kruskal-Wallis chi-squared = 5.2141, df = 1, p-value = 0.0224). The top-ranked option, chosen by 49.3% of respondents, was Dancer support and care comparable to elite sports. In second place, at 41.3%, was the Optimization of regeneration and transition phases, and in third place, at 34.7%, was Planning certainty.

CONCLUSION: In comparison to elite athletes, the working conditions for professional dancers are not sufficiently aligned with the demands of the job. The aim should be to integrate sports science knowledge within the performing arts by implementing training science and sport psychology. This could lead to a balance between artistic pursuits and sports science support, while implementing structural changes to enhance overall performance and health.

## Oral Presentations

### OP-PN16 Respiratory / Pulmonary Physiology

**EFFECTS OF HIGH ALTITUDE (HA) AND HEAVY PHYSICAL EXERCISE ON LUNG MECHANICS OF ITALIAN ALPINE SOLDIERS**

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INTRODUCTION: An increasing number of individuals reach HA for sports, leisure and work. HA hypoxia induces adaptive responses in unacclimatized lowlanders, including pulmonary vasoconstriction. The increase in pulmonary artery pressure and endothelial permeability during HA exposure may lead to lung extravascular fluid accumulation (interstitial edema, IE), affecting lung mechanics, mainly impairing the elastic properties of the respiratory system. Similarly, intense physical exercise (E) may lead to the development of IE. However, the effects of HA and E on pulmonary resistance (R) and reactance (X) have been poorly investigated. We aimed to study the impact of HA and E on lung mechanics in healthy men.

METHODS: Lung mechanics of 36 soldiers of the Italian Alpine Corps (age: 34 ± 9 yr; height: 179 ± 7 cm; weight: 77 ± 8 kg) were assessed by respiratory oscillometry during quiet breathing, at rest and after an intense, standardized E. R and X were measured at 5, 11 and 19 Hz using the Resmon pro full device (RESTECH, Italy) at sea level (SL), and at 3375 m (Torino Hut, Mont Blanc). HA assessments were performed as follows: Day 1, 1-h post-arrival by cable car and after E; Day 2 at rest in the morning and after E; Day 3 at rest in the morning. At the same time, acute mountain sickness (AMS) symptoms were evaluated with the Lake Louise score (LLS). Post hoc comparisons with Bonferroni correction were performed following significant results ($p < 0.05$) from Friedman tests. Subjects were stratified into 3 groups: A (young officers), B (special forces operators) and C (military alpine guides). Between-group differences were explored using Kruskal Wallis test.

RESULTS: R5, R11, R19 significantly decreased from SL to HA (i.e R5: 2.66 ± 0.84 vs. 2.28 ± 0.91 cmH2O/(s/L), $p < .001$; other values not shown). X5 and X11 significantly changed from SL to HA on Day 1 (-0.796 ± 0.236 vs. -1.006 ± 0.417, $p < .001$; 0.028 ± 0.318 vs. -0.127 ± 0.345 cmH2O/(s/L), $p < .001$), Day 2 (-1.001 ± 0.532, $p = 0.019$; -0.132 ± 0.345 cmH2O/(s/L), $p <$

.001) and Day 3 (-0.985 ± 0.424, p = 0.002; -0.172 ± 0.503 cmH2O/(s/L), p < 0.001). Spearman correlations revealed a moderate but significant relationship between X5 on Day 1 and LLS on Day 2 (ρ = -0.334, p = 0.046).

E induced variations in X5 were more pronounced at HA even if not significant (SL: 0.006 ± 0.192, Day 1: -0.020 ± 0.289, Day 2: -0.044 ± 0.306 cmH2O/(s/L); p > 0.05).

ΔX5 between pre- and post-E revealed significant differences between groups B and C on Day 1 (-0.122 ± 0.149 vs. 0.131 ± 0.265 cmH2O/(s/L); p = 0.016).

CONCLUSION: As expected, R decreased at HA due to reduced air density. HA and E lead to acute changes in lung mechanics, with primarily HA increasing respiratory system stiffness, probably due to lung IE development. To note that X5 changes preceded the development of AMS. Military alpine guides showed a more favourable E response at HA, suggesting better lung compliance, likely due to physiological adaptations acquired from prior HA exposure.

**ALTERATION IN LUNG DIFFUSION CAPACITY DURING A MOUNTAIN ULTRAMARATHON**

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INTRODUCTION: Participation in mountain ultramarathons (MUM) has increased rapidly in recent years. One of the most extreme MUM, the Tor des Géants, is characterized by 330 km with a cumulative elevation gain of +24,000m and altitude ranging between 322 and 3,300 m.

While it is known that such MUMs alter pulmonary volume and ventilatory flow, there is a paucity of data comprehensively assessing their effects on lung diffusing capacity (DL), and its kinetics during the race. Therefore, the aim of this study was to investigate changes in DL during and after a MUM.

METHODS: A total of 53 volunteers participated in the study, but only 25 completed the race (i.e., 47% dropouts, in line with the overall rate). Participants underwent lung diffusing capacity before (pre-), after 148.7 km (mid-), and immediately (< 1-h) after (post-) the race. Pulmonary function was evaluated at pre- and post-.

DL was assessed using the single-breath method with carbon monoxide (DLCO) and nitric oxide (DLNO), while pulmonary function was evaluated through the maximal flow-volume curve (HypAir, MGC Diagnostics, Saint Paul, MN), following standardized procedures. DLCO values were corrected for hemoglobin concentration (Hb201+, Hemocue, Ängelholm, Sweden).

RESULTS: Forced vital capacity (-5.9%), forced expiratory volume in the first second (-5.7%), and peak expiratory flow (-7.1%) were significantly lower at post- compared to pre-.

From pre- to mid-, alveolar volume (-6.8%, 7.6 ± 1.4 vs. 7.0 ± 1.2 L, p < 0.001), DLCO (-13.3%, 35.9 ± 6.1 vs. 33.4 ± 6.1 $mL \cdot min^{-1} \cdot mmHg^{-1}$, p = 0.008), DLNO (-11.4%, 175 ± 31 vs. 156 ± 39 $mL \cdot min^{-1} \cdot mmHg^{-1}$, p = 0.001), and membrane diffusing capacity for carbon monoxide (DmCO) (-11.5%, 152 ± 27 vs. 140 ± 27 $mL \cdot min^{-1} \cdot mmHg^{-1}$, p < 0.001) decreased, but they were not further impaired during the second part (mid- to post-) of the race.

KCO and KNO (i.e., DLCO and DLNO expressed as the rate of gas transfer per unit of alveolar volume, respectively), were not modified from pre- to mid- (KCO: 4.79 ± 0.46 vs 4.76 ± 0.56 $mL \cdot min^{-1} \cdot mmHg^{-1} \cdot L^{-1}$, NS ; KNO: 23.5 ± 2.4 vs. 23.01 ± 2.13 $mL \cdot min^{-1} \cdot mmHg^{-1} \cdot L^{-1}$, NS) but were lower at post- (KCO: 4.58 ± 0.57 $mL \cdot min^{-1} \cdot mmHg^{-1} \cdot L^{-1}$, p = 0.018; KNO: 22.03 ± 2.45 $mL \cdot min^{-1} \cdot mmHg^{-1} \cdot L^{-1}$, p < 0.001).

The volume of lung capillaries exposed to alveolar air decreased from pre- to mid-race (96 ± 19 vs. 87 ± 17 mL, p = 0.002) and further declined at post- (82 ± 17 mL, p = 0.007). However, the DLNO/DLCO ratio remained constant across all time points.

CONCLUSION: DL alterations were driven by reduced alveolar volume during the first half of the race, while a decrease in lung capillary volume exposed to alveolar air likely contributed to further changes in the second half. The decline in DmCO, with a stable DLNO/DLCO ratio, suggests impaired membrane permeability.

In conclusion, mountain ultramarathons result in a precociously observed substantial decline in lung diffusing capacity, with further pulmonary alterations occurring later during the race.

**DIFFERENCES IN BREATHING RESERVE ACROSS A WIDE RANGE OF TRAINING STATUSES**

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INTRODUCTION: It has been shown that individuals with a breathing reserve (BR) less than 20% had a higher maximal oxygen uptake (VO2max) than those with a BR greater than 20% (1,2). Regrettably, the maximum voluntary ventilation (MVV) used to calculate BR was estimated from force expiratory volume in 1s (FEV1), even though recent studies have demonstrated that there is a significant difference between measured and estimated MVV (3). Therefore, the purpose is to assess differences in BR, with directly measured MVV, across a wide range of training statuses.

METHODS: We examined 198 males (41±10yrs, 74.0±8.1kg, 175.2±6.5cm, 18.5±6.8%fat) and 60 females (37±14yrs, 59.1±8.4kg, 164.7±6.1cm, 25.7±8.6%fat) who performed a baseline MVV and a ramp incremental exercise test (consisting of a 3-min warm-up at 4-6 km/h followed by an incremental phase starting at 4-8 km/h, with speed increasing by 1 km/h per minute) to assess maximal ventilation (VEmax) and VO2max. BR was calculated by the following equation: BR=(1–

VEmax/MVV)x100. Participants were classified based on BR depletion (yes/no) and categorized into low, medium, or high training levels according to VO2max tertiles.

RESULTS: A main effect of training status on BR was found ($F(2,249)=7.43$; $p<0.001$; $\eta 2p=0.056$). Pairwise comparisons showed higher BR in low (males: 24.59±17.09%; females: 21.36±13.93%) than in medium (males: 16.73±10.5%; females: 17.02±13.52%; $p=0.022$; $d=0.53$) or high training status (males: 14.56±12.93%; females: 12.09±10.65%; $p<0.001$; $d=0.82$). Moreover, females exhibited a lower BR than males ($F(1,249)=5.39$; $p=0.021$; $\eta 2p=0.021$; $d=0.46$). The number of individuals who depleted the BR did not differ between the different training statuses in either males ($\chi 2(2)=5.37$; $p=0.068$) or females ($\chi 2(2)=0.46$; $p=0.794$).

CONCLUSION: Lower BR was only observed in individuals with high or medium training status compared to those with low training status, and the number of individuals who depleted BR was not different between training statuses. These results allow us to better understand that reaching maximum possible ventilation during exercise (i.e., depleting the BR) is not a cause for ceasing exercise more prevalent in individuals with high training status, indicating that performance limitation by the respiratory system due to BR depletion is not more likely in individuals with the highest training status.

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**DOSE-DEPENDENT EFFECT OF INSPIRATORY MUSCLE WARM-UP ON RESPIRATORY MUSCLE FATIGUE, EXERCISE TOLERANCE AND PHYSIOLOGICAL RESPONSES TO INCREMENTAL EXERCISE**

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INTRODUCTION: Traditionally, exercise performance has not been considered to be limited by ventilation or respiratory muscle function. However, prior reports suggests that respiratory muscle fatigue may influence exercise tolerance following prolonged submaximal exercise, as well as during short-term maximal exertion. Approaches such as inspiratory muscle warm-up (IMW) have emerged as plausible strategies for alleviating respiratory muscle fatigue and, arguably, enhancing exercise performance. While some studies have reported significant improvements, others have found no notable effects, suggesting that IMW may not significantly impact exercise tolerance. The underlying reasons for these discrepancies may stem, in part, from differences in the relative load of maximal inspiratory pressure (%MIP) prescribed during IMW. This hypothesis, however, remains unexplored. Therefore, we investigated the effects of different IMW loads on respiratory muscle fatigue, exercise tolerance, and physiological responses to incremental exercise in healthy adults.

METHODS: Ten recreationally active men (mean age 22 ± 2 yrs; VO2max: 44 ± 4 $mL \cdot kg^{-1} \cdot min^{-1}$) attended the laboratory on four separate occasions. On Day 1, participants underwent a familiarisation with the procedures and measurement of MIP, a key indicator of inspiratory muscle strength. On Days 2-4, participants performed a ramp-incremental exercise test on a cycle ergometer to volitional exhaustion. Each test was preceded by an IMW, which involved two sets of 30 breaths using a Powerbreathe® device, with loads set at 15%, 40%, and 60% of MIP. Pulmonary gas exchange and ventilation data, along with near-infrared spectroscopy (NIRS)-derived muscle oxygenation parameters, were continuously monitored throughout the tests. Respiratory muscle fatigue was assessed by measuring MIP before IMW and 30 sec post-exercise tests. Perception of dyspnoea was assessed using a category, modified Borg scale.

RESULTS: Respiratory muscle fatigue was significantly attenuated (-8%; $P<0,05$) following IMW at 40%, but not at 15% or 60% of MIP. However, perceived dyspnoea at both before (0.7 ± 0.3, 0.6 ± 0.2, and 0.6 ± 0.2) and after (9.0 ± 0.3, 9.2 ± 0.3, and 9.2 ± 0.3) the exercise test did not differ across the IMW loads (15%, 40%, and 60%, respectively) ($P > 0.05$). Similarly, no significant differences were observed in pulmonary gas exchange and ventilation, or NIRS-derived muscle oxygenation parameters between the different IMW loads during the exercise tests ($P > 0.05$). Exercise tolerance, as indicated by time to exhaustion (777 ± 79 s, 774 ± 71 s, and 775 ± 70 s), also remained comparable across the IMW loads ($P > 0.05$).

CONCLUSION: Our findings suggest that IMW, regardless of the prescribed relative load, does not appreciably influence respiratory muscle fatigue, exercise tolerance, or physiological responses to incremental exercise in healthy adults. However, further research is needed to explore alternative IMW protocols and exercise modalities.

**OXYGEN STORAGE, DIVING RESPONSE AND PERFORMANCE IN COMPETITIVE FEMALE ARTISTIC SWIMMERS**

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INTRODUCTION: Recent changes in artistic swimming (AS) rules emphasize prolonged apnea periods. During apnea, spleen contraction increases circulating hemoglobin (Hb), enhancing oxygen buffering capacity. While spleen contraction and lung volumes are well-documented in freedivers [1], their role in AS remains unexplored. This study investigated pulmonary function as well as the spleen contraction and the diving response during an apnea series in female artistic swimmers in relation to their competition category and performance scores.

METHODS: Twelve competitive artistic swimmers were divided into two groups based on their competition level: youth (YO, n=6, 14.5±0.8 years) and junior/senior (JS, n=6, 18.5±3.0 years). Testing was conducted prior to competing in the Nationals. Body composition was assessed by bioimpedance. Static and force spirometry tests were used to determine lung volumes and flow rates [2]. Each athlete then performed three maximal static apneas with 2-minute rest in between. Spleen volume (SV, mL), measured via ultrasound, and hemoglobin concentration (Hb, g/L) were assessed before the 1st apnea and immediately after the 3rd apnea. Heart rate (HR, bpm) and oxygen saturation ($SpO_2$, %) were continuously monitored throughout the apneas, with mandatory termination if $SpO_2$ dropped below 70%.

RESULTS: Both groups presented no significant differences in body composition, including weight (59.9±10.7 kg, p=0.240), height (167±6 cm, p=0.378), and total fat percentage (24.8 ± 5.6 % body weight, p=0.936). Regarding spirometry values, JS exhibited significantly higher forced vital capacity (FVC, 5.14±0.85 vs. 3.93±0.41 L, p=0.026), forced expiratory volume in 1 second (FEV1, 4.19±0.75 vs. 3.06 ± 0.26 L, p=0.010), peak expiratory flow (PEF, 7.80±1.14 vs. 5.25±1.01 L/s, p=0.004), and forced expiratory flow at 25–75% of FVC (FEF25-75, 4.04±0.53 vs. 2.84±0.60 L/s, p= 0.009) compared to YO. However, no significant differences were observed between groups in vital capacity (VC, 3.95±0.76L, p=0.065) or $FEV_1$/FVC ratio (80.2±6.3 %, p=0.394). The maximal apnea duration did not significantly differ between groups (JS: 123±60 s vs. YOU: 74±30 s, p=0.132). However, HR diving response was only significant in the JS group across all three apneas (Apnea 1: 74.3±9.7%, Apnea 2: 73.3±11.2%, Apnea 3: 76.4±11.1% of baseline HR, p<0.05). The absolute splenic contraction was significant for both groups (average 39.1±23.1 mL, p<0.001), whereas baseline Hb concentration remained unchanged after the test. A strong positive correlation between maximal apnea time and competition scores was only observed in the SJ group (rho=0.866, p=0.033).

CONCLUSION: In competitive AS, superior pulmonary function and an enhanced diving response may contribute to success. These findings indicate that apnea training are a valuable component in competitive female AS.

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## Oral Presentations

### OP-MH19 Physiotherapy

**MAXIMAL VOLUNTARY ISOMETRIC FORCE VERSUS RATE OF FORCE DEVELOPMENT IN HAMSTRING ASSESSMENT AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH GRACILIS AND SEMITENDINOSUS GRAFT**

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INTRODUCTION: After anterior cruciate ligament (ACL) reconstruction with doubled gracilis and semitendinosus (DGST) many studies have pointed out how difficult is to restore neuromuscular parameters like maximal voluntary isometric force (MVIF) and rate of force development (RFD) of quadriceps and how it remains altered even 6-9 months post-surgery. Currently, studies regarding the behavior of the knee flexor muscles are still limited. The aim of this pilot study is to investigate the deficits and trends of these parameters also in hamstrings.

METHODS: 12 male amateur sport subjects who underwent ACL reconstruction with DGST technique and did not have other concomitant injuries (age: 28aa±3aa; weight: 71Kg±13Kg) have been selected. All participants completed a 6-month rehabilitation program with specific hamstring exercises. The protocol included isometric dynamography tests of the hamstring on prone leg curl (HAM_OCK) with a knee flexion angle of 60° (from the ground). All data were sampled at 1000 Hz. The parameters of MVIF and RFD at 30, 50 and 90% of MVIF (RFD30; RFD50; RFD90) have been assessed. The tests were performed at 3- and 6-months post-surgery (3PS – 6PS). For each variable, the values of the operated limb were compared to the uninvolved limb at 3PS and 6PS. The results were reported as mean and SD as well as side-to-side asymmetries. The data were compared using Students t-test for paired data (p<0.05).

RESULTS: The results show a statistically significant difference in all parameters investigated for the HAM_OKC tests performed at 3PS and at 6PS. The Side-to-side asymmetries are as follows: HAM_OKC test at 3PS (MVIF: -40%; RFD30: -33%; RFD50: -37% RFD90: -46%); HAM_OKC at 6PS (MVIF: -29%; RFD30: -17%; RFD50: -22% RFD90: -36%). At the clinical follow up all the test's results are good or excellent.

CONCLUSION: All parameters showed a progressive improvement between the tests performed at 3PS compared to those at 6PS. The most deficient parameters in HAM_OKC at 6PS are the MVIF and the RFD90, unlike the results highlighted on the quadriceps, as reported by previous studies, where the main deficit is about all the RFD parameters. The MFVI and the RFD90 are strongly connected to cross-sectional area of the muscle and it has been also shown that ST muscle atrophy was non accompanied by a compensatory hypertrophy of the other hamstring muscle. The different behavior of RFD30 and RFD50 in the hamstrings compared to what is expressed in the literature for the quadriceps could depend on the lower sensitivity of the hamstrings to the phenomena of arthrogenic and neuromuscular inhibition. The discrepancy with the results obtained in other studies, where the biggest deficit was in the early phase of RFD, could be attributed to the different test setting, the time after surgery, the way to calculate the RFD parameters and rehabilitation program. Fur-

ther studies are certainly needed to understand the residual deficit affecting the hamstrings and thus improve recovery paths.

**BEYOND PHYSICAL RECOVERY: PSYCHOLOGICAL, SOCIAL, AND CONTEXTUAL FACTORS IN RETURNING TO SPORT AFTER HAMSTRING INJURIES.**

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INTRODUCTION: Return-to-sport (RTS) criteria are widely used in sports to assist specialists in decision-making. In addition to biomechanical recovery, psychological readiness plays a critical role in successful RTS and reducing re-injury risk. The importance of psychosocial factors in RTS decisions has been highlighted in the international Consensus statement for hamstring injury management. Researchers emphasize psychosocial aspects, with 98.3% of experts supporting the inclusion of emotional and psychological well-being in RTS screening (Paton et al., 2023). Despite this, research on psychosocial factors in RTS after hamstring injuries remains unclear. This scoping review examines psychological, social, and contextual factors influencing RTS after hamstring injuries.

METHODS: This review followed Scoping review guidelines from the JBI Manual for Evidence Synthesis. The research protocol was registered in Open Science Framework (OSF) (https://doi.org/10.17605/OSF.IO/8RK7E). Between March and December 2024, systematic searches were conducted in Medline, Embase, PsycINFO, CINAHL, SPORTDiscus, Scopus, and ProQuest. Eligible studies included English, French, German, Spanish, and Italian articles across study designs, provided they addressed psychosocial or contextual management in RTS after hamstring injuries. Grey literature (theses and dissertations) was also considered. Data extraction included participant demographics, methodologies, psychological and social measures, and psychological readiness definitions. The Mixed Methods Appraisal Tool (MMAT) assessed methodological quality, while the Oxford Centre of Evidence-Based Medicine (OCEBM) evaluated the included studies.

RESULTS: Out of 1882 retrieved records, 12 studies met the inclusion criteria, representing four study designs. A total of 799 athletes and 546 professionals were included, with only 124 females, highlighting gender imbalance. About 50% of studies focused on football (soccer), mostly within Europe (58%), with others in Asia, Oceania, and South America. Psychological readiness was central to the RTS process but lacked a clear definition. Self-reported measures such as recovery timelines, comfort during sprinting, and subjective feelings were common, but no standardized assessment tool was used. Contextual stressors, including motivation and team-related factors, influenced psychological readiness. Athlete pressure was also key, as they often set unrealistic expectations due to fear of losing their team position. Team dynamics and poor communication impacted RTS decisions, shaped by institutional resources and cultural differences. Social factors, though underexplored, played a role. External pressures from media, sponsors, and agents sometimes conflicted with recovery decisions. Five of the 12 studies attempted to define psychological readiness, including confidence, resilience, and emotional regulation, but a unified conceptual definition was lacking.

CONCLUSION: Athlete perceptions, external pressures, and resource availability shape recovery, yet frameworks remain inconsistent. The results highlight heterogeneity, methodological limitations, and the lack of standardized tools. A better understanding of these factors could optimize the RTS decision-making process and promote long-term athlete health-related quality of life.

**THE EFFECT OF BLOOD FLOW RESTRICTION ON MUSCULAR ACTIVATION AND VASCULAR STRUCTURES DURING NORDIC HAMSTRING EXERCISES**

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INTRODUCTION: Blood flow restriction training (BFRT) has gained popularity for enhancing muscle strength and hypertrophy by restricting venous return while maintaining partial arterial inflow. While BFRT has been investigated in various training modalities, its effects when combined with Nordic hamstring exercise (NHE) remain unclear. This study aimed to explore the impact of BFRT during NHE on neuromuscular activation of the hamstring muscles and endothelial function.

METHODS: A randomized, single-blind study was conducted with fourteen physically active, healthy male participants (mean age: 27.5 ± 1.24 years). Each participants lower limbs were randomly assigned to either the BFR group or the control group. In the BFR condition, blood flow was restricted at 60% of arterial occlusion pressure using an inflatable cuff. Participants performed three sets of five repetitions of NHE. Neuromuscular activation of the semitendinosus (ST) and biceps femoris (BF) muscles was recorded using surface electromyography (sEMG) during each repetition. Endothelial function was assessed using flow-mediated dilation (FMD) via Doppler ultrasound before and after exercise. Additionally, the ankle-brachial index (ABI) and popliteal artery diameter were measured to evaluate vascular responses.

RESULTS: No statistically significant differences in FMD values were observed between the BFR and non-BFR groups before and after exercise ($F(1,13) = 0.156$, $p = 0.7$, partial $\eta^2 = 0.012$). Popliteal artery diameter increased significantly in both groups post-exercise (BFR: $p = 0.004$; Non-BFR: $p = 0.000$), but there was no difference between groups ($p = 0.942$). Neuromuscular activation of both ST and BF muscles decreased across sets in both groups, with no significant differences between groups (ST: $F(2,26) = 1.172$, $p = 0.448$, partial $\eta^2 = 0.09$; BF: $F(2,26) = 1.442$, $p = 0.527$, partial $\eta^2 = 0.1$). The ABI values remained stable across conditions, with no significant differences noted.

CONCLUSION: The findings of this study suggest that the incorporation of BFRT during NHE does not provide additional benefits in terms of neuromuscular activation and endothelial function when compared to traditional NHE. Despite prior

evidence suggesting that BFRT may enhance muscle activation, our results indicate that its application in high-intensity eccentric exercises such as NHE does not yield significant improvements.

From a vascular perspective, short-term application of BFRT did not negatively impact endothelial function, as indicated by stable FMD and ABI values. These findings suggest that BFRT, when applied within controlled parameters, is a safe intervention for vascular health in trained individuals.

Future research should investigate the chronic adaptations of BFRT combined with eccentric training to determine whether prolonged exposure elicits beneficial neuromuscular and vascular adaptations.

**MAXIMUM-SPEED SINGLE-LEG BRIDGE TEST: A NOVEL APPROACH FOR RAPID HAMSTRING MUSCLE ENDURANCE EVALUATION**

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INTRODUCTION: Hamstring strain injuries frequently occur in sports involving sprinting, with high demands placed on the hamstrings during high-speed biarticular movements. The Single-Leg Bridge Test (SLBT) evaluates hamstring muscle endurance but lacks speed regulation and requires prolonged testing [1]. To address these limitations, the Maximum-Speed Single-Leg Bridge Test (MS-SLBT) was developed, combining high-speed elements with SLBTs benefits [2]. This study aimed to evaluate muscle activation and motion characteristics during 20 repetitions of the MS-SLBT to determine its suitability for assessing hamstring muscle endurance.

METHODS: A cross-sectional observational study was conducted with 26 recreational male athletes. During the MS-SLBT, participants placed their heel on a 40-cm platform and were instructed to "push down through the heel and raise the buttock as fast and high as possible". Surface electromyography was used to measure muscle activity, including median frequency (MDF) and amplitude, in the semitendinosus (ST), biceps femoris (BF), and gluteus maximus (GM) during 20 repetitions of the MS-SLBT. Motion characteristics, including buttock-raising height, buttock-raising speed, and heel-bearing force, were assessed. All variables were analyzed across 18 repetitions (2nd–19th) to evaluate changes over the test. MDF (Hz) and amplitude (%MVIC) were compared using a two-way repeated-measures ANOVA and a linear mixed model, while motion characteristics were analyzed with a one-way repeated-measures ANOVA, followed by Dunnetts test (baseline: 2nd repetition, $p < 0.05$).

RESULTS: MS-SLBT decreased the MDF of the ST and BF from 231 to 196 Hz and 227 to 193 Hz ($p<0.01$), respectively, without significant changes in the GM (from 118 to 115 Hz, $p=0.23$). The MDF slope for ST and BF decreased significantly more than that for GM ($p<0.001$), while no significant difference was found between ST and BF ($p=0.037$). MS-SLBT increased the amplitude of the ST and BF from 77 to 113 %MVIC and 102 to 133 %MVIC ($p<0.01$), respectively, with the increase observed after the 6th repetition for the ST and the 9th repetition for the BF. Regarding motion characteristics, during later repetitions, the buttock-raising speed and heel-bearing force decreased by 8.9% and 9.0%, respectively ($p<0.01$), without significant changes in the buttock-raising height (+1.1%, $p=0.24$).

CONCLUSION: Twenty MS-SLBT repetitions, completed in 30 s, revealed MDF reduction and amplitude increases for the ST and BF, with reduced buttock-raising speed and heel-bearing force during later repetitions. The MS-SLBT is a practical, specific tool for evaluating hamstring muscle endurance.

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**HAMSTRING MUSCLE DAMAGE DURING MAXIMAL, HIGH-SPEED ECCENTRIC EXERCISE: THE ROLE OF METABOLIC STRESS**

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INTRODUCTION: Exercise-induced muscle damage (EIMD) has traditionally been attributed primarily to mechanical stress during eccentric exercise (1,2). However, recent evidence suggests a substantial metabolic component, particularly concerning oxygen demands and microcirculatory dysfunction (3,4). This study examined whether changes in muscle oxygen saturation (SmO2) and ventilatory parameters (VO2/VCO2) play a role in EIMD in trained individuals performing high-speed eccentric exercise.

METHODS: Thirty trained male participants completed five sets of 15 maximal, seated eccentric hamstring curls at 210°/s. Near-infrared spectroscopy measured SmO2 in the m. biceps femoris, while spirometry recorded oxygen uptake (VO2) and carbon dioxide production (VCO2). EIMD markers included peak torque, shear-wave elastography, creatine kinase, and perceived muscle soreness were assessed pre- and post-exercise, and on the following four days.

RESULTS: Peak torque declined by 25.6% at 48 hours post-exercise, coinciding with the peak in creatine kinase levels. Shear-wave elastography indicated increased hamstring stiffness immediately post-exercise ($p < 0.001$), normalizing within 24 hours. VO2 and VCO2 rose by approximately 50% within sets, whereas SmO2 decreased by 13% and rebound-

ed 25% during rest intervals. Linear regression showed that VO2 increases during the intervention significantly predicted peak torque after 48 hours (p = 0.005) and accounted for 25.5 % of the variance.

CONCLUSION: These findings reveal that mechanical stress alone does not fully explain EIMD. Incorporating metabolic considerations into training and recovery may alleviate EIMD and reduce injury risk, particularly in high-speed protocols. Future research should clarify mechanistic links between metabolic and mechanical stressors.

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## Oral Presentations

### OP-MH37 Lifestyle

**IMPACT OF NIGHT SHIFT WORK ON VASCULAR FUNCTION IN HEALTHY ADULT WORKERS**

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INTRODUCTION: Night shift work, including shift work, forces workers to adopt irregular lifestyles that can adversely affect human physiology. In particular, impaired vascular function increases the risk of atherosclerotic disease, an important occupational health issue. While previous studies have shown that vascular endothelial function decreases after night shift work, it remains unclear whether this is temporary. A chronic decrease may lead to serious health risks such as cardiovascular disease and stroke, highlighting the need for effective lifestyle interventions. The aim of this study was to compare vascular endothelial function (flow-mediated dilation (FMD)) and structural markers of arterial stiffness [brachial-ankle Pulse Wave Velocity (baPWV), Ankle Brachial Index (ABI)] between the Day Work Group (DWG) and the Night Shift Work Group (NSWG) and to examine associations with lifestyle factors.

METHODS: Forty healthy adult workers (20 each in DWG and NSWG), classified based on their current night shift work status. In a cross-sectional design, body composition, blood tests, vascular stiffness markers (baPWV, ABI) and FMD were assessed. Lifestyle factors, including dietary intake, physical activity, and sleep, were monitored for one week. Dietary intake was assessed using a smartphone app, and physical activity and sleep were assessed using an accelerometer. Group comparisons and correlations with lifestyle factors were analyzed. The Shapiro-Wilk test was used to test for normality; t-tests or Mann-Whitney U tests were used to compare groups, and Pearson or Spearman coefficients were used to analyze correlations.

RESULTS: There were no significant differences in age, BMI or work history. NSWG had significantly higher body fat mass (14.9±5.0 kg vs. 11.8±3.3 kg, p=0.03) and body fat percentage (25.4±6.3% vs. 21.0±5.5%, p=0.02). NSWG showed higher hs-CRP (0.05±0.06 mg/dL vs. 0.01±0.02 mg/dL, p=0.03) and leptin levels (8.5±6.1 ng/mL vs. 5.3±3.3 ng/mL, p=0.02). Systolic and mean blood pressure were significantly higher in NSWG ($p<0.05$), but no differences were observed in baPWV or ABI. FMD was significantly lower in NSWG than in DWG (4.0±1.9% vs. 7.0±2.9%, $p<0.01$). In NSWG, FMD correlated negatively with sedentary behavior (≤1.5 METs; r=-0.47, p=0.04) and positively with light activity (1.6-2.9 METs; r=0.52, p=0.02).

CONCLUSION: NSWG showed significantly lower FMD than DWG, with no differences in baPWV and ABI. This suggests that night shift work may chronically affect vascular endothelial function, whereas structural atherosclerotic changes require longer exposure. The association between FMD and physical activity suggests that lifestyle improvements may help reduce the risk of atherosclerosis in night shift workers. Future longitudinal and intervention studies are needed to evaluate the effects of increasing physical activity and reducing sedentary time on FMD.

**AEROBIC PERFORMANCE AND BODY COMPOSITION: INSIGHTS FROM RECREATIONAL FOOTBALL**

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INTRODUCTION: The Yo-Yo Intermittent Endurance Level 2 Test (YYIE2) is widely used to estimate cardiorespiratory fitness in recreational footballers using the aerobic performance construct. However, the shuttle-running nature of the YYIE2 protocol may pose challenges for overweight and untrained individuals. The present study examines the relationship between

body composition parameters, assessed by dual-energy X-ray absorptiometry (DEXA), and aerobic performance and aerobic fitness measures (YYIE2 performance and $VO_2$peak, respectively) in recreational football players.

METHODS: Three hundred male recreational footballers (age: 39±6 years, YYIE2: 427±167m, VO2peak: 38.57±6.28 mL.kg−1.min−1, body mass: 83.6±13.1 kg, stature: 173.7±6.2cm) participated in this cross-sectional study. Body composition parameters, including body mass, lean mass, fat mass percentage, android and gynoid fat mass, were measured using DEXA scans. YYIE2 performance was recorded as total distance covered, and cardiorespiratory fitness was determined via $VO_2$peak. Pearson correlation analysis was conducted to assess relationships between body composition variables and aerobic performance and aerobic fitness measures.

RESULTS: YYIE2 performance was largely associated with $VO_2$peak (r=0.753, p<0.001). Moderate negative correlations were found between YYIE2 and body mass (r=-0.435, p<0.01), while $VO_2$peak demonstrated a large negative correlation with body mass (r=-0.530, p<0.01). Android fat mass was largely negatively correlated with both YYIE2 (r=-0.531, p<0.001) and $VO_2$peak (r=-0.612, p<0.001). Gynoid fat mass also showed moderate negative correlations with both YYIE2 (r=-0.350, p<0.01) and $VO_2$peak (r=-0.425, p<0.01). Fat mass percentage displayed large and very large negative correlations with YYIE2 (r=-0.674, p<0.001) and $VO_2$peak (r=-0.709, p<0.001), respectively. Correlations with lean mass were weaker, highlighting the dominant role of fat accumulation in limiting aerobic performance and aerobic fitness.

CONCLUSION: This study highlights the significant impact of body composition on aerobic performance and aerobic fitness in recreational male footballers. Fat mass, particularly in the abdominal region, is a key limiting factor for both YYIE2 performance and $VO_2$peak. These findings suggest that targeted interventions aimed at reducing abdominal fat may lead to substantial improvements in aerobic fitness, aerobic performance and overall fitness in recreational football players.

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**THE ACUTE EFFECTS OF SLEEP FRAGMENTATION ON NEUROMUSCULAR PERFORMANCE**

SLUNECKO, M., SOMBORATZ, S., CSAPO, R.

*UNIVERSITY OF VIENNA*

INTRODUCTION: Acute sleep loss can impair physical performance, with reduced sleep duration being consistently linked to decreased performance [1]. One common form of sleep loss, sleep fragmentation – characterized by repeated sleep interruptions – is a common problem among athletes [2], but its effects on neuromuscular performance have not been well researched and remain unclear. Thus, this study aims to examine the impact of induced sleep fragmentation on neuromuscular performance.

METHODS: Fifteen trained adults (8M/7F, 25.8±2.4 years, 174.5±6.3 cm, 77.3±9.6 kg) participated in a randomized crossover study comparing two sleep conditions: fragmented (INT) and habitual sleep (CON), separated by a 5-night washout phase. Fragmentation was induced by having participants wake up every 2 hours for two consecutive nights, requiring them to turn on the lights and complete a brief task. Time in bed was standardized across conditions, based on a 7-night baseline average, and monitored using wearable technology. Following the sleep conditions, lower limb strength was assessed using an isokinetic dynamometer with a leg press adapter (ISOMED 2000). Maximal voluntary isometric contraction strength (MVIC) was tested at a 60° knee angle. Strength endurance was evaluated through a concentric-eccentric isokinetic test (20–90° knee ROM) at 90 mm/s with 15 all-out repetitions. Total work (Wtot) and a fatigue index (FI), reflecting the decline from the first three (MF3) to the last three repetitions, were separately calculated for the eccentric and concentric phases. Paired t-tests were used to compare all outcome measures between sleep conditions ($\alpha = 0.05$).

RESULTS: Time in bed (INT: 7.6±0.6h, CON: 7.8±1.0h, p=0.47) and time asleep (INT: 6.6±0.5h, CON: 6.8±0.9, p=0.38) did not differ significantly between conditions. No significant difference was found for MVIC (INT: 4.04±0.94kN, CON: 4.22±0.87kN, p=0.25, d=0.31). For concentric efforts, Wtot was significantly lower after INT (5.15±1.39kN) than after CON (5.32±1.33kN) (p=0.04, d=0.59). Despite no change in concentric FI (INT: 54.1±12.2%, CON: 52.8±13.1%, p=0.57, d=0.15), the concentric MF3 was lower after INT (2.16±0.51kN) than after CON (2.29±0.47kN) (p=0.04, d=0.57) indicating a higher starting force level after CON nights.

During the eccentric efforts, no significant differences were observed for Wtot (INT: 6.68±1.91kJ, CON: 6.84±1.68 kJ, p=0.33, d=0.26), FI (INT: 49.1±13.7%, CON: 46.1±11.1%, p=0.38, d=0.23) and MF3 (INT: 3.21±0.76kN, CON: 3.45±0.82kN, p=0.09, d=0.48).

CONCLUSION: Even with unchanged total sleep duration, the sleep fragmentation intervention caused a notable decline in concentric force production during an isokinetic leg press task. The fatigue index remained stable between conditions, but the participants produced greater concentric force at the beginning of the trial and greater total work. No changes were observed for the MVIC and eccentric outcome measures.

1 Craven et al., Sports Medicine, 2022

2 Vitale et al., Int J Spo Med, 2019

**COGNITIVE PERFORMANCE PREDICTION USING PHYSIOLOGICAL, PHYSICAL, AND LIFESTYLE RELATED DATA: A PILOT STUDY**

GINESTRETTI, L., BARDINI, S., LAZZARI, J., SANTAMBROGIO, M.D.

*POLITECNICO DI MILANO*

INTRODUCTION: Wearable devices have revolutionized physiological and activity monitoring, enabling a shift from reactive to proactive healthcare. Within this context, improving cognitive performance remains challenging due to its reliance on multiple factors, including physical activity, physiological markers, and lifestyle habits. While machine learning models have been used to predict cognitive states, few effectively account for individual variability aimed at cognition improvement. This study introduces a multimodal regression framework that integrates physiological, sports, and lifestyle data to enhance the predictive accuracy of cognitive performance while focusing on the interpretability of model predictions.

METHODS: Data were collected from 30 healthy participants (mean age 25.43 ± 7.36 years, 21 males, 9 females). Physiological and activity metrics were obtained using Garmin smartwatches, while dietary intake was logged to assess nutritional impact. Metabolic data were collected through indirect calorimetry. Two processing pipelines were developed: one extracting features from physiological signals and physical activity, and another using raw time-series data. The first approach, which focused on feature extraction, was implemented with Random Forest and XGBoost models, while the second approach, based on LSTM networks, aimed to capture temporal dependencies.

RESULTS: Model performance was evaluated using mean absolute error (MAE), with a naïve baseline of 0.286. Feature-based models significantly outperformed the baseline, with Random Forest achieving an MAE of 0.1587 and XGBoost improving to 0.147, while the LSTM-based approach was less effective. To interpret model predictions, SHAP analysis was applied, revealing that moderate-intensity physical activity from the previous day had the strongest influence on cognitive performance, followed by stress range, respiration rate, and heart rate-derived metrics. In some cases, physical activity alone contributed up to 80% of the predicted outcome. Lifestyle factors such as nutrition played a moderate role. In contrast, demographic factors and metabolic data had minimal predictive value.

CONCLUSION: This study demonstrated that feature-based models can effectively predict cognitive performance, with physical activity and stress being the most influential factors. The findings highlight the importance of individualized modeling to enhance prediction accuracy. Future research should focus on expanding datasets, exploring advanced deep learning architectures, and incorporating real-time feedback to improve cognitive performance itself. Integrating wearable data with AI-driven insights represents a promising step toward personalized cognitive performance monitoring and enhanced well-being.

## 13:30 - 14:45

### Invited Symposium

### IS-SH01 ECSS-FEPSAC Invited Symposia-Psychological First Aid: Welfare strategies at major sports events

**IMPLEMENTING PSYCHOLOGICAL FIRST AID PROTOCOLS IN SPORTS: TOOLS AND INSIGHTS FROM THE FIELD**

BARIC, R.

*UNIVERSITY OF ZAGREB*

Psychological First Aid (PFA) has emerged as an important tool for supporting athletes' mental health in high-stakes environments like major sporting events. Renata Barić, an esteemed Sport Psychologist and Professor at the University of Zagreb, shares insights into implementing PFA protocols tailored to the dynamic, stress-intensive environment of elite sports. Her approach emphasizes immediate, targeted responses to emotional and psychological crises, equipping sports psychologists, coaches, and support staff with essential skills for mitigating acute stress and trauma. Drawing from her extensive research and practice, The presentation will cover best practices for recognizing early signs of mental health risks and delivering intervention strategies that are both compassionate and culturally sensitive. This presentation will highlight how PFA is integrated into existing welfare frameworks, providing a preventive approach to athlete support and fostering resilience in sports communities.

**WELFARE AND WELL-BEING IN ELITE SPORTS: MENTAL HEALTH INTERVENTIONS IN THE PARIS 2024 OLYMPICS**

MANSI, V.

*PRIVATE PRACTICE OR WESTCOAST INSTITUTE OF NEUROSCIENCES*

As the Welfare Officer for India at the Paris 2024 Olympics, Dr. Mansi Vora provides a unique perspective on how Psychological First Aid (PFA) is applied to ensure the well-being of athletes, officials, and staff. In this session, Dr. Vora will delve into the practical application of PFA at one of the world's largest and most demanding sporting events. She will explore the challenges welfare officers face in recognizing and addressing mental health risks in real-time, especially under high-stress and high-visibility conditions. Through case studies and reflections from Paris 2024, Dr. Vora will illustrate how welfare networks operate collaboratively to provide swift interventions, reduce stress-related impacts, and promote resili-

ence among team members. Emphasizing the role of welfare officers, this talk underscores how PFA fosters a proactive, ethical approach to safeguarding mental health, particularly in the context of an international multi-sport event. Attendees will gain insight into developing a welfare infrastructure that protects mental health, enhances performance, and respects the dignity of each participant.

**SAFEGUARDING THROUGH PSYCHOLOGICAL FIRST AID: BUILDING A CULTURE OF SAFETY IN SPORT**

VISERAS, G.
*INTERNATIONAL OLYMPIC COMMITTEE*

Gloria Viseras, a former Olympian and Senior Project Manager IOC Safe Sport Unit/IOC Safeguarding Officer. brings an invaluable perspective on implementing Psychological First Aid (PFA) as a core component of safeguarding in sports. Having dedicated her career to advocating for child protection and safe sport practices, she will share her experience in integrating PFA protocols across large-scale international events. Her talk will address how PFA not only serves as an immediate response to trauma but also as a foundational element in creating a culture of safety, respect, and well-being within sport. In her presentation she will discuss the critical role of education, awareness, and policy development in equipping coaches, staff, and support teams with skills to identify and respond to crises, including recognizing signs of abuse or distress. Through real-life examples and collaborative safeguarding models, her insights offer a vision for embedding PFA as a preventative and responsive practice that transcends individual interventions, aiming to foster a universally safe and inclusive sporting environment. Gloria Viseras has coordinated the activity of the Welfare officers in Paris 2024 Olympic Games.

## Oral Presentations

### OP-PN19 Exercise and Energy Intake

**METABOLIC EFFECTS OF MODERATE VERSUS HIGH-INTENSITY TRAINING ACCOMPANIED BY CALORIE-RESTRICTED DIET IN OVERWEIGHT ADULTS WITH TYPE 2 DIABETES**

GHOLAMI, F., DELVARYAN ZADE, M., IRANPOUR, M., SAEIDPOUR, A., SHERAFAT, F., HAJIANI, N.
*SHAHROOD UNIVERSITY OF TECHNOLOGY*

INTRODUCTION: Diabetes management is increasingly focusing on lifestyle interventions and high-intensity interval training is getting more attention in clinical setting for being effective and time-eficient. However, the comparative effectiveness of different exercise protocols remains a crucial area for investigation. The present study aimed to compare the effects of energy-matched moderate-intensity continuous training (MICT) and high-intensity interval training (HIIT) accompanied by a calorie-restricted diet on metabolic measures in overweight and obese individuals with type 2 diabetes (T2D).

METHODS: This randomized clinical trial included 42 overweight or obese participants with T2D who were randomly assigned to three groups: MICT, HIIT, and a control group with no intervention. MICT was performed at an intensity of 55%-65% of heart rate reserve, while HIIT comprised of running at 85% heart rate reserve interspersed with one minute walking at the intensity corresponding to 40-45% heart rate reserve. Both experimental groups followed a calorie-restricted diet for 12 weeks, incorporating a 20% caloric deficit. Measurements of body composition and resting metabolic rate via indirect calorimetry were made before and 48 hours following the last session. In addition, blood samples were collected for the analysis of fasting glucose, 2-h postprandial glucose, HbA1c, insulin, lipid profile, ALT, AST, creatinine and urea. Data were analyzed using one-way ANOVA and Tukey's post hoc tests with significance set at $p < 0.05$.

RESULTS: Both MICT and HIIT significantly reduced fasting blood glucose, 2-hour postprandial glucose, hemoglobin A1c, insulin resistance, ALT, AST, creatinine levels, total cholesterol and triglycerides. Besides re significant reduction in weight (…% in MICT and …% in HIIT) and body mass index (…% in MICT and …% in HIIT) were observed. However, no significant differences were observed for insulin levels, resting metabolic rate, urea, low-density and high-density lipoprotein when comparing the experimental groups with the control group ($p > 0.05$). Furthermore, no significant differences were found between the experimental groups concerning the variables ($p > 0.05$).

CONCLUSION: The findings suggest that in sedentary, overweight individuals with T2D, the energy expenditure during exercise might play a more critical role than exercise intensity itself in weight loss and improving metabolic indices. Both MICT and HIIT can yield comparable results in metabolic outcomes, allowing for flexibility in exercise prescription while promoting adherence. This has practical implications for diabetes management, encouraging individuals to engage in whichever modality suits their preferences and schedules, as similar health benefits can be achieved in a shorter duration with HIIT. Future research should explore long-term sustainability and adherence to these exercise interventions, as well as the psychosocial factors influencing exercise choices among this population.

**SYNERGISTIC EFFECTS OF TIME-RESTRICTED EATING AND RESISTANCE TRAINING ON HEPATIC FAT REDUCTION IN PATIENT WITH METABOLIC SYNDROME: RESULTS FROM THE TERA RANDOMIZED CONTROLLED TRIAL**

STERNFELD, R.1, YAVETZ, R.1, LAHAV, Y.1, REIN, M.2, ZELBER-SAGI, S.2, GEPNER, Y.1

*1. DEPARTMENT OF EPIDEMIOLOGY AND PREVENTION MEDICINE, SCHOOL OF PUBLIC HEALTH, FACULTY OF MEDICINE AND HEALTH SCIENCES, AND SYLVAN ADAMS SPORTS INSTITUTE, TEL-AVIV UNIVERSITY, TEL-AVIV, ISRAEL. 2.SCHOOL OF PUBLIC HEALTH, FACULTY OF SOCIAL WELFARE AND HEALTH SCIENCES, UNIVERSITY OF HAIFA, HAIFA, ISRAEL.*

INTRODUCTION: Metabolic dysfunction–associated steatotic liver disease (MASLD) affects ~30% of the global population and is strongly associated with obesity and metabolic syndrome (MetS). Time-restricted eating (TRE) and resistance training (RT) independently improve metabolic health, but their combined effects on hepatic fat content (HFC) and glycemic control remain unclear. This study investigates the synergistic impact of TRE and RT on HFC and glycemic markers in patients with MetS, independent of weight loss.

METHODS: The TERA study, a 10-week randomized controlled trial (RCT), included 76 overweight/obese adults (40-60 years) with MetS, who were randomized into TRE alone (n=26), RT with a normal diet (ND+RT, n=25), and TRE combined with RT (TRE+RT, n=25). The TRE diet limited food intake between 12:00 PM and 8:00 PM, whereas the ND group adhered to a standard eating pattern without time restrictions. All groups adhered to iso-caloric diets with a protein intake of 1.5 g/kg/day. RT sessions were conducted with up to three participants and supervised three times per week. Each 60-minute session included a full-body workout consisting of nine exercises targeting major muscle groups. HFC, measured by magnetic resonance spectroscopy, and glycemic markers were assessed pre- and post-intervention. Data were analyzed using ANCOVA, with baseline values as covariates, and logistic regression was applied for dichotomous variables.

RESULTS: Of the initial 76 participants, 68 completed the study: 22 in the TRE alone, 22 in the ND+RT, and 23 in the TRE+RT groups. Following the 10-week intervention, although weight loss was minimal in all groups (0-1.6 kg), significant differences were observed between ND+RT and both TRE alone (1.8 kg, p = 0.01) and TRE+RT (1.57 kg, p = 0.01), with no difference between TRE alone and TRE+RT (0.25 kg, p = 0.57).

Compared to TRE alone (-4.6%±6.4, relative change -24.3%±29.6), HFC reductions was significantly greater for the TRE+RT group (-7.1% ± 7.7, relative change -41.1% ± 31.6, p<0.05 for both), but not for the ND+RT (-5.5% ± 6.8, relative change -32.6% ± 27.6). A >30% reduction in HFC was achieved by 73.9% of participants in the TRE+RT group compared to 59.1% in the ND+RT group (p=0.23) and 40.9% in the TRE group (p = 0.028). The TRE+RT achieved the largest reductions in insulin (-5.2 ± 10.2 µU/ml) and HbA1c (-0.07 ± 0.12%), followed by moderate reductions in the ND+RT group (insulin: -2.6 ± 12.7 µU/ml; HbA1c: -0.07 ± 0.27%), and minimal changes with TRE alone (insulin: -0.97 ± 9.5 µU/ml; HbA1c: -0.03 ± 0.24%). However, none of these differences reached statistical significance compared to TRE alone.

CONCLUSION: In overweight/obese adults with MetS, TRE+RT demonstrated significantly greater reductions in HFC compared to TRE alone, independent of substantial weight loss. These findings highlight the distinct advantages of combining TRE with RT for managing MASLD and emphasize the role of RT in HFC reduction, potentially mediated by improved insulin sensitivity.

**PLASMA LIPIDS AMONGST OLYMPIC WOMENS 7S RUGBY PLAYERS: DO THEY DIFFER BY RISK OF LOW ENERGY STATUS?**

BLACK, K., MATKIN-HUSSEY, P., BAKER, D.

*UNIVERSITY OF OTAGO*

INTRODUCTION: Problematic Low Energy Availability (LEA) can result in Relative Energy Deficiency in Sport (REDs) which has multiple adverse health effects. Research investigating its impact on cardiovascular health is limited and conflicting, but suggests problematic LEA is associated with unfavourable lipid profiles and endothelial dysfunction. To date no studies have investigated the cardiovascular effects amongst elite team sport players.

METHODS: Eighteen players of Māori or Pacifica descent who were part of the Olympic women's 7s squad participated in this study. The Low Energy in Females Questionnaire (LEAF-Q) was used to group players as at risk or not at risk of LEA. Blood samples were collected and measured for plasma lipids, and inflammatory markers. Arterial stiffness was measured by pulse wave velocity (PWV) (SphygmoCor Xcel PWV and PWA system, AtCor, Medical Pty Ltd). Energy intakes were obtained via three day diet records, which were analysed via Foodworks using the New Zealand database.

Independent sample t-tests were performed, significance set at p≤0.05. Results are presented as mean ±standard deviation, mean difference(95% confidence intervals).

RESULTS: Similar to other research ten (55%) players were classed as at risk of LEA. Those at risk of LEA had a significantly lower energy intake (8053±1,999 kJ vs 11,072±1,951 kJ, p=0.05). Low-density lipoprotein was moderately higher by 11.3% in those at risk (2.42± 0.75 mmol.L-1 vs 2.14±0.45 mmol.L-1, 0.15 (95%CI: 0.73, -0.43)mmol.L-1) p=0.19. Whereas high-density lipoprotein concentrations were 10.7% lower, but not statistically different between groups (1.50±1.31 vs 1.64± 0.44 mmol.L-1, 0.29 (95% CI: 0.07, -0.65) mmol.L-1 p=0.31). There was no statistically significant differences for ApoA nor ApoB, p>0.05. There was a small elevation pulse wave velocity (6.55 ± 1.54) ms-1 for those at risk compared to not at risk 5.69 ± 1.11 ms-1 (0.86 ms-1 (2.40, -0.68) p=0.22).

CONCLUSION: There is a small body of literature suggesting athletes at risk of LEA have different blood lipid profiles compared to those not at risk. It is plausible that decreases in estrogen seen with REDs are responsible for changes in plasma lipids. However, not all studies have shown differences in lipid profiles. The results from the current study were not significantly different, but may have some clinical relevance. The large standard deviations and small sample size likely contrib-

ute to the lack of statistical findings, but this study does reflect the small pool of elite female 7s players. This study shows female 7s players at risk of LEA which may impact their cardiovascular health. Therefore, all involved in Rugby 7s should be aware of REDs. Further, specialist medical teams should lead diagnosis and treatment, as signs of REDs can also signify other health conditions.

**THE EFFECTS OF HIGH INTENSITY INTERVAL TRAINING IN HYPOXIA ON GLUCOSE REGULATION AND INSULIN SENSITIVITY IN SEDENTARY INDIVIDUALS WITH OVERWEIGHT OR OBESITY**

SOO, J., GOODS, P., GIRARD, O., DELDICQUE, L., LAWLER, N., CHARLESWORTH, J., FAIRCHILD, T.

*MURDOCH UNIVERSITY*

INTRODUCTION: Obesity and reduced physical activity are closely associated with impaired insulin sensitivity and glucose regulation. High intensity interval training (HIIT) increases reliance on muscle glycogen, and consequently results in improved insulin sensitivity. Consequently, HIIT in hypoxia may enhance these effects. Accordingly, the aim of this research was to investigate the chronic effects of a 10-week HIIT intervention in hypoxia on insulin sensitivity and glucose regulation in sedentary individuals with overweight and obesity.

METHODS: 30 sedentary individuals with overweight or obesity (36±7 yrs, BMI 33.9±6.5, body fat percentage: 40.2±7.0%) underwent 10 weeks (3 session/week) of exercise training which consisted of 2 weeks of standardised training in normoxia followed by 8 weeks of HIIT training with (HYP) or without hypoxia (NOR). Each session consists of four to six, 1-min cycling bouts performed at a rating of perceived exertion (RPE) of 16 interspersed with 4-min of recovery at RPE 10, and resistance exercise (comprising 4 different exercises, always performed in normoxic conditions). Body composition and glucose tolerance (via an oral glucose tolerance test; OGTT) was examined before and after the 10-week training program. The primary analyses included all data irrespective of dropouts and completeness of outcome measures (intention to treat). Linear mixed method models were used with condition, time, and interaction defined as the fixed effects and participants as random effects.

RESULTS: There was no significant effect on glucose area under the curve (AUC) during the OGTT in either condition (pre-post diff: HYP: -47±131mmol/L/120min; NOR: +31±92mmol/L/120min, p=.55). Within-group differences in insulin AUC was reduced after training in HYP (-1346±2209mU/L/120min, p=.03, g=0.26) but not NOR (-270±1165 mU/L/120min, p=.28, g=0.11) with no difference between groups (p=.73). Insulin AUC normalised for glucose AUC was not significantly different in either condition. There was no difference in insulin resistance (HOMA2-IR) following training in both groups (HYP: 1.34 vs 1.38; NOR: 1.12 vs 1.06, p=.41, g=0.03). Within group differences in fat mass (FM) and fat free mass (FFM) were reduced and increased, respectively in HYP (FM: -0.97±1.89kg, p=.03; FFM: +1.89±2.6kg, p=.04) but not NOR (-0.51±2.85kg, p=.29; FFM: +0.21±1.76kg, p=.36).

CONCLUSION: Perceptually regulated HIIT performed in hypoxia demonstrated a tendency for improvement in body composition compared to matched training in normoxia. Additionally, reductions in insulin AUC suggest an improvement in insulin sensitivity, although this did not reach statistical significance. Participants were however, normoglycemic at baseline, possibly limiting substantial changes in metabolic outcomes. Future studies are needed to investigate the efficacy of HIIT in hypoxia on glycemic control in individuals with impaired glycemic function.

## Invited Symposium

### IS-MH02 International perspective on how PA impacts mother, cord, & baby metabolome & inflammation

**GESTATIONAL PARENT & CORD BLOOD METABOLOME LINKS TO PHYSICAL ACTIVITY STATUS IN PREGNANCY**

ADAMO, C.

*UNIVERSITY OF OTTAWA*

Background: Gestational physical activity (PA) reduces the risk of pregnancy and birth complications, such as gestational diabetes, gestational hypertension, and macrosomia. While the benefits of PA during pregnancy are well documented, the mechanisms behind these effects remain unclear. Studying the metabolome and how it responds to PA can be valuable in understanding these mechanisms. Investigating the metabolome response to PA may clarify these mechanisms, yet limited data exist on the metabolomic profile of gestational parents (gesP) and cord blood metabolome associations with PA. Purpose: We aimed to i) examine the association between PA and gesP serum metabolome in mid-pregnancy, ii) explore cord blood metabolome associations with PA for participants who maintained their PA status from mid (24-28 weeks) to late gestation (34-38 weeks). Methods: Twenty-nine participants were classified as "active" or "inactive" based on their objectively assessed (accelerometer) PA data. Untargeted metabolomics using Ultra-Performance Liquid Chromatography-Quadrupole Time-of-Flight Mass Spectrometry provided a global metabolic profile, with data processed in MS-DIAL and analyzed via MetaboAnalyst 6.0. Results: Based on the clustering of the samples in PCA and PLS-DA plots, no major serum metabolome differences were found between physically active and inactive pregnancies. Inactive participants were shown to have higher pipecolic acid, a lysine derivative. Receiver Operating Characteristic (ROC) analysis revealed that pipecolic acid and phosphatidylcholine (18:1e/8-HEPE) exhibited a fair ability to discriminate between the active and inactive groups (AUC>0.7). The cord blood metabolome analysis revealed a moderate separation between the metabolome of babies born to active vs. inactive pregnancies. Babies born to active pregnancies showed significantly

lower levels of phenylalanine, valine, threonine, lysophosphatidylcholine (LPC) 16:0, LPC 18:2, LPC 18:1, O-acetylcarnitine, and 5-hydroxyindole-3-acetic acid. ROC analysis identified several metabolites with discriminatory power in cord blood. The marked difference between the gesP and cord blood metabolomes suggests a closer correlation between cord blood metabolome and the placental metabolome than gesP serum metabolome. Conclusion: Gestational PA can affect the gesP and fetal metabolome, with the magnitude of the effect being much higher in the fetus. The protective effects of gestational PA likely modulate pathways involving the identified metabolites, possibly by enhancing antioxidant capacity and reducing inflammation.

**MATERNAL-PLACENTAL-FETAL CYTOKINES & METABOLITES RELATED TO PHYSICAL ACTIVITY**

ACOSTA-MANZANO, P.
*UNIVERSITY OF GRAZ*

Pregnancy induces remarkable immunometabolic changes in physiology to support maternal, placental-fetal demands, thus ensuring a successful gestation. Challenges to homeostasis are common in pregnancy. For some women, particularly those exposed to an adverse lifestyle (e.g., suboptimal eating habits, sedentary time, sleep hygiene, or stress), these alterations might lead to adverse short- and long-term outcomes. Indeed, the harmful consequences related to a dysfunctional metabolic machinery in pregnancy have the potential to negatively affect not only one life, but two (the mother and child), and possibly the next generation. Consequently, research institutions are focused on identifying effective strategies to promote an optimal maternal and intrauterine environment, and to break the maternal-fetal intergenerational diabesity cycle. In this regard, physical activity (PA) and exercise are promising tools to optimize metabolic control during pregnancy, and thus avoid potential complications and future diseases, such as obesity. Unfortunately, available evidence remains scarce and inconclusive, leaving many questions unanswered. To address this knowledge gap, we have led and collaborated on several pregnancy clinical studies examining the impact of PA on maternal, placental and fetal phenotypes, as well as the biological mechanisms driving PA beneficial adaptations. We have demonstrated that maternal PA and concurrent exercise of moderate to vigorous intensity can optimize the inflammatory profile of pregnant women with a healthy weight and with overweight-obesity, and of their fetuses. Exercise was also found to slightly attenuate the maternal–fetal pro-inflammatory status (pro-inflammatory cytokines) associated with excessive weight gain. Additionally, our results showed that the influence of exercise on traditional maternal metabolites (e.g., lipids) was minimal, except in those exercisers who increased the levels of specific cytokines (IL-8), where exercise was related to lower maternal total cholesterol and low-density lipoprotein-cholesterol gains. Regarding placental adaptations, we have shown that sedentary time during pregnancy is related to higher placental IL-6 gene expression and lower cord blood IL-6 content, while moderate-to-vigorous PA has minimal influence. Moreover, we identified placental IL-6 gene expression as a potential mechanism linking sedentary behaviour to neonatal adiposity. Finally, our recent findings suggest that exercise modulates key placental cytokines and metabolites involved in placental-fetal adaptations in a sex-dependent manner. Thus, this lecture will provide deeper insights into how maternal sedentary time, PA and exercise influence maternal, placental and fetal cytokines and metabolites in pregnant women with a healthy weight status and/or with overweight/obesity. The target audience of this lecture are exercise scientists, physiologists, and clinicians working with pregnant women and children.

**INFANT CYTOKINES & METABOLITES RELATED TO MATERNAL EXERCISE TYPES & CLINICAL IMPACT**

MAY, L.
*EAST CAROLINA UNIVERSITY*

World-wide there are increasing rates of non-communicable diseases, such as obesity, and cardiovascular disease, especially in women of child-bearing age. Thus, it is critical to develop strategies to prevent the intergenerational cycle of obesity. Data supports that maternal physical activity (PA), and exercise positively influence pregnancy outcomes and offspring health. However, little is known about maternal exercise type on infant health phenotype via metabolite and inflammatory signatures. To elucidate the biological mechanisms behind positive adaptations to maternal exercise and identify potential targets for clinicians and future interventions, we assessed infant metabolite & inflammatory markers; women did aerobic (AE), strength (SE), combination (aerobic + strength, AESE), or attention-control (CON) for 24+ weeks of pregnancy. We hypothesized that any maternal exercise type will be associated with improved infant metabolite and inflammatory profile. Blood samples from the infant were processed with Untargeted metabolomics using Liquid Chromatography-Quadrupole Time-of-Flight Mass Spectrometry (LC/MS/MS) for a global metabolic profile, as well as multiplex kits for pro- and anti- inflammatory cytokine expression. Based on clustering, there are 4 distinct metabolite signatures from infants exposed to maternal exercise types. There are specific pathways that are up- and down-regulated in the exercise-exposed infants relative to infants from controls; however, there are also exercise-type specific metabolite changes as well. Additionally, key cytokine expression (i.e., IL-6, IL-8) are different based on exercise-type exposure in utero. We will discuss the impact of maternal exercise mode on infant cytokine and metabolomic phenotype relative to infants of those in the non-exercise group. Maternal exercise is also associated with metabolic pathways associated with controlling appropriate inflammation in infants of exercisers compared to infants of controls. Our data suggests that any maternal exercise type can improve infant cytokine and metabolomic phenotype. These changes in offspring cytokine/inflammation and metabolomic signature suggest improved overall phenotype and thus could decrease the propensity to develop obesity and associated cardiometabolic conditions later in life. The target audience of this lecture are

researchers in the field of physical activity in pregnancy, clinicians working with pregnant women and children, as well as exercise professionals.

## Oral Presentations

### OP-PN01 Physiology of Fatigue I

**MUSCULAR RESPONSES TO ACUTE AND CHRONIC FINGER FLEXORS BLOOD-FLOW RESTRICTION TRAINING IN EXPERIENCED SPORT CLIMBERS.**

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INTRODUCTION: In sport climbing, high-load resistance training (HLRT) is traditionally used for performance enhancement, with an important part of it dedicated to improving finger specific isometric flexor digitorum (FD) muscle strength and endurance. However, specific FD training at high intensity can be traumatic, often leading to injuries in climbers. Low-load blood-flow resistance training (LLBFR) has been shown to be a promising substitute to HLRT for promoting strength and endurance while reducing mechanical stress on tissues (e.g. lower training loads). However, the physiological responses associated with LLBFR to climbing-specific exercises are poorly understood. Therefore, the aims of the study were to i) examine acute and chronic muscular responses to LLBFR during climbing specific FD training, and ii) compare these responses to HLRT.

METHODS: An acute and a chronic phase were completed. The acute phase involved 15 advanced to elite climbers who conducted two bouts of three sets of FD intermittent exercise on a hangboard under two experimental conditions in a randomized order: 1) HLRT (~70% maximal voluntary contraction, MVC); 2) LLBFR (~40% MVC with a cuff pressure of 60% of the individual limb occlusion pressure). Finger flexors muscle oxygenation was measured throughout exercise by near-infrared spectroscopy; muscle fatigue was quantified as MVC decrement 1, 5 and 15 min post exercise. Perceived discomfort, effort, and finger pain were assessed at the end of each set. Moreover, 36 advanced to elite climbers participated in the chronic study phase and were randomized to 3 groups: LLBFR, HLRT and a control group (CON). Participants of the LLBFR and HLRT groups conducted the specific training session presented in the acute study phase twice a week over 5 weeks, while the CON group maintained their usual climbing routine. FD MVC, endurance and oxygenation and brachial artery blood flow during contraction were measured before and after the training protocol.

RESULTS: The acute study phase demonstrated higher muscle fatigue in LLBFR than in HLRT 1 min post exercise (25±8% vs 19±7% of MVC loss, p=0.016), which recovered faster, leading to similar fatigue between the two modalities 15 min post exercise. LLBFR led to greater muscle deoxyhemoglobin values (+20±25%, d=0.9), greater upper-limb discomfort during inter-sets recoveries, and less finger pain during exercise. The chronic phase showed that LLBFR and HLRT induced similar improvements in FD MVC (+9±8%, d=1.0 and +13±11%, d=1.2, respectively), and endurance (+22±15%, d=1.7 and +24±21%, d=1.2, respectively).

CONCLUSION: Climbing specific LLBFR FD training led to comparable chronic muscular adaptations to HLRT, while reducing exercise intensity and FD pain. These chronic adaptations may be due to the repetitive acute higher metabolic stress during LLBFR sessions, illustrated by the higher muscle fatigue and greater deoxygenation, despite lower mechanical stress.

**HIGH-VELOCITY ISOTONIC KNEE-EXTENSION FATIGUING EXERCISE AFFECTS MOTOR UNIT BEHAVIOUR**

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INTRODUCTION: Performance fatigability alters neuromuscular function in a task-dependent manner [1,2]. In isometric conditions, the motor-unit (MU) discharge behavior appeared to be adjusted differently when performing intermittent or sustained contractions [3]. After knee-extension isokinetic exercise at slow speed, MU discharge rate increased to overcome peripheral impairments [4]. During daily life, dynamic tasks at various speed are usually performed and it remains unclear how high-velocity contractions affect MU discharge characteristics. This study aimed to investigate the MU behavior immediately after a maximum-velocity isotonic fatiguing exercise.

METHODS: Healthy young participants (n=16, 4 females) underwent a fatiguing task consisting in 80 maximal-velocity isotonic contractions (1 every 3 s) at 40% of the maximal voluntary isometric contraction (MVIC) torque [5]. Power output was quantified at the initial and final phases of the exercise. MVIC with voluntary activation (VA) and potentiated resting twitch (St) were assessed, through femoral nerve stimulation, before (PRE) and immediately after (POST) the exercise. Vastus lateralis high-density electromyography signals were recorded during isometric contractions at 25% of MVIC (10s ramp + 10s plateau) both in PRE and POST. MU spike trains were decomposed and edited. Recruitment threshold (RT) of each MU was normalized by the MVIC PRE to categorize MUs into early-recruited (0-12.5% MVIC) and late-recruited (LR; 12.5-25.0% MVIC) populations. Mean discharge rate (DR) was analyzed during recruitment (first 5 spikes) [6] and plateau phase (10s) of each MU. The coefficient of variation (CoV) of force was calculated during the plateau at target force.

RESULTS: Power output started from 247±81W and it decreased by 36±18%. MVIC torque declined from 168.1±39.4Nm to 110.9±31.5Nm (p<0.001). VA and St torque decreased in POST (all p<0.04). Global EMG amplitude increased after the fatiguing task (p=0.02). During ramps, RT did not change (24.9±6.1Nm; p>0.05). Mean DR increased during recruitment phase (7.9±1.7 to 8.6±2.6pps in POST; p=0.007) but not during plateau. Notably, only the LR MUs exhibited increased DR both at recruitment (7.8±1.5 to 8.9±2.9pps; p=0.002) and plateau phases (10.0±1.6 to 10.8±2.5pps; p=0.02). CoV of force increased from 2.6±0.9% (PRE) to 3.8±2.4% (POST; p=0.03).

CONCLUSION: High-velocity fatiguing task induced loss of muscle force and power due to impairments in both voluntary activation and muscle contractile proprieties. Following the maximal-velocity fatiguing task, mean motor unit recruitment discharge rate increased while only late-recruited MUs showed a higher discharge rate in the plateau phase. Thus, in fatiguing state, impaired central motor drive and excitation-contraction coupling affect motor unit behavior to maintain absolute force output

References: 1. Adam & De Luca, 2005; 2. Taylor et al., 2016; 3.Valencic et al., 2024; 4. Hirono et al., 2022; 5. Sundberg et al., 2018; 6. Del Vecchio et al., 2020

**USE OF SUBJECTIVELY REPORTED PARAMETERS OF PHYSICAL AND MENTAL FATIGUE, SLEEP AND STRESS FOR ASSESSMENT OF ULTRA-ENDURANCE CYCLING INDUCED COGNITIVE IMPAIRMENT (VELOREALITY)**

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INTRODUCTION: Objectively determined physical and mental fatigue has detrimental effects on cognition. However, subjective perception of fatigue can vary significantly from person to person. The aim of this study was to determine an extent to which subjectively reported parameters (SRPs) of physical and mental fatigue can be used to assess cognitive performance.

METHODS: 39 male and 4 female amateur cyclists (38.8±8.7 y/o, BMI: 25.2±2.8 kg/m2) who completed an ultra-endurance cycling race in under 24-hours completed cognitive function test battery (Stroop test (ST), Finger tapping test (FTT)) pre-race, post-race and ~20h in the recovery period. Additionally, following SRPs were evaluated: sleep hours, sleep quality, mental fatigue, physical fatigue, physical strength, stress levels during the previous day, effort to answer the questions in a scale from 1 to 10. Changes between the timepoints were assessed by one-way repeated measures ANOVA or Friedman test. The association between cognitive function test variables that changed significantly and SRPs was analysed using mixed model regressions.

RESULTS: Significant change in all SRPs except for stress levels during the previous day was observed from pre- to post-race (p<.001). While in recovery sleep quality, mental fatigue and effort to answer the questions had returned to pre-race levels, there was a significant increase in sleep hours, physical fatigue and reduced physical strength reported. The increase in muscle pain in post-race (from 2 (1;2) to 5 (4;8) was sustained in recovery (5 (3;7), p<.001).

The post-race ST average time for correct reaction of all 3 stages increased: by 22, 35 and 68 ms (p<.001), correspondingly. Stage 1 and 3 values returned to baseline in recovery, yet stage 2 showed an improvement compared to baseline (from 651 (88) to 630 (89) ms, p<.001). Performance in ST stage 2 was associated with a better sleep quality, reducing the average time for correct reactions by 10.10 ms (p<.001) for a point increase. In stage 3, average time for correct reactions was increased by stress levels during the previous day by 12.80 ms (p=.015) and decreased physical strength by 12.70 ms (p=0.006) per point.

FTT showed impaired performance of the non-dominant hand in post-race; average number of taps decreased from 54.7 (6.4) to 52.0 (6.9), p<.001, average interval between taps increased from 189.0 (22.5) to 202.0 (27.1) ms, p<.001 and returned to baseline in recovery. Higher effort to answer questions was associated with a diminished performance in the FTT for non-dominant hand (p=0.028).

CONCLUSION: A single SRP cannot estimate the changes in cognition, but perceived effort to answer the questions is associated with fine motor performance measured by FTT, and sleep quality, stress levels and physical strength are associated with executive functions measured by ST.

**A DETAILED INVESTIGATION OF THE NEGATIVE EFFECT OF MENTAL FATIGUE ON PHYSICAL PERFORMANCE: A RANDOMIZED CROSSOVER TRIAL WITH 117 PARTICIPANTS**

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INTRODUCTION: Mental fatigue (MF) is defined as a psychobiological state that arises after a period of prolonged demanding cognitive activity. Research has shown that MF negatively influences physical performance, which has been linked an increase in the rate of perceived exertion (RPE). However, there are still numerous variables, such as pacing and other subjective values, that have been underexplored in the negative impact of MF on physical performance. The aim of the present study is to examine these specific variables and their interaction to get a clearer image on how MF affects physical performance.

METHODS: 117 participants (60♂, 32.2±8.6y, 22.6±2.6kg/m2, 47.6±9.4ml/min/kg) were included in this randomized crossover trial, consisting of a familiarization, intervention and control visit. MF was induced using a 45 min Stroop task, while the control condition consisted of a documentary of the same duration. The level of MF was checked using a visual

analogue scale (MVAS) and by analysing performance on a pre/post GoNoGo task. Physical performance was assessed using a 15 min cycling time trial (TT). Primary outcomes include distance covered, power output and cadence. Secondary outcomes collected during the TT were physical fatigue (PVAS), RPE, MVAS, lactate, blood glucose, motivation (MotiVAS) and mental demand (NASA-TLX). Paired sample t-tests and linear models (or non-parametric equivalents) were used for analysis.

RESULTS: Mental fatigue was successfully induced, as seen in the interaction effect between condition and time in the subjective level of MF ($F=122.78$; $p<0.001$; $\eta p2=0.15$) and GoNoGo task performance ($F=24.74$; $p<0.001$; $\eta p2=0.08$). A trend towards significance was found regarding the influence of MF on TT distance ($t=-1.92$; $p=0.058$; $d=0.20$), with a significant negative influence on cadence ($t=-2.06$; $p=0.042$; $d=0.22$). This significant influence is also seen when comparing cadence values throughout the TT ($F=26.65$; $p<0.001$; $\eta p2=0.02$). There was no influence of MF on the mean ($V=1749$; $p=0.300$; $r=0.08$) and maximal ($V=2245$; $p=0.162$; $r=0.10$) power output. Linear models also showed significant increases in RPE ($F=7.19$; $p=0.007$; $\eta p2=0.005$), PVAS ($F=18.30$; $p<0.001$; $\eta p2=0.01$) and MVAS ($F=288.56$; $p<0.001$; $\eta p2=0.19$) values collected during the TT in the MF condition. A trend towards a significant decrease in motivation in the MF condition before the start of the TT was also found ($t=1.87$; $p=0.064$; $d=0.19$). There was no effect of MF on mental demand, blood glucose and lactate ($p>0.05$).

CONCLUSION: The present study shows a significant effect of MF on a number of variables that were collected during the TT, with specific influences on pacing and the different collected subjective variables, and with a large degree of interindividual variability between the over 100 included participants. Not only can these results be used to further update current mechanistic models of MF, it also informs us on the different possible pathways of future research, such as a focus on this extensive variability.

**CURRENT PRACTICE AND RECOMMENDATIONS FOR THE QUANTIFICATION AND INDUCTION OF MENTAL FATIGUE IN MOVEMENT SCIENCE**

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INTRODUCTION: Mental fatigue (MF) is a complex psychobiological state, resulting from prolonged cognitive activity, known to significantly impair physical and cognitive performance. Despite extensive research, inconsistencies in methodologies for inducing and quantifying MF hinder comparability across studies and lead to inconsistent findings. A standardized approach is essential to enhance methodological rigor, ensure reproducibility and advance our understanding of MF. However, a comprehensive synthesis of procedures employed for inducing and measuring MF, and clear guidelines, remain lacking.

METHODS: A review of the literature was conducted to present an overview of the methods currently used to induce and quantify MF in movement science. This review critically evaluates their strengths and limitations and introduces a structured framework to utilize or design cognitive tasks to induce MF. Additionally, an in-depth analysis of MF quantification methods was performed, considering subjective, behavioural, and physiological measures, with the benefits and drawbacks of each. Finally, to improve research consistency, reporting guidelines were developed.

RESULTS: Based on 106 reviewed studies, two frameworks (MF induction and quantification) and a checklist-based reporting guideline were developed.

The Three Task Properties Framework provides a structured approach to design MF-inducing tasks, emphasizing three core elements: task duration, difficulty and nature. Context is central to the framework, as it influences all aspects of both induction and control tasks. Depending on the study's objectives, trade-offs between task properties may be necessary, such as adjusting task duration in favor of difficulty or complexity.

Three primary MF quantification domains were identified. Physiological measures are considered the most 'objective' measure of MF, however they are typically costly and technically demanding. Bevahioural assessments are considered the most 'valid' but make it difficult to isolate specific MF effects. Finally, subjective measures are considered the most 'sensitive', however, they are susceptible to response bias. Ideally, researchers should use an outcome of at least two domains to quantify MF as holistically as possible.

To enhance research consistency and transparency, the SPeCIFY (Settings, Protocol establishments, Confounders, Individuals, Framework, and Yield) reporting guidelines were developed. The SPeCIFY guidelines address essential aspects such as environmental settings, protocol specifics, participant characteristics, and control of confounding factors.

CONCLUSION: By presenting frameworks for MF induction and quantification, this review provides a structured approach to improving the methodological quality of MF research and generalizability of study results. Moreover, by designing the SPeCIFY reporting guidelines, the present review offers a tool to enhance study transparency and replicability, addressing the key challenge of methodological variability.

Invited Symposium

## IS-PN01 Human skeletal muscle plasticity studied with single-nuclei RNA sequencing and novel spatial proteomic approaches

### SINGLE NUCLEI TRANSCRIPTOMICS TO UNRAVEL THE MECHANISMS OF SKELETAL MUSCLE HOMEOSTASIS IN DISUSE

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Inactivity can be considered a pandemic, causing 5 million deaths per year, decreasing exercise tolerance and dramatically increasing disease risks. The major phenomena occur at the level of muscle (loss of mass and strength), nervous system (impairment in central and peripheral motor control) and metabolism (impaired oxidative metabolism and insulin resistance). So far, most studies aiming to clarify the mechanisms underlying muscle deterioration following disuse focused on structure and function of muscle fibers and on intracellular pathways controlling muscle mass, metabolism, and redox balance. However, a clear and comprehensive explanation of why loss of muscle mass and force occurs is still lacking, especially in humans. Global transcriptomics recently provided important clues on the mechanisms underlying muscle adaptations. However, such approach has some important limitations. It has been recently understood that up to 40% of all skeletal muscle nuclei are not from myofibers and that although satellite cells are the stem cells regenerating skeletal muscle fibers, other resident mononuclear cell populations (including Fibro-Adipogenic Progenitors (FAPs), endothelial cells and immune cells) play important roles not only in regeneration, but also in normal muscle homeostasis in conditions such as disuse and ageing. Global transcriptomic analysis fails to assess individual cells gene expression. Hence, the complex interactions among muscle fibers and mononuclear cells in muscle homeostasis are missed. One of the ways to address most of the above limitations is to extract all nuclei from muscle samples and perform single nuclei RNA-Seq (snRNA-Seq). The key advantages of such approach are: (i) define clusters of nuclei representing different mononuclear resident cell types and nuclei of muscle fibers (NMJ; myotendinous junction (MTJ); nuclei along the length of muscle fibers or myonuclei) by means of specific marker genes (ii) study gene expression of each cluster of nuclei, addressing the heterogeneity of gene expression among different cells and of different nuclei of muscle fibers. This approach should enable to address the interplay among the heterogeneous cell populations orchestrating muscle homeostasis. Prof Bottinelli will guide the audience through the journey to study human skeletal muscle deterioration following disuse with the above-mentioned approaches, the findings and limitations that each of them entail together with preliminary findings obtained applying snRNA-Seq on human muscle samples from young subjects before bed rest, after 10 and 21 days of BR an after 3 weeks recovery.

### A TRANSCRIPTOMIC AND SPATIAL PROTEOMIC ATLAS OF HUMAN AGING AND SARCOPENIA

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Aging is associated with a progressive decrease in muscle mass and strength. Sarcopenia is the clinical manifestation of the extreme age-related muscle atrophy and weakness, and affects approximately 50 million people worldwide. Severe consequences of sarcopenia include increased frailty and reduction in ability to perform basic life functions, leading to higher risk of falls, increased healthcare costs, institutionalization, and mortality risk. Diagnosing and treating sarcopenia is challenging because of the complex pathophysiology of sarcopenia, which is a multifactorial syndrome. Current research lacks comprehensive studies investigating the mechanisms involved in sarcopenia development and progression in humans, which hinder the ability to identify biomarkers for its diagnosis and effective drugs to slow down its progression. Dr. Monti will present data showing transcriptomic (snRNA-seq, single cell RNA-seq, ATAC-seq) and proteomic changes observed in aging and late aging as well as data personally generated from 67 muscle biopsies from 15 young (18-35 years old) and 52 aged (>70 years old) stratified for sarcopenia according to the most updated guidelines. These samples were processed using snRNA-seq and, for the first time, CODEX spatial proteomics technologies, with the aim to generate the first matched transcriptomic and spatial proteomic atlas of human aging and sarcopenia, encompassing changes in muscle cell type composition and spatial interaction and changes in gene and protein expression. Evidence that will be presented show increased muscle denervation and transcriptomic changes in the neuromuscular junction nuclei, altered mitochondria biogenesis, complexes and metabolism confirmed by western blot analyses are aging signature exacerbated by sarcopenia. Further, sarcopenia leads to increase in immune and pro-fibrotic cells (fibro-adipogenic progenitors, FAPs), alterations in their transcriptome and cell-cell spatial interaction. The lab Dr. Monti currently works in has demonstrated with prostaglandin E2 (PGE2) to be a beneficial molecule for muscle regeneration. Decrease in PGE2 and increase in its degrading enzyme 15-PGDH were shown in old mice, and 15-PGDH inhibition rejuvenated muscle strength, force and mitochondria in old mice. Dr. Monti will show evidence for 15-PGDH to be upregulated specifically in sarcopenic patients muscles, and novel insights derived from snRNA-seq and CODEX that show how the increase in this enzyme may be implicated in sarcopenia development.

**RESISTANCE TRAINING AND MUSCLE DISUSE. ENHANCING MUSCLE PLASTICITY ANALYSIS WITH DEEP VISUAL PROTEOMICS**

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Skeletal muscle plasticity is a highly complex phenomenon, as this tissue is composed of multinucleated cellular units, slow and fast muscle fibers, with different molecular and physiological properties. In her talk, prof. Murgia will describe single fiber proteomic workflows and their limitations. She will present a novel mass spectrometry-based proteomic approach, Deep Visual Proteomics (DVP), allowing to tackle the analysis of single human muscle fibers from a spatial angle. DVP allows to analyze subcellular compartments of muscle fibers in a fiber type-resolved manner. DVP uses high-resolution imaging to guide automated laser-capture microdissection (LMD) of tissue sections, which is then followed by MS-based proteomic profiling. At the core of the workflow is artificial intelligence (AI)-guided image analysis, that allows single-cell/single shape classification and subsequent LMD-based isolation. We applied DVP to frozen sections of human skeletal muscle, with various fiber type-resolving staining as well as fluorescent lectins to mark fiber borders and guide AI-based segmentation. Compared to previous single fiber proteomic workflows, based on fibers freshly dissected under a stereomicroscope, there are at least three major practical advantages of the new DVP-based workflow on frozen tissue: i) minimal handling time from biopsy collection to freezing, making it potentially compatible with the analysis of highly reversible post-translational modifications; ii) no loss of highly soluble cytosolic proteins in the isolation solution and iii) easier multicentric sample collection due to the compatibility of the workflow with frozen tissue. The added conceptual value of DVP is that it allows to carry out proteomics of muscle subcellular compartments in a fiber type-resolved manner. Prof. Murgia will provide some data concerning the application of this workflow to study skeletal muscle plasticity in response to different activity conditions and loading states.

## Oral Presentations

### OP-AP02 Running I

**SEX-DIFFERENCES BETWEEN FEMALE AND MALE TRAIL RUNNERS WITH EQUAL PERFORMANCE CAPACITY.**

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INTRODUCTION: The sex gap in endurance performance ranges from 8–12% across most sports and is greater in uphill events due to lower maximal oxygen uptake, lean-to-fat mass ratio, muscle mass, and fewer fast-twitch fibers in women1. Yet, sex-differences between females (F) and males (M) with similar absolute performance (e.g., same-race finishing time) remain unexplored, particularly in mountain sports. This study aimed to investigate these differences in recreational trail runners.

METHODS: 53 runners (11 F, 42 M) completed a 26 km, 1920-m D+ trail race. Within 3-weeks before the race (Pre-), they performed i) anthropometrical measures; ii) a graded treadmill (slope 10%) running test to exhaustion to assess aerobic capacity, vertical velocities (Vv in vertical m per h, mv.h-1) and running energy cost (REv) at maximal (Max) and second ventilatory threshold (VT2); iii) knee extensors' maximal voluntary contraction (MVC) and rate of force development (RFD). The weekly training volume (WTV) of the 3 months preceding the race was retrieved from a popular training platform. MVC and RFD were reassessed within 20 min after the race (Post-). From the total sample, F were matched to 11 M with similar performance, and sex-differences analyzed with unpaired Student's t-tests.

RESULTS: Race time of F and M was identical (246±28 min,p=0.994). No difference in WTV was found (335±135 vs 318±131 min, p=802). F presented lower body mass index (21.1±1.2 vs 23.3±1.5 kg.m-2,p=0.001), lean body mass (LBM) (47.5±4.0 vs 64.4±4.0kg,p=0.004), and higher fat mass (16.2±2.2 vs 11.3±4.2%,p=0.004). VO2 (ml.kg-1.min-1) was similar at Max and VT2 (53.5±4.3 vs 56.9±4.8,p=.139 and 48.6±3.6 vs 51.8±5.4 ml.kg-1.min-1,p=0.122), also when expressed relative to LBM ( VO2/kgLBM; Max: 63.7±4.7 vs 64.1±5.3,p=.922; VT2: 57.9±3.9 vs 58.4±5.2 ml.kgLBM-1.min-1,p=.870). Lower Vv and higher REv relative to LBM (REvLBM) were found in F at both Max (1030±98 vs 1127±83 mv.h-1,p=0.020 and 3.74±0.40 vs 3.42±0.27 ml.kgLBM-1.mv-1,p=0.040) and VT2 (896±92 vs 983±81 mv.h-1,p=0.020 and 3.91±0.34 vs 3.57±0.27 ml.kgLBM-1.mv-1,p=0.018). When normalized to LBM, MVC (11.3±1.9 vs 11.4±1.5 $N{\cdot}kgLBM^{-1}$,p=0.960) and RFD (34.0±8.2 vs 33.8±6.2 $N{\cdot}kgLBM^{-1}$,p=0.942) were comparable between sexes. However, the relative pre-to-post decline was lower in F for MVC (-4.1±15.8 vs -17.3±10%,p=0.032) and tended to be lower for RFD (-5.3±32.6 vs -26.3±17.2%,p=0.093).

CONCLUSION: Despite comparable performance, training volume, and VO2/kgLBM, females had reduced vertical velocities at Max and VT2, likely due to higher REvLBM. These results suggest that the observed uphill sex-differences (9% in Vv in the present study) are not only due to lean-to-fat mass ratio. Moreover, females lower post-race decline in neuromuscular function confirms reduced muscle fatigability2. These findings suggest that women rely on different strategies to achieve similar performance, emphasizing the need for sex-specific training/pacing approaches.

1.Millet et al. (2025) 2.Besson et al.(2022)

**CONTRIBUTIONS OF CHANGES IN MUSCLE FUNCTION, KINEMATICS, AND RUNNING VOLUME TO IMPROVEMENTS IN RUNNING ECONOMY AFTER PLYOMETRIC TRAINING IN MIDDLE-AGED RUNNERS**

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INTRODUCTION: Middle-aged runners make up over half of all recreational runners [1] and are highly motivated to improve their endurance running performance [2]. Running economy plays a key role in endurance performance and can be enhanced by incorporating plyometric training into daily running routines [3]. Although improvements in running economy after plyometric training are suggested to be attributable to changes in muscle functions [4], kinematics [5], and running training modality/volume [6], it remains unclear which factors contribute the most in middle-aged runners. This study aimed to identify the key factors influencing the effects of plyometric training combined with daily running on running economy of middle-aged runners.

METHODS: Thirty-five male endurance runners (30-50 years) performed plyometric training twice per week for 10 weeks. The program included countermovement jumps (CMJ), jump rope, and hopping. Participants were asked to maintain their regular running volume during the intervention. Measurements were taken before and after the intervention for muscle strength (knee extension/flexion, ankle dorsiflexion/plantarflexion torques), jump performance (CMJ, drop, and rebound jump), running-related variables (running economy and kinematics) at 80% velocity of VO2max. In addition, long-distance running (≥3000 m per session) and interval training (multiple runs of <3000 m per session) volumes before and during the intervention were obtained from participants' training logs. A repeated-measures correlation analysis assessed relationships between changes in running economy and other variables, with p-values corrected using the Holm-Sidak method. Stepwise regression analysis was performed with the changes in running economy as a response variable and those of the variables that showed significant correlations with running economy changes ($P<0.05$) as independent variables.

RESULTS: Plyometric training combined with daily running significantly improved running economy (3.8%, $P=0.004$). The change in running economy was significantly correlated with those in drop and rebound jump height and index (height/ground contact time), and interval training volume ($r=-0.582$ to $-0.453$, $P\leq0.007$). Furthermore, the changes in drop jump height and interval training volume were identified as significant explanatory variables for the improvement in running economy ($R2=0.338$, $P=0.006$).

CONCLUSION: Incorporating plyometric training into daily running effectively enhances the running economy in middle-aged runners. The magnitude of improvement in running economy is influenced by increases in drop jump height and interval training volume. These findings suggest that plyometric training programs should be designed to enhance drop jump height while incorporating more interval training to improve running economy efficiently.

[1] Anderson et al. (2021) [2] Garasimuk et al. (2021) [3] Eihara et al. (2024) [4] Li et al., (2021) [5] Folland et al (2017) [6] González-Mohíno et al (2016)

**THE EFFECTIVENESS OF COLD AND HOT WATER IMMERSION IN MITIGATING POST-RUNNING FATIGUE DEPENDS ON THE EXERCISE INTENSITY AND THE PARAMETERS BEING ASSESSED**

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*UNESP*

INTRODUCTION: Cold and hot water immersion (CWI/HWI) are commonly used to mitigate post-exercise fatigability [1]. However, fatigue mechanisms are task-dependent, with the type of exercise influencing its causes and characteristics [2]. Given the specific mechanisms by which CWI and HWI may affect recovery [1], their efficacy in mitigating post-exercise fatigability may be task-dependent [3]. Therefore, this study aimed to investigate the effectiveness of CWI and HWI, compared to a placebo condition and passive rest, in mitigating fatigability following different running efforts.

METHODS: On separate occasions, recreationally trained runners underwent different recovery interventions after performing either a 40-min continuous run at a velocity corresponding to the respiratory compensation point (vRCP) (CONT, n=12, maximal oxygen uptake: 48.5±3.4 mL/kg/min) or an intermittent run at a velocity 50% above vRCP (HIIT; n=10, maximal oxygen uptake: 49.5±4.5 mL/kg/min). The recovery interventions included cold water immersion (11°C, 15-min), hot water immersion (41°C, 45-min), immersion in colored water (placebo; 26°C, 10-min), or passive rest sitting on a chair (10-min). Before and up to 24 hours after exercise, cardiac parasympathetic activity, maximal voluntary contractions (MVCs) and evoked responses of the knee extensors were assessed using the twitch interpolation technique. Additionally, cardiorespiratory responses were monitored during a brief effort (3-min run at 80% of vRCP). A two-way repeated-measures ANOVA was used to evaluate the effects of the interventions in both CONT and HIIT conditions, and partial eta squared was calculated to estimate effect sizes (ES). Statistical significance was set at $p<0.05$.

RESULTS: The ratio of the root mean square of electromyography activity of the vastus lateralis during MVCs to the amplitude of the evoked M-wave (RMS/M-wave) was higher 2 and 4 h after CONT when HWI was used, compared to placebo and passive rest (interaction effect, $p=0.01$, $ES=0.18$). In contrast, following HIIT, RMS/M-wave was higher 4 h post-exercise when CWI was used, compared to placebo and passive rest (interaction effect, $p=0.01$, $ES=0.25$). Furthermore, cardiac parasympathetic activity was higher 2 h after CONT and HIIT when CWI was used compared to placebo and passive rest (interaction effect, $p<0.01$, $ES>0.27$), and oxygen uptake during brief efforts was lower over 24 h after CONT and HIIT when HWI was used compared to placebo and passive rest (condition effect, $p<0.01$, $ES>0.16$).

CONCLUSION: In conclusion, CWI seems to mitigate central fatigue after CONT, while HWI appears to mitigate central fatigue after HIIT. In both CONT and HIIT, CWI increases cardiac parasympathetic activity 2 h post-exercise, whereas HWI reduces oxygen uptake during brief submaximal efforts over the following 24 hours.

1. Versey et al. (2013) 2. Brownstein et al. (2021) 3. Thorpe (2021)

**UPHILL VS. DOWNHILL: PHYSIOLOGICAL DETERMINANTS OF PERFORMANCE IN A SHORT TRAIL RACE**

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INTRODUCTION: Performance in trail running races is multifactorial and the classical endurance model (1) is less strongly associated with trail running performance compared to road running (2). Several studies have analyzed the determinants of these races as a whole, but little research is present on whether and how performance factors vary between different uphill and downhill race sections. This study aims to identify which physiological factors determine performance of a trail race (TOT) and to assess whether these factors differ when considering only the uphill (UH) and downhill (DH) sections.

METHODS: 54 trail runners (42 M, 12 F) completed a 26 km, 1920m D+ trail race (Malcesine Baldo Trail). Each subject underwent laboratory testing within three weeks before the competition (-pre). Tests included: body composition (%fat); maximal voluntary contraction (MVC/kg) and local endurance (LE) of knee extensor; countermovement jump (CMJ) and reactive force index (RSI); uphill incremental running test to exhaustion (fixed %10 slope) during which were measured oxygen consumption and speed at maximal (VO2max and vmax), ventilatory thresholds and energetic cost (CE). On race day, MVC, LE, CMJ, and RSI were reassessed within 20 minutes after finishing the competition (-post). Total race times (TimeTOT) and intermediate times for uphill (TimeUH) and downhill (TimeDH) segments were obtained from the official race timing system. Correlations and linear enter and stepwise regressions were performed.

RESULTS: For all our analysis (TOT, UH and DH), the best model found is formed by vmax, CE, LE-pre (adjR2: 0.76, 0.77, 0.67, for all $p<0.01$); however CE and LE-pre variables do not significantly improve the predictive ability in any of the three conditions (all $p>0.05$). UH and DH differ in terms of correlated strength factors: for UH, MVC/kg-pre (r -0.27) and CMJ-pre (r -0.34) ($p<0.05$); for DH, RSI-pre(r -0.38) and LE-pre(r -0.3) ($p<0.05$). The predictive power of the classical model (VO2max/kg, %VO2VT2, CE; adjR2: TOT 0.58, UH 0.63, DH 0.47, all $p<0.01$) is lower than the above-mentioned model for all three conditions. VO2max/kg alone predicts UH better than DH (adjR2: UH 0.58, DH 0.47, both $p<0.01$).

CONCLUSION: The classical performance model show a low predictive power of performance in this short trail race, although, the VO2max/kg alone is a good predictor of UH section, in line with previous studies (3) (i.e. single-factor determination higher than DH). Previous studies have found an interaction between lower-limb strength factors and performance in races of similar distances (4-5). Our data suggested that for UH, maximal strength and the ability to elevate the centre of gravity are more crucial, while for DH, muscle-tendon reactivity appears to play a more significant role.

1 Basset et al., 1997; 2 Waal et al., 2021; 3 Fornasiero et al., 2022; 4 Kolyfa et al., 2021; 5 Ehrstrom et al., 2018

**THE EFFECT OF 90 AND 120 MIN OF RUNNING ON THE DETERMINANTS OF ENDURANCE RUNNING PERFORMANCE IN WELL-TRAINED MALE MARATHON RUNNERS**

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INTRODUCTION: Marathon performance is largely determined by maximal oxygen uptake ($\dot{V}O_2$max), fractional utilization at lactate threshold (FULT), and running economy (RE) [1], with speed at lactate threshold (sLT) closely associated with marathon speed. Whilst these determinants are thought to deteriorate during prolonged exercise [2,3], except for RE [4], their temporal changes with fatigue remain largely unknown. This study aimed to measure the changes in $\dot{V}O_2$max, FULT, RE, and sLT after running for 90 and 120 min in the heavy-intensity domain.

METHODS: Fourteen well-trained marathon runners ($\dot{V}O_2$peak 63.1 ± 5.8 ml·kg-1·min-1; marathon time 2:46:58 ± 0:10:37 h:min:s) completed three separate visits to determine sLT, FULT, and $\dot{V}O_2$peak under the following conditions (sessions): unfatigued, and after two prolonged runs, one of 90 and one of 120 min at a fixed speed (10% Δ between LT lactate threshold 2). During the runs, respiratory gases were collected at 15 min intervals to quantify RE and fractional utilization at trial's speed (FUrun). One-way repeated measures ANOVA was used to quantify differences between conditions, with significance defined as $P < 0.05$ and effect size calculated as $\eta p2$.

RESULTS: Participants ran at 14.1 ± 0.9 km·h-1, covering 28.2 ± 1.8 km in the 120 min trial (26.0–33.0 km). Non-linear changes were found with decreases in $\dot{V}O_2$peak (-3.1%, p=0.04 (post-90); -7.1%, $p<0.001$ (post-120)) and subsequent increases in FULT (+2.8%, p=0.03 (post-90); +4.9% p=0.01 (post-120)), while RE (ml·kg-1·km-1) deteriorated more linearly with time (by 4.2% (post-90) and 5.8% (post-120), both $p<0.001$). Similarly, sLT decreased non-linearly, from 14.0 ± 0.9 to 13.5 ± 1.0 (post-90, p=0.01) and 13.0 ± 1.1 km·h-1 (post-120, $p<0.001$). Furthermore, FUrun increased substantially, from 79.3% at 15 min, to 85.6% at 90 min and 90.6% at 120 min ($p<0.001$).

CONCLUSION: In conclusion, all three performance determinants and sLT changed following 90 min, and particularly 120 min of prolonged running. These dynamic changes have strong implications for running performance and, considering the particularly exacerbated changes between 90 and 120 min, would particularly affect longer duration events such as the marathon.

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# Oral Presentations

## OP-BM01 Motor Control

### ENHANCING MOTOR IMAGERY EFFECTIVENESS WITH TENDON VIBRATION

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INTRODUCTION: Motor imagery (MI) is the mental representation of movement without concurrent execution. The fact that MI can lead to similar brain cortical areas activation than actual movement makes it a valuable training for patients with motor impairments. The effectiveness of MI training is influenced by the quality of mental representation (i.e. MI vividness), that is further correlated to corticospinal excitability measurements [1]. MI can be enhanced by simultaneous movement [2], but when movement is impossible, tendon vibration (TV) may be an alternative to provide movement-like proprioceptive feedbacks. This study investigated whether combining MI with TV is likely to enhance MI vividness.

METHODS: Ten healthy participants (8 males and 2 females, 24.9 ± 6.3 years) completed one test session. Transcranial magnetic stimulation (TMS) was used to elicit motor-evoked potentials in the right hand's flexor carpi radialis muscle at increasing stimulating intensity during four conditions: at rest (REST), during the mental representation of a maximal right wrist flexion (MI), during the application of tendon vibration on the right wrist (TV) and during the combination of MI and TV (MI+TV). At each of the 6 tested TMS intensities, MI, and TV and MI+TV trials were applied for 10 repetitions lasting 6s with 6s of rest in-between. The area under the input-output curve was computed to quantify corticospinal excitability during each condition.

RESULTS: The MI and VT conditions exhibited increases in corticospinal excitability with magnitude of 139.83% ± 124.30% ($p<0.05$) and 142.42% ± 75.20% ($p<0.01$) when compared to REST, respectively, and with no difference between MI and TV conditions ($p=0.99$). Moreover, the MI+TV condition showed a 295.23% ± 153.30% increase in corticospinal excitability when compared to REST ($p<0.01$), with values reached being greater than those observed for MI ($p<0.01$) and TV ($p<0.01$).

CONCLUSION: The key finding of this study is that combining TV and MI allowed to increase corticospinal excitability compared to MI alone, suggesting that the application of TV improved MI vividness. Overall, these results suggest that TV could therefore strengthen MI effects in individuals unable to perform voluntary movements, likely through TV-related proprioceptive feedbacks, offering a promising non-invasive approach for motor rehabilitation.

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[2] Williams et al., Behavioural brain research, 2012

### A NOVEL EXPERIMENTAL PARADIGM TO MANIPULATE THE MOTOR AND COGNITIVE DEMAND OF PSYCHOMOTOR TASKS

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INTRODUCTION: In everyday life, motor and cognitive demands are intricately related. Effort is the intentional mobilization of resources towards a task, and its perception is the awareness of this mobilization. Current experimental paradigms investigating effort and its perception isolate motor and cognitive demands (1). As integrative views of effort considering the mobilization of motor and cognitive resources are emerging (2), experimental paradigms manipulating both types of demands are needed to better understand how each domain impact effort and its perception. This study aimed to develop an experimental paradigm to manipulate both motor and cognitive demands during psychomotor tasks. We hypothesized that effort perception would increase with both types of demands.

METHODS: Two experiments were done (n=20 each), during which participants completed bimanual psychomotor tasks with computer mice (exp 1) or handgrip dynamometers (exp 2). The task consisted of identifying arrow directions displayed on a computer screen. In both experiments, there were three levels of cognitive demand; easy: identify arrow directions displayed in the center of the monitor (congruent responses), moderate: identify the opposite arrow direction (50% incongruent responses), difficult: identify opposite arrow direction (50% incongruent responses) displayed on the left and right sides of the screen (~50% of arrows pointing away from their spatial location). In exp 2, participants performed the same task and responded by squeezing either hands on handgrip dynamometers at one of two levels of motor demands: 5%

and 30% of maximal voluntary force. Performance was measured with accuracy (correct vs incorrect responses) and response time (time taken for response validation). Effort perception was measured with visual analogue scales after each 30-s block.

RESULTS: In exp 1, participants reported greater perceived effort with higher cognitive demand (main effect of cognitive demand, p<.001). In exp 2, participants reported greater perceived effort with higher motor and cognitive demands (main effects of motor and cognitive demands, p's<.001). In both experiments, accuracy decreased (main effects of motor and cognitive demands, p's<.001) while response time increased (main effects of motor and cognitive demands, p's<.048) with both types of demands.

CONCLUSION: Increasing both motor and cognitive demands lead to greater perceived effort This experimental paradigm can be used in future studies to explore effort and its perception by manipulating the motor and cognitive demands of the task. From a fundamental perspective, this will be useful to explore the neural correlates of effort and its perception. From a clinical perspective, this paradigm can be adapted into rehabilitation programs of clinical populations with cognitive and motor deficits, such as stroke patients.

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(2) Halperin & Vigotsky (2024). Sports Medicine, 54(8), 2019-2032

**ENHANCING TRIP-RESISTING SKILLS VIA PERTURBATION-BASED GAIT TRAINING USING A RESISTIVE KNEE BRACE IN HEALTHY YOUNG ADULTS**

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INTRODUCTION: Perturbation-based gait training effectively improves fall resisting skills, which are retainable over years (1) and can be partly transferred to real world scenarios (2). An essential component to recover balance following trip-like perturbations is the ability to increase the base of support (BoS) via modulation of leg-extensor muscular output. We aimed to develop a mechatronic system which unpredictably perturbs knee-extensor muscular output during gait and prove its effectiveness to enhance trip-resisting skills via repeated perturbations in healthy young adults.

METHODS: 20 young adults performed a functional gait training session on a treadmill using an electromagnetic resistive knee brace perturbing neuromuscular control during the swing phase of the gait cycle. Gait perturbations were conducted via a combination of unpredictable and sustained perturbations within a period of 20 min walking. Transfer to recovery actions in trip-like perturbation was assessed using pulling forces at subjects' ankle either in early swing (elevating strategy: ELE; n=10) or mid swing phase (lowering strategy: LOW; n=10). Twenty matched controls experienced the transfer task either with elevating or lowering strategies. 3D motion capture was used to analyse joint kinematics and centre of mass (CoM) trajectories, allowing for the calculations of margin of stability (MoS) and BoS. Leg-extensor muscular activity was determined during walking using EMG and normalised to MVC.

RESULTS: Knee muscular perturbations during walking led to a reduction in MoS and BoS (more instable body configuration) in relation to normal walking and caused a change in neuromuscular control by increasing EMG activity in the monoarticular knee extensors during swing phase and in the plantar flexors during push-off (p<.05). In the transfer tripping-task, the LOW group showed a higher MoS and BoS at touchdown of the perturbed leg in relation to the control group (p<.05) and required less recovery steps to reach positive MoS values following perturbation. Statistical parametric mapping identified differences in lower limb joint kinematics following a trip-like perturbation, with greater knee extension angles for LOW compared to control (p<.05). There were no differences between ELE and controls in the analysed parameters during tripping.

CONCLUSION: Unpredictable and sustained perturbations at the knee during walking lead to adaptive changes in balance recovery responses which were transferred to trip-like perturbations, hence highlighting the relevance of knee extensor neuromuscular function for fall resilience. However, due to differences in neuromuscular control between elevating and lowering strategies, the effectiveness of knee extensor perturbation-based exercises in transferring locomotor adaptive changes to various trip scenarios seems to be limited.

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**SPECTRAL POWER AND EVENT-RELATED POTENTIALS ASSOCIATED WITH COGNITIVE-MOTOR DUAL-TASK BALANCING IN EARLY PARKINSON'S DISEASE**

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INTRODUCTION: Individuals with Parkinson's Disease (PD) often compensate for impaired automatic balance control by recruiting additional attentional resources for motor tasks. However, as the disease progresses, cognitive function also deteriorates, further compromising postural stability. The interaction between cognitive and motor systems in the early stages of PD remains insufficiently understood. This study aimed to elucidate behavioral and neurophysiological changes in early-stage PD, providing a more precise characterization of disease-related deviations from healthy cognitive and motor functioning.

METHODS: Eighteen individuals with PD (mean age: 62.9 ± 6.6 years) and 18 age-matched healthy controls (mean age: 62.9 ± 6.4 years) performed three tasks: (i) a balance single-task in a semi-tandem stance (ST-sts), (ii) a visual oddball single-task featuring conflicting Stroop color-word stimuli (ST-Stroop), and (iii) a dual-task (DT) combining both. Postural stability was assessed via center-of-pressure displacement using a force plate, while neurophysiological responses were recorded using 128-channel electroencephalography (EEG).

RESULTS: Participants with PD exhibited reduced ($p = .009$) and slower ($p = .008$) postural sway compared to controls. Additionally, less sway was observed during DT than ST ($p < .001$). EEG analyses revealed distinct spectral activity patterns across both groups: central midline low-frequency (delta, theta) power increased with cognitive load ($p < .012$), centroparietal beta desynchronization intensified with motor engagement ($p < .050$), and parietal alpha desynchronization was more pronounced in DT ($p = .025$), underscoring the functional roles of specific frequency bands in cognitive-motor integration. Additionally, PD participants compared to healthy controls exhibited prolonged event-related P300 responses ($p = .034$), a component associated with conflict resolution, suggesting compensatory neural strategies or impaired neural efficiency.

CONCLUSION: In PD, reduced sway may result from postural rigidity and tonic muscle activation, whereas in DT, it may reflect resource competition between cognitive and motor demands. The findings demonstrate that in medicated participants with early-stage PD, the cortical power spectra are indistinguishable from that of healthy controls. At the same time, data indicate that the cognitive-related evoked potentials might offer more sensitivity to disease-specific cortical changes and that selective attention capacities may be more vulnerable than sensory acuity in early PD.

**YIPS-SPECIFIC FACILITATION OF CORTICOSPINAL EXCITABILITY DURING MOTOR IMAGERY OF BASEBALL PITCHING**

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INTRODUCTION: Yips is defined as a psycho-neuromuscular impairment that disrupts the execution of fine motor skills in sports performance [1]. Yips is associated with abnormal muscle activity and kinematics; however, its underlying neural mechanisms remain unclear. Major challenges in investigating these mechanisms are (1) the difficulty in eliciting yips symptoms in a controlled laboratory setting, which complicates comparisons between yips and non-yips conditions, and (2) the technical difficulties of measuring neural activity during dynamic movements, where motion artifacts can contaminate signals. Motor imagery (MI) offers a possible solution, as it elicits neural activity patterns similar to those during actual motor execution [2]. This study aimed to elucidate the neural mechanisms underlying yips by using MI and focusing on corticospinal excitability, which is a key component of motor command output.

METHODS: Fourteen male baseball players with yips symptoms participated in this study. During the experiment, participants were seated comfortably on a chair. Electromyographic activity was recorded from the flexor carpi radialis (FCR) and abductor pollicis brevis (APB) muscles of the dominant hand used for pitching. Transcranial magnetic stimulation (TMS) was applied over the primary motor cortex of the contralateral side of the dominant hand. Motor evoked potentials (MEPs) induced by TMS were used to assess corticospinal excitability. MEPs were measured 15 times with eyes closed under the following conditions: a) rest condition: relaxed state and no thoughts; b) yips-MI condition: kinesthetic MI of pitching with yips; c) no yips-MI condition: kinesthetic MI of pitching without yips. MEP amplitudes in the MI conditions were normalized to those in the rest condition. Wilcoxon signed-rank tests were used to compare MEP amplitudes across conditions, with statistical significance set at $p < 0.05$.

RESULTS: Both MI conditions significantly increased the MEP amplitudes in the FCR and APB muscles compared to the rest condition (yips-MI, FCR: $p < 0.01$, 210±77 % (% of rest, rest=100%), APB: $p < 0.01$, 189±66 %; no yips-MI, FCR: $p < 0.05$, 172±93 %, APB: $p < 0.05$, 139±49 %). Furthermore, MEP amplitudes were significantly higher in the yips-MI condition than in the no yips-MI condition (FCR: $p < 0.01$, APB: $p < 0.05$).

CONCLUSION: This study is the first to employ a within-subject comparison to examine the neural mechanisms of the yips using MI. Although MI is known to facilitate corticospinal excitability in the muscles recruited in the imagined movement [3], our results revealed yips-specific facilitation of corticospinal excitability. These suggest that the symptoms of yips are associated with heightened motor-related neural activity. These findings provide important fundamental knowledge and a methodology for developing future strategies to overcome yips.

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# Oral Presentations

## OP-BM21 Neuromuscular Fatigue

### BIOMECHANICAL, FATIGUE, AND MUSCLE DAMAGE RESPONSES TO ECCENTRIC QUASI-ISOMETRIC CONTRACTIONS: FINDINGS FROM MULTIPLE STUDIES

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INTRODUCTION: Eccentric quasi-isometric (EQI) contractions are gaining attention due to their theorized benefits for muscle endurance, tendon stiffness, and hypertrophy (Oranchuk et al., 2019). However, these claims remain largely speculative. This series of exploratory studies aims to examine the biomechanics, fatigue patterns of EQI contractions, and compare their acute effects with traditional exercise modes

METHODS: Three studies examined EQI contractions across different muscle groups and loading conditions. Study 1 investigated EQI knee extensions and flexions in 16 active participants, analysing torque, fatigue, and range of motion (RoM). Study 2 compared plantarflexion EQIs at 75% and 90% of maximal voluntary isometric contraction (MVIC) in 20 participants, assessing contraction time, torque impulse, and fatigue. Study 3 contrasted EQI and isokinetic heavy-slow resistance exercise in 32 participants, evaluating neuromuscular performance, pain, and RoM across multiple time points.

RESULTS: Study 1 showed distinct fatigue responses between extensors and flexors, with extensors exhibiting greater peak torque loss (16.6% vs. 13.3%) and shifts in the optimal angle (+7.4%) following EQI contractions. Knee flexors demonstrated higher intra-repetition velocity and more stable RoM across repetitions. Study 2 found no significant effect of EQI on MVIC torque, but EQIs at 75% MVIC resulted in 34% longer contraction duration, 23% greater torque impulse, and 19% increased RoM compared to 90% MVIC. Study 3 demonstrated that EQI induced lower fatigue, pain, and perceived effort than isokinetic heavy-slow resistance exercise while accumulating greater total torque impulse. Additionally, EQI participants experienced a smaller reduction in MVIC force torque post-exercise ($\eta^2 = 0.16$), and pain levels remained significantly lower across all time points ($\eta^2 = 0.32$).

CONCLUSION: EQI contractions exhibit distinct biomechanical and fatigue characteristics depending on muscle group and loading conditions. Knee extensors may be more susceptible to EQI-induced fatigue than flexors, and moderate loading (75% MVIC) may optimize torque impulse and RoM in plantarflexion EQIs. Compared to isokinetic heavy-slow resistance exercise, EQI appears to induce less fatigue and post-exercise pain, suggesting potential advantages in rehabilitation settings. However, given the exploratory nature of these studies, further research is required to substantiate these findings and establish practical applications.

### THE LEVEL OF UNILATERAL MOTOR PERFORMANCE-INDUCED FATIGUE DOES NOT INFLUENCE THE IMMEDIATE MOTOR PERFORMANCE FATIGUE OF THE CONTRALATERAL LIMB AFTER ECCENTRIC EXERCISE OF THE KNEE EXTENSORS

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INTRODUCTION: Although crossover fatigue, defined as a decline in maximal voluntary isometric contraction in the non-exercised contralateral homologous muscle, is still debated in the literature, recent studies have shown that eccentric contractions impair contralateral motor performance. However, to date, no study has evaluated the influence of the fatigue level induced in the exercised muscle group on contralateral motor performance fatigue. Therefore, this study aimed to investigate the impact of two exercises involving submaximal unilateral knee extension eccentric contractions, which induce different levels of fatigue, on crossover fatigue. We hypothesized that motor performance-induced fatigue in the exercised muscle group would influence the magnitude of crossover fatigue.

METHODS: Fifteen participants, comprising 8 males (aged 22.3 ± 3.6 years) and 7 females (aged 20.1 ± 1.7 years), randomly underwent unilateral submaximal eccentric exercises of the knee extensors performed at 80% of maximal voluntary eccentric contraction (MVEC) until a reduction of 20% (FAT20%) or 40% (FAT40%) in maximal voluntary isometric contraction (MVIC) of the exercised limb (EL) was achieved. Motor performance fatigue (i.e., central and peripheral factors assessed via percutaneous nerve stimulation) were collected before (PRE), immediately after (POST), 2 minutes (POST2), 5 minutes (POST5) and 10 minutes after (POST10) the fatiguing exercises on both the EL and the non-exercised limb (NEL). Perceived motor fatigue and perceived muscle soreness were assessed at PRE, and POST and POST10, respectively.

RESULTS: Contralateral motor performance fatigue was evident after both fatiguing exercises ($p<0.05$). Although the level of fatigue induced in the EL at POST was greater after FAT40% (-44.9 ± 8.9% of MVIC produced at PRE) compared to FAT20% (-24.3 ± 5.9%), this fatigue level did not significantly influence the significant decline in MVIC in the NEL (-8.3 ± 10.2%, vs -8.8 ± 10.5% after FAT20% and FAT40%, respectively). While significantly impaired in the EL ($p<0.001$), no significant alterations in neuromuscular parameters (i.e., central or peripheral factors) were observed in the NEL. However, a global increase of perceived motor fatigue at POST ($p<0.001$) and perceived muscle soreness at POST10 in both limbs was observed ($p<0.001$). Fatigue in the EL was maintained up to 10 minutes in a lower extent after FAT20% compared to FAT40% (PRE-POST2: -17.6% vs -30.9%; PRE-POST5: -15.0% vs -32.7%; PRE-POST10: -15.7% vs -27.2%, respectively). In the NEL, the loss of MVIC at POST10 was no longer significantly different from PRE following FAT20%, whereas it remained significantly altered until POST10 following FAT40%.

CONCLUSION: The current study highlights that the level of fatigue in the EL did not influence crossover fatigue in the NEL. Although motor performance fatigue in the EL involved peripheral and central alterations, increased global perceived motor fatigue may likely account for the crossover fatigue in the NEL.

**HOW DOES EXERCISE-INDUCED FATIGUE ALTER NEUROMUSCULAR CONTROL DURING THREE-POINT JUMP SHOTS IN HIGHLY TRAINED BASKETBALL PLAYERS?**

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INTRODUCTION: Exercise-induced fatigue significantly impairs three-point jump shot accuracy by affecting neuromuscular control, including muscle activation patterns and postural balance (1). However, the underlying mechanisms of these impairments remain unclear. Muscle synergies are low-dimensional control modules organized within the central nervous system that coordinate muscle activation to produce efficient movement patterns (2). Synergy analysis offers a valuable approach to understanding how multiple muscles work together to optimize shooting performance (3). This study aimed to compare the muscle synergies of highly trained basketball players during three-point jump shots before and after exercise-induced fatigue to better understand neuromuscular coordination under fatigued conditions.

METHODS: Fifteen highly trained male basketball players participated in this study. Fatigue was induced through a high-intensity protocol combining shuttle sprints and vertical jumps to simulate game-related conditions (4). During pre- and post-fatigue testing, participants performed three-point jump shots continuously on force plates until three successful and three unsuccessful attempts were recorded, following a standardized warm-up and immediately after fatigue induction. Surface electromyography (EMG) was recorded from 16 muscles across the trunk, upper, and lower extremities during the shooting task. Muscle synergies were identified using non-negative matrix factorization (NNMF) to compare neuromuscular coordination before and after fatigue (5).

RESULTS: We observed five muscle synergies in successful shots before fatigue, which were reduced to four after fatigue. Unsuccessful shots consistently displayed four synergies both pre- and post-fatigue. Fatigue caused a merging of muscle synergies during the preparation phase, shifting from distinct upper and lower limb activation pre-fatigue to continuous co-activation post-fatigue, closely associated with changes in the center of pressure. During the ball elevation phase, the modular organization of muscle synergies remained unaffected with fatigue. However, significant alterations were observed in the motor modules and primitives of synergy 4 (responsible for push-off), particularly in the tibialis anterior (left: $d = -1.06$; right: $d = -1.47$) and gastrocnemius lateral (left: $d = 1.61$; right: $d = 1.66$) muscles, resulting in distinct muscle activation patterns and temporal shifts. The time-to-peak of synergy 4 vectors occurred significantly earlier before fatigue than after ($d = -0.71$).

CONCLUSION: The changes in the central nervous systems modular control strategies highlight neuromuscular adjustments that are essential for maintaining shooting performance and accuracy under fatigue. Therefore, coaches and athletes should incorporate targeted neuromuscular training programs aimed at optimizing muscle synergy patterns and improving postural control, ensuring athletes can sustain performance even under fatigued conditions.

**THE EFFECTS OF VISUAL FEEDBACK, EXTERNAL FOCUS OF ATTENTION, AND VERBAL ENCOURAGEMENT ON RESISTANCE TRAINING PERFORMANCE, MOVEMENT MECHANICS, PHYSIOLOGICAL AND PSYCHOLOGICAL MARKERS OF FATIGUE**

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INTRODUCTION: Performing resistance training with maximal intent enhances neuromuscular adaptations, often encouraged through external focus cues, visual feedback (VF), or verbal encouragement (VE). While these strategies aim to increase movement velocity (MV) and movement velocity maintenance (MVM), their effects on acute physiological, psychological, and biomechanical responses remain unclear. This study examined the impact of VF, external focus of attention (EFA), and VE on MV, MVM, neuromuscular, metabolic, and perceptual fatigue proxies, and mechanical energy expenditure (MEE) during resistance training.

METHODS: Nineteen resistance-trained individuals (6 females; 13 males) completed one-repetition maximum (1RM) and 12RM tests in the free-weight back squat, followed by familiarisation with rating of perceived exertion (RPE), rating of fatigue (ROF), and exercise enjoyment scales. Participants then performed four experimental sessions consisting of two sets of 10 repetitions at 12RM. The first session served as a control condition (CON) without external cues, while VF, EFA, and VE were applied in randomised order in subsequent sessions. Blood lactate (BL) was collected pre- and post-exercise, and countermovement jumps (CMJs) were performed before and after squatting to assess neuromuscular function. Biomechanical data were captured using 50 retro-reflective markers on anatomical landmarks, allowing for joint-specific and total MEE evaluation.

RESULTS: Linear mixed-effects model analyses (diagnostics cleared) revealed that VF elicited the greatest MV, followed by EFA and VE (all $p < 0.001$). MVM was higher in VF and EFA than in CON ($p < 0.05$), indicating better velocity retention in these conditions. Interestingly, BL and CMJ height did not differ between conditions, suggesting acute metabolic and neuromuscular responses were unaffected. RPE and ROF were lowest in VF ($p < 0.001$), with no significant differences among the remaining conditions ($p > 0.05$). Exercise enjoyment was highest in VF, exceeding EFA ($p = 0.016$) and CON ($p = 0.001$), indicating that VF promoted a more positive training experience. Total MEE was greater in VF compared to CON ($p < 0.001$), with all joints exhibiting increased expenditure. The spine showed the greatest proportional increase in MEE,

particularly in the second set, suggesting altered movement mechanics and a greater spinal contribution when training with VF.

CONCLUSION: VF proved most effective for optimising MV and MVM and reducing perceptual fatigue, making it a valuable tool for coaches, sport scientists, and rehabilitation professionals. However, its association with increased spinal MEE suggests potential biomechanical trade-offs, highlighting the need for careful monitoring and coaching to mitigate inefficient or altered movement mechanics. EFA also provided notable benefits, making it a viable alternative when VF is unavailable. These findings offer practical insights for refining resistance training strategies to enhance both performance and safety.

**EFFECT OF NEUROMUSCULAR FATIGUE ON MUSCLE FIBRE CONDUCTION VELOCITY IN YOUNG MALES AND FEMALES**

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INTRODUCTION: Muscle fatigue is characterized by an exercise-induced reduction in force generation capacity, involving both neural and muscular mechanisms. Muscle fibre conduction velocity (MFCV) has been widely used to examine changes in muscle fibre excitability during fatigue and can also reflect progressive recruitment of motor units (MUs), due to its linear relationship with the fibre diameter (1,2). However, studies investigating potential differences in the effect of fatigue on MFCV between males and females remain limited. This study aimed to examine the sex differences in neuromuscular responses during and after sustained submaximal isometric contraction.

METHODS: Thirty-one healthy young adults (16 females: 21.7±2.1yr) performed sustained submaximal isometric fatiguing contraction of the knee extensors (KE) at 30% maximal voluntary isometric contraction (MVIC) until task failure. MVICs of the KE were recorded before, immediately after and throughout 10 min of recovery. During recovery, an MVIC was performed at 0, 2, 5 & 10min (post 0, 2, 5, 10) after the end of the fatiguing contraction. High-density surface EMG signals from the vastus lateralis muscle were recorded simultaneously throughout. EMG root mean square (RMS) amplitude and median frequency (MDF) were assessed during MVICs and, with MFCV, during the fatiguing contraction. Values corresponding to 10% intervals of the endurance time were selected and normalized to their initial values for statistical analysis.

RESULTS: Males were stronger ($p<0.001$) with greater BMIs ($p<0.05$) than females. There was no significant difference in endurance time (113.3 vs 114.9s) and post-fatigue MVIC% reduction (22.8 vs 30.7%) between sexes. During the fatiguing contraction, a similar increase in RMS% was observed in both sexes (all $p<0.01$), however, females exhibited a greater decrease in MDF% ($p<0.001$) and MFCV% ($p<0.05$) compared to males. Moreover, during recovery, females showed a greater increase in MDF% (16.8 vs 9.2%) and MVIC% (14.2 vs 2.6%) from post 0 to post 2 ($p<0.05$).

CONCLUSION: In this study, no differences were observed in endurance time or post-fatigue MVIC% decline between sexes. However, females showed a greater linear decline in MDF% and MFCV% during the fatiguing task. Additionally, females exhibited superior recovery of MVIC% and MDF% after fatigue. These findings suggest that 1) males may adopt a different MU recruitment strategy to maintain the sustained force production, possibly by recruiting more high-threshold, higher MFCV MUs during the fatiguing contraction. This may be due to their larger diameter and proportional area of the type II fibres. 2) females may benefit from greater muscle perfusion and higher capillarization of the muscle bed, facilitating more efficient removal of metabolic by-products, thus faster recovery.

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## Oral Presentations

### OP-MH21 Physical Training in Cancer Patients

**COMBINED TRAINING AS A SAFE AND EFFECTIVE STRATEGY TO ENHANCE MUSCLE STRENGTH WITHOUT COMPROMISING SHOULDER-ARM VOLUME AND DISABILITY IN SURVIVORS OF BREAST CANCER: THE EFICAN RCT**

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INTRODUCTION: With increasing survival rates, a growing number of women live with the long-term effects of breast cancer and its treatments, including reduced muscle mass and strength, impaired upper-limb function, diminished cardiorespiratory fitness, lower quality of life, and risk of lymphedema. Evidence suggests that exercise, particularly combining resistance and aerobic training, can help mitigate these effects. The primary aim of the EFICAN trial was to evaluate the effects of a 12-week combined training program on muscle strength in breast cancer survivors. Secondary outcomes included shoulder-arm volume and disability, body composition, cardiorespiratory fitness, quality of life, cancer-related fatigue, and depression.

METHODS: A randomized trial was conducted with 60 women who had completed surgery, chemotherapy, and/or radiotherapy within the past ten years. Participants were randomized to exercise (EG; two weekly resistance training sessions + 10,000 daily steps) or control (CG; 10,000 daily steps). Baseline and post-intervention assessments included muscle

strength, shoulder-arm volume and disability, body composition, cardiorespiratory fitness, quality of life, cancer-related fatigue, and depression.

RESULTS: The EG (32 participants) showed significant improvements in overall muscle strength (0.718; 95%CI: 0.361–1.074, P<0.001, d-Cohen=1.04), upper-limb strength (0.727; 95%CI: 0.294–1.160, P=0.001, d=0.87), and lower-limb strength (0.709; 95%CI: 0.324–1.094, P=0.001, d=0.96) compared to the CG (28 participants). Secondary analyses indicated that surgical and treatment characteristics did not influence the intervention's effects on lymphedema or upper-limb problems. However, increased upper-limb strength was associated with reduced shoulder-arm problems (-0.429; P=0.020). Regarding body composition, chemotherapy was linked to increased fat mass (B=2.313, P=0.034), fat percentage (B=3.282, P=0.003), and visceral fat (B=1.434, P=0.011) in the CG. No significant differences were observed in other variables.

CONCLUSION: A 12-week combined training intervention improved muscle strength without compromising shoulder-arm volume and disability, regardless of the surgical and treatment history. Although no significant changes were seen in other variables, risk factors for lymphedema did not impact training outcomes, reinforcing the recommendation to exercise the affected limb. Additionally, chemotherapy was associated with worsened body composition in the CG, suggesting that exercise may help counteract these adverse effects, which are critical for long-term prognosis. The findings indicate that increased upper-limb strength may help alleviate shoulder-arm problems, further supporting the integration of combined training into post-cancer rehabilitation programs. This study underscores the importance of exercise in reducing the negative effects of cancer treatment, reinforcing its role as a key component in breast cancer survivorship care.

**THE EFFECTS OF TWO MULTIMODAL EXERCISE PROGRAMS (FACE-TO-FACE VS ONLINE) ON PHYSICAL AND FUNCTIONAL OUTCOMES IN BREAST CANCER SURVIVORS: A RANDOMIZED CONTROL TRIAL.**

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INTRODUCTION: Physical exercise programs has been demonstrated to reduce many of the side effects of cancer and its treatments, primarily by addressing alterations in body composition, CRF, and fatigue, all of which are associated with quality of life and survival [1, 2]. Despite these benefits, it is estimated that only 36% of breast cancer survivors adhere to the exercise recommendations for cancer survivors set by the World Health Organization (WHO) [3]. In this Randomized Control Trial (RCT), we examined the impact of a face-to-face oncological exercise program compared with an online oncological exercise program on body composition, CRF, fatigue, and quality of life in patients with breast cancer in stage IA to IIIB.

METHODS: Women diagnosed with primary breast cancer (stages IA to IIIB); aged 18 years or older were included in this study. Patients assigned to the intervention group underwent a multimodal exercise program intervention for 16 weeks. This intervention was conducted both in-person at the training center and online to enhance participant adherence.

Both oncological exercise programs included resistance, endurance, balance, and proprioception exercises, with intensity ranging from 55% to 95% of heart rate reserve (HRR). Each session lasted 75 minutes and was structured as follows: 10 minutes of warm-up involving joint mobilities, balance exercises, and aerobic exercise. This was followed by two 20-minute bouts of combined endurance and resistance exercises at an average intensity of 70-75% HRR with 30 to 60 second bouts of high-intensity activity of 85% to 100% HRR. Resistance exercises were developed with free weights of 8 exercises of 3x10 or 3x15.

RESULTS: 40 patients in the intervention group and 34 in the control group completed the study. In the intervention group, 14 (35.9%) patients participated in the online program, while 25 (64.1%) attended the in-person sessions. The attendance rates for the intervention group were 89.5% in both instances. Specifically, for the online group, 84.02% of the sessions were conducted online, while 15.98% of the attendance occurred in person. Conversely, for the in-person intervention, 76.64% of the sessions were face-to-face, and 23.35% of the attendance was through online classes. No differences in attendance between interventions were observed (p=0.997). In addition, no significant differences between interventions were observed in physical (cardiorespiratory fitness, functional capacity, and body composition) or emotional (fatigue and quality of life) variables.

CONCLUSION: The multimodal physical exercise interventions (online and face-to-face) in this study prove to be effective not only in improving fitness and body composition, but also in promoting different exercise strategies, and improving the accessibility of exercise programs for patients far from sports centers. This accessibility is crucial in ensuring high levels of adherence to these programs and adapting the intervention to the personal situation of patients.

**THE IMPORTANCE OF PROFESSIONALLY SUPERVISED AND STRUCTURED EXERCISE PROGRAMS IN CANCER PATIENTS: A 16-WEEK PROSPECTIVE STUDY USING THE EQ-5D QUESTIONNAIRE**

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INTRODUCTION: The benefits of exercise in cancer patients are well established; however, its effectiveness largely depends on proper structuring, supervision, and professional guidance. Poorly designed or inadequately supervised pro-

grams may fail to provide optimal outcomes or even pose risks. This study evaluates the impact of a structured and professionally guided 16-week exercise program on health-related quality of life (HRQoL) in cancer patients, using the EQ-5D questionnaire to quantify improvements and their economic implications.

METHODS: A total of 195 cancer patients (95% female, mean age 54.30, (SD=15,07) years) participated in this professionally supervised exercise intervention. The sample included patients in different treatment stages: 30% undergoing active treatment, 30% on hormone therapy, 22% metastatic, and 17% without active treatment. The intervention consisted of 16 weeks of high-intensity cardiovascular and strength training, conducted twice per week in a controlled setting with trained professionals ensuring safety, adherence, and individualized adaptation.

The EQ-5D questionnaire, a validated tool assessing five health dimensions (mobility, self-care, usual activities, pain/discomfort, and anxiety/depression), was administered at baseline and post-intervention. The EQ-5D index score was calculated using Spanish reference values, and quality-adjusted life years (QALYs) were estimated based on HRQoL changes.

RESULTS: Following the professionally structured intervention, there was a significant improvement in HRQoL, with the EQ-5D index increasing by 0.061 (SD=0,03) points from baseline ($p = 0.02$). This corresponds to an annualized gain of 0.061 QALYs per patient, a clinically meaningful enhancement in quality of life.

Economic analysis, based on Spain's willingness-to-pay (WTP) threshold (€20,000–€30,000 per QALY gained), suggests that this structured program generates an estimated economic benefit of €1,220 to €1,830 per patient. Given the cohort size (n = 195), the total potential economic impact ranges between €237,900 and €356,850.

CONCLUSION: This study underscores the critical role of structured and professionally supervised exercise programs in maximizing benefits for cancer patients. The significant improvements in HRQoL and economic impact reinforce the need for these interventions to be delivered by trained professionals who can ensure individualized adaptation, safety, and adherence. In contrast, unsupervised or poorly structured programs may fail to provide similar outcomes or even pose risks to vulnerable patients.

To fully integrate exercise into oncology care, it is essential to standardize structured programs, ensuring they are led by qualified professionals who can adapt interventions to patients' clinical status, treatment phase, and physical capacity. Future research should focus on optimizing program scalability while maintaining high safety, efficacy, and cost-effectiveness standards.

**EFFECTS OF EXERCISE QUANTITY AND INTENSITY ON CANCER CACHEXIA: PHYSICAL AND PSYCHOLOGICAL EFFECTS**

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INTRODUCTION: Cancer cachexia leads to a loss of muscle mass associated with a decrease in quality of life, treatment response, and patient survival. Once cachexia is established, there is no cure, and it is recommended to limit its progression by combining medical, nutritional, and exercise interventions. Indeed, cachexia induces metabolic and muscular alterations that are counterproductive to exercise-induced adaptations. The benefits are beginning to be identified in cancer patients suffering from cachexia, but further studies are needed (Cheung, 2023). Furthermore, a recent study highlights that the effects of exercise on muscle mass may depend on compliance to the program, suggesting a possible dose-response relationship (Parent, 2025). The aim of this study is to evaluate the effects of the intervention based on the quantity and intensity of exercise practiced by cachectic cancer patients (CCP).

METHODS: 15 CCP participated in a supervised exercise program combining endurance and resistance training. Over a 3-month period, CCP could engage in exercise sessions twice a week, each lasting one hour. The number and intensity (HRR) of exercise sessions were recorded. Physical condition assessments included body composition, strength, and endurance. Psychological condition assessments included quality of life (QoL) and cancer-related fatigue (CRF). Results were analyzed in terms of compliance and compared with the evolution of cancer patients without cachexia (CPWC).

RESULTS: CCP completed 74±17% of the prescribed sessions at a mean intensity of 68.6±8.8% HRR. The program led to significant benefits in cancer cachexia symptoms, increasing BMI, muscle mass, endurance, and lower limb strength, while counteracting loss of appetite ($p<.05$). Despite these improvements, QoL and CRF were not impacted, whereas improvements were observed in CPWC. Regarding the dose-response relationship, despite a trend, no significant correlations were found between changes in muscle mass or endurance and the amount of exercise performed ($r=-0.35$, $p=.21$; $r=0.17$, $p=.55$) or the session intensity ($r=-0.14$, $p=.63$; $r=-0.24$, $p=.41$).

CONCLUSION: CCP engage in the program and experience physical and nutritional benefits. Exercise improves weight, muscle mass, appetite, endurance, and strength. These findings highlight the importance of incorporating exercise into cachexia management. According to our results, a frequency of 1.5 to 2 sessions per week for three months seemed sufficient to yield positive outcomes. Within our small sample, no clear dose-response or intensity-response relationship emerged, although a trend suggested a reduction in muscle mass benefits with increased compliance. Strangely, exercise did not lead to psychological benefits in terms of quality of life and perceived fatigue. This could be explained by disease progression and its visibility, which may remain a barrier to social engagement. Research will continue to refine the effects of exercise according to patient characteristics.

**EFFECTS OF A 3-MONTH EXERCISE INTERVENTION IN PATIENTS WITH ADVANCED PANCREATIC CANCER UNDERGOING CHEMOTHERAPY: A SINGLE-ARM FEASIBILITY STUDY**

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INTRODUCTION: Patients with pancreatic cancer face severe physical and psychological burdens due to the aggressiveness of the disease and the side effects of treatment, which contribute to a decline in quality of life and survival. Exercise has shown benefits in mitigating symptoms and improving physical fitness. However, the feasibility of structured exercise programs during treatment for pancreatic cancer remains challenging. This study evaluates the feasibility and preliminary effects of a 3-month exercise intervention in this population.

METHODS: Patients with pancreatic cancer treated at the Oncology Unit of the University of Verona Hospital Trust were invited to participate in a 3-month structured exercise intervention, with the freedom to choose between a home-based or gym-based program. Both modalities included individually tailored twice-weekly sessions of aerobic and resistance training and each session comprised a warm-up, aerobic training, five resistance exercises using elastic bands, and a cool-down with stretching. The primary outcome was feasibility, assessed through recruitment rate, attendance, adherence, dropout rate, tolerability, and safety. Secondary endpoints, assessed at baseline and post-intervention were: i) cardiorespiratory fitness evaluated with the six-minute walking test ii) muscle strength assessed with the handgrip strength test iii) flexibility measured with the back scratch and chair sit and reach tests, iv) body mass index and waist-hip ratio, and v) quality of life evaluated with the European Organization for Research and Treatment of Cancer Quality of Life Questionnaire. Descriptive statistics and paired t-tests were used to analyze the results.

RESULTS: Of the 30 patients enrolled, 18 completed the intervention, with a recruitment rate of 83% and a dropout rate of 40% (n=12), primarily due to disease progression. All participants were undergoing chemotherapy, and 87% had metastatic cancer. Twelve patients chose the home-based program, while six opted for the gym-based format. Median attendance was 80%, adherence to prescribed exercise volume was 79%, and tolerability was 100%. Two non-severe adverse events were recorded. Post-intervention, significant improvements were observed in upper limb flexibility (p=0.045), moderate-intensity physical activity (p=0.004), and total weekly physical activity (p=0.020). Although no significant changes were detected in cardiorespiratory fitness, muscle strength or anthropometric measures, participants reported significant improvements in emotional (p=0.042) and social functioning (p=0.009), along with a reduction in appetite loss (p=0.008).

CONCLUSION: A highly tailored exercise program is feasible and well-tolerated in patients with pancreatic cancer undergoing chemotherapy. Moreover, the intervention was effective in enhancing quality of life, highlighting the potential role of exercise in supportive care for this population.

## Oral Presentations

### OP-PN12 Metabolomics and Health

**EFFECTS OF EXERCISE TRAINING INTENSITY ON RUNNING CAPACITY AND SKELETAL MUSCLE METABOLIC GENE EXPRESSION IN A MOUSE MODEL OF LOWER EXTREMITY PERIPHERAL ARTERY DISEASE**

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INTRODUCTION: Lower extremity peripheral artery disease (PAD), caused by the buildup of atherosclerotic plaque that narrows the lower extremity arteries, is a global health concern. PAD patients often experience ischemic muscular pain during exercise, which leads to a significant decline in functional capacity. Exercise training is a first-line treatment for PAD; however, the comparison of the effectiveness of different exercise training intensities on skeletal muscle adaptations is lacking.

This study compared the effects of moderate-intensity continuous training (MICT) and high-intensity interval training (HIIT) on endurance capacity and mRNA expression of metabolic genes in skeletal muscles of mice with PAD.

METHODS: Male C57BL/6 mice underwent surgical ligation of the right common iliac artery and were then divided into three groups: sedentary (SED), MICT (40 minutes of running at 70% of maximal aerobic speed), and HIIT (8x 2.5 minutes running at 90% of maximal aerobic speed, interspersed with 2.5 minutes running at 50% of maximal aerobic speed). Mice were subjected to treadmill running 3 times/per week for 8 weeks. Maximal running distance was determined by an incremental exhaustion test.

Quantitative PCR (qPCR) was performed to determine skeletal muscle mRNA expression of markers involved in the metabolism of glucose (GLUT-4, HK2, PFK), lactate (LDHA), lipid (CD36, HSL), as well as markers related to mitochondrial biogenesis and oxidative metabolism (PGC-1a, TFAM, mtND6, CS, CYTB). Analyses were performed in both non-ischemic and ischemic gastrocnemius (primarily fast-twitch fibers), and soleus (primarily slow-twitch fibers) muscles.

RESULTS: At the end of the study, maximum running distance was significantly greater in both MICT and HIIT mice compared to SED (439 +/- 33.2 m in MICT vs 470.0 +/- 32.0 m in HIIT vs 311.6 +/- 21.2 m in SED, p< 0.05), with no significant difference between MICT and HIIT.

In the ischemic gastrocnemius muscle, HIIT upregulated the mRNA expression of PFK, CD36, HSL, and CS (p<0.05 vs SED), while in the non-ischemic gastrocnemius, only CS expression was increased (p<0.05 vs SED). MICT did not significantly alter the mRNA levels of metabolic genes in either the ischemic or non-ischemic gastrocnemius muscle.

In the ischemic soleus muscle, HIIT increased mtND6 and CYTB mRNA expression (p<0.05 vs SED). In the non-ischemic soleus, HIIT upregulated PGC-1a and CYTB while downregulating CD36 and HK2 (p<0.05 vs SED). MICT upregulated the mRNA expression of GLUT-4, LDHA, TFAM in the ischemic soleus muscle (p<0.05 vs SED), but had no impact on gene expression in the non-ischemic soleus.

CONCLUSION: MICT and HIIT are equally effective in improving endurance capacity in PAD mice. However, HIIT induces greater skeletal muscle transcriptional adaptations compared to MICT in our mouse model of PAD.

**SUBCELLULAR PROTEOMIC NETWORKS UNDERLYING ACUTE AND CHRONIC EXERCISE RESPONSES IN HUMAN SKELETAL MUSCLE**

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INTRODUCTION: Mitochondria serve as critical signalling hubs, integrating and relaying intracellular information to facilitate skeletal muscle adaptations to exercise. Despite known roles of mitochondrial (MITO) protein signalling and translocation between other organelles (i.e., the nucleus and cytosol), major knowledge gaps remain in our understanding of the complex muscle subcellular protein networks underlying acute responses to exercise and exercise training.

METHODS: A total of 197 vastus lateralis muscle biopsies were collected from 20 untrained men and 20 untrained women (26.5 ± 5.9 y, BMI 24.9 ± 3.4 kg/m², VO2max 31.1 ± 5.6 mL/min/kg) pre, mid, post, and 3 h-post an acute bout of high-intensity interval exercise (HIIE) and following 8 wk HIIE training (4 sessions/wk). The acute HIIE session consisted of four 4-min workbouts based on individual maximum power output and lactate threshold, with 2-min rest. Subcellular fractionation workflows were developed to isolate MITO, nuclear (NUC) and cytosolic (CYTO) fractions from snap-frozen human muscle biopsies using differential centrifugation. Global mass spectrometry-based proteomic analysis was then performed to map acute and chronic exercise-induced changes in protein abundance and potential protein translocation between subcellular compartments.

RESULTS: Proteomic and bioinformatic analysis of 591 total muscle subcellular fractions mapped acute and chronic exercise-induced dynamics of MITO, NUC, and CYTO protein abundance. We quantified 1440 total proteins in the MITO fraction, representing over 40% of all annotated MITO proteins. Differential expression analysis revealed significant changes (adjusted p<0.05 versus pre) within the MITO fraction mid (102 proteins), post (604), and 3 h-post (376) acute exercise, and following 8 weeks of training (611). HIIE acutely downregulated MITO ribosomal proteins and proteins involved in MITO fission/fusion dynamics, whereas proteins related to reactive oxygen species were upregulated. Robust upregulation of MITO proteins was observed following training, consistent with other molecular markers of MITO biogenesis (e.g., citrate synthase activity, transmission electron microscopy). In the NUC fraction, 491 total proteins were significantly regulated (216 up and 275 downregulated, respectively) across all time points, including robust regulation of auxiliary proteins linked to ribonucleotide processes. There were no sex differences in subcellular proteomes observed in response to acute and chronic exercise.

CONCLUSION: These subcellular proteomic datasets represent one of the most extensive human muscle proteome analyses to date and a valuable resource of the intricate subcellular networks underlying acute exercise responses and training-induced adaptations. Collectively, these datasets highlight the overall lack of subcellular proteomic sex differences and key pathways that warrant further investigation including MITO protein translation and fission/fusion machinery.

**AGING DETERIORATES SKELETAL MUSCLE MITOCHONDRIA INDEPENDENTLY FROM PHYSICAL ACTIVITY: NEW INSIGHTS FROM A TRANSLATIONAL APPROACH**

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INTRODUCTION: Aging inevitably results in a decline in whole-body cardiorespiratory fitness (1). Impairments in muscle oxidative metabolism serves as key contributing factor to age-related cardiorespiratory fitness reduction, potentially driven by alterations in mitochondrial content, distribution and function (2). However, some studies suggest aging does not lead to mitochondrial impairments when high level of physical activity are maintained and there is ongoing debate in the scientific literature (3,4). This study aimed to clarify the relationship between aging, mitochondria and training by investigating muscle oxidative capacity through both in-vivo and ex-vivo technique to characterize mitochondrial function, content, and distribution in human skeletal muscle of active and sedentary older individuals.

METHODS: Forty young sedentary adults (YG, n=40; 24±4 yrs) and fifty older individuals (O, n=50; 68±10 yrs) were recruited. Free-living physical activity was monitored by accelerometry and used to stratify O into active (OA) and sedentary (OS) groups. All participants completed a cycling incremental test to assess maximal pulmonary oxygen uptake (VO2peak). In-vivo vastus lateralis muscle oxidative function was estimated as oxygen uptake recovery rate constant (k) during intermit-

tent arterial occlusions after brief exercise by near-infrared spectroscopy (5). Muscle biopsies from vastus lateralis were collected in a subsample of subjects (n=40). High-resolution respirometry was used to assess mitochondrial respiration. Immunohistochemistry analysis and Citrate Synthase activity assay were performed to determine fibre cross-sectional area (fCSA), mitochondrial content and distribution.

RESULTS: YG showed higher VO2peak (35.2±7.4 ml/kg/min) compared to O (24.1±5.6 ml/kg/min, p<0.001). k was higher in YG compared to O (p<0.001), without differences between OA and OS (p=0.83). After adjusting for physical activity, age negatively correlated with VO2peak and k (both p<0.01). Mitochondrial respiration was not affected by age or physical activity. In both YG and O, type I and type II fibers differed for TOM20 (p<0.03). Markers of mitochondrial content were lower in O, compared to YG (p<0.05). OA and OS did not show any difference in the mitochondrial markers investigated (p = 0.29).

CONCLUSION: Cardiorespiratory fitness and skeletal muscle oxidative capacity were negatively affected by age but the age-related decline in muscle oxidative metabolism was not preserved or restored by physical activity. Mitochondrial function did not change with age or according to physical activity level in older individuals, suggesting changes mitochondrial content and distribution during aging may disrupt mitochondrial network integrity and connectivity, potentially having a greater impact on in-vivo muscle oxidative capacity.

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(4) Marcinek & Ferrucci, 2025

(5) Pilotto et al, 2022

**SALIVARY PROTEOME CHANGES FOLLOWING AN INTEGRATED NEUROMUSCULAR TRAINING (INT) INTERVENTION IN SCHOOL CHILDREN**

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INTRODUCTION: Integrated Neuromuscular Training (INT) is defined as an exercise program that integrates strength and general conditioning tasks (e.g., basic motor skills) alongside specific exercises (e.g., agility, dynamic stabilization, coordination, plyometrics). The early application physical exercise intervention such as INT has beneficial effects on reducing the risk of cardiovascular disease and has great anti-inflammatory potential. Saliva presents a non-invasive alternative for detecting inflammatory, metabolic and cardiovascular risk factors in pediatric population. This study aims to explore the impact of an INT intervention on the salivary proteome.

METHODS: Thirty-nine schoolchildren were included in the study [7.53±0.33 years; 56% girls]. Control group (n=16) who followed a standard physical activity protocol for 3 months, and intervention group (n=23), who followed an INT protocol. Salivary proteome analysis was performed by nano HPLC-Orbitrap mass spectrometry (MS/MS). The fragments obtained were compared with UniProt database, allowing the identification proteins from two fragments. Volcano Plot were used to identify relevant and significant changes in protein expression levels (m/z) between groups, control and intervention.

RESULTS: A total 2231 proteins were identified by mass spectrometry. By comparing both groups control versus intervention before and after intervention, a total of 52 proteins presented adjusted p value below 0.05 (p-value (Fold-Change) >0.05), of which 39 proteins having a fold-change above 1.5 (log2=1.5). From those, 22 proteins were significantly upregulated, and 17 proteins were downregulated. Among them, proteins involved in energy metabolism and cardiovascular risk, such as PFKM, AK1 and OXTC1 showed lower expression levels in the intervention group, along with proteins involved in the inflammatory response, such as NRIP1 and PLA2G4E, which also exhibited lower expression levels in the intervention group.

CONCLUSION: The INT intervention applied in primary schoolchildren is associated with a better cardiovascular and inflammatory profile, highlighting the positive impact of this intervention in schoolchildren. Our findings also demonstrate the utility of saliva to assess the risk for cardio metabolic disease in pediatric populations.

**SALIVARY PROTEOMICS INSIGHTS INTO EXERCISE-INDUCED MOLECULAR ADAPTATIONS IN SCHOOL CHILDREN**

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INTRODUCTION: Physical activity induces molecular adaptations detectable at proteomic level across multiple tissues, with skeletal muscle being one of the primary sites for these changes. However, the exploration of proteomic changes in saliva, particularly in school children, remains largely unexplored. This study aims to (1) investigate whether a neuromuscular training intervention elicits changes in the salivary proteome of school children, (2) identify which proteins are altered by the intervention and potentially derived from skeletal muscle and (3) examine if changes in these proteins correlate with physical activity, motor competence, strength, and health parameters.

METHODS: Saliva samples were collected from school children (age 7.7 ± 0.3) who participated in a three-month integrated neuromuscular training programme (INT; n = 23) and from a control group following standard physical education

classes (CON; n = 16). Physical activity levels (minutes per day spent in moderate-to-vigorous physical activity [MVPA]) and daily seated time were measured with a triaxial accelerometer (Actigraph). Motor competence (CAMSA), strength (handgrip dynamometer) and health markers (blood pressure, body mass index [BMI], fat mass, and muscle mass) were also collected. Proteins were identified and quantified using Orbitrap mass spectrometry, and pathway and process enrichment analysis were performed using Metascape. Statistical analyses were performed using R Statistical Software (v4.4.1; R Core Team 2024).

RESULTS: A total of 2231 salivary proteins were identified. In the INT group, 86 proteins showed a log2 fold change >1 or <-1 (2-fold change expression), compared to 64 in the CON. The INT group had a higher number of proteins involved in enriched biological pathways and higher pathway similarity compared to the CON. The most enriched pathways included endosomal/vacuolar transport, epithelial cell differentiation and energy metabolism. Moreover, the summary of enrichment analysis with Pattern Gene Database (PaGenBase) revealed 6 enriched skeletal muscle-derived proteins (AK1, PFKM, MAPK12, SEMA7A, SPEG, MYH13) in the INT group, whereas none were detected in the CON group. Lower levels of AK1, PFKM, MAPK12, and SEMA71 were detected after the INT, while SPEG levels increased. Correlation analyses revealed negative associations between AK1 levels and BMI (rs = -0.41, p= .01), and SEMA7A and grip strength (rs= -0.36, p = .03). Additionally, SPEG levels were negatively correlated with daily seated time (rs=-0.39, p=.02) but positively correlated with MVPA (rs = 0.36, p = .03).

CONCLUSION: These findings suggest that the integrated neuromuscular training induces structured molecular adaptations detectable in saliva at the proteomic level, reinforcing the idea that exercise promotes coordinated molecular changes. Furthermore, the detection of skeletal muscle-related proteins in saliva highlights its potential as a non-invasive biomarker tool for monitoring exercise-related biological responses.

## Oral Presentations

### OP-PN18 Nutrition II - Caffeine

**SUBLINGUAL CAFFEINE SPRAY DOES NOT ACCELERATE ABSORPTION, COGNITIVE BENEFITS, OR HEMODYNAMIC EFFECTS COMPARED TO CAFFEINATED BEVERAGES**

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INTRODUCTION: Buccal caffeine absorption bypasses digestion, can elicit peak serum caffeine concentration within ~30 min of administration, potentially accelerating cognitive benefits compared to ingestion. Caffeine mouth sprays are commercial products that involve sublingual delivery, but their ability to increase blood caffeine remains largely unknown.

METHODS: This study investigated whether caffeine mouth spray can accelerate the time to peak serum caffeine concentration compared to coffee or an energy drink. Fourteen regular caffeine users (6 males, 8 females; 24 ± 3 years, 69.9 ± 9.3 kg) abstained from caffeine for 16 h, ate a standardized breakfast, then consumed 60 mg of caffeine via either mouth spray, coffee, or energy drink in a randomized, crossover, open-label design (osf.io/m9t3v). Serum caffeine concentration was determined at baseline as well as 5, 10, 20, 30, 45, 60, 75, and 90-min post-caffeine ingestion via commercial enzyme linked immunosorbent assay. Blood pressure was measured via automated oscillometric cuff (BpTRU). At ~30 and ~90 min post-ingestion, cognitive function was assessed via Stroop test and digit symbol substitution task (Inquisit version 6, millisecond, Seattle, USA).

RESULTS: Serum caffeine level increased from baseline in all conditions ($p<0.0001$) but did not differ between the mouth spray, coffee, and energy drink at any time point (all $p>0.06$). Caffeine area under the curve was not different after mouth spray, coffee, or energy drink (61 [54-73], 82 [51-119], 68 [43-78] min*mg/L respectively, $p=0.22$) nor was peak concentration (1.6 [1.2-1.8], 1.9 [1.4-2.4], 1.2 [0.8-3.0] mg/L respectively, $p=0.19$). Within the mouth spray condition, serum caffeine was higher than baseline from 10 to 90 min ($p<0.03$) but not at 5 min ($p=0.50$), and peak concentration occurred 90-min after use. Average response latency per Stroop test (Time $p<0.0001$) was different at all timepoints (baseline = 667±81 ms, 30 min = 710±89 ms, 90 min = 770±154 ms, $p<0.02$ for all), but was unaffected by condition ($p=0.83$) or time*condition ($p=0.27$). The number of correct responses relative to total responses and total correct responses on the digit symbol substitution task were unaffected by time, condition, or their interaction ($p > 0.22$ for all). Systolic blood pressure (time $p=0.002$) was higher at 60 and 90 min vs. baseline (baseline: 102±7, 30-min: 106±7; 90-min: 105±8 mmHg, $p<0.03$ for both), but unaffected by condition ($p=0.20$) or time*condition ($p=0.60$). Diastolic blood pressure was 69±7 mmHg at baseline, 69±6 mmHg at 30 min, and 71±7 mmHg at 90 min (time $p=0.08$, condition $p=0.32$, time*condition $p=0.92$).

CONCLUSION: In conclusion, sublingual caffeine administration via mouth spray did not accelerate the time to peak serum caffeine nor induce cognitive benefits compared to caffeinated beverages.

**CAFFEINE SUPPLEMENTATION RESCUES REDUCED TRAINING QUALITY DUE TO LCHF DIET BUT CAFFEINE + CARBOHYDRATE IS BEST**

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INTRODUCTION: We have previously shown that training quality was reduced in elite athletes who undertook a low-CHO high-fat diet ketogenic LCHF diet. We wanted to confirm the reduced training metrics associated with such an intervention using an improved methodology, and to investigate whether this could be attenuated with caffeine supplementation. We also wanted to investigate effects of caffeine supplementation on cognitive function after exercise.

METHODS: Tier 3-5 (national to internation) level race-walkers (n=21) completed 3 weeks of periodized training while adhering to diets of chronic LCHF or high carbohydrate availability (HCHO). During baseline, where all athletes followed HCHO, and then 3 intervention weeks, we monitored training quality and cognitive performance during a weekly tempo session (14 km with a 450 m elevation gain). On weeks 2 and 3, in a randomized crossover allocation, participants received 3 mg/kg caffeine or placebo (gum), 20 min before the session. Race-walking speed, heart rate, RPE, blood metabolites and Stroop word-color test metrics were collected.

RESULTS: Although LCHF athletes walked at a higher percentage of VO2max speed at baseline compared to HCHO (+3.4%, p = 0.04), relative speeds during Weeks 2 and 3 were lower (-5.2%; p = 0.01 and -4.4%; p = 0.05, respectively). Hill course completion for LCHF was slower by ~7 min (Week 1) to ~3 min (Week 3), compared to a 3.5 min improvement (Week 3) from baseline in the HCHO group. Compared to baseline, the 14 km hill session was faster (p = 0.01) with caffeine than placebo, without detectable differences in the magnitude of the effect between groups (HCHO: +2.9%, LCHF: +2.0%; p=0.66). Post-exercise Stroop metrics were also improved.

CONCLUSION: Caffeine supplementation partially rescued the performance impairment associated with an LCHF diet, but training quality remained lower than the combination of caffeine and high CHO availability.

**EFFECT OF CAFFEINE ON FAT OXIDATION RATE DURING A ONE-HOUR OF MOUNTAIN CYCLING AT FATMAX.**

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INTRODUCTION: The intake of between 3 and 6 mg/kg of caffeine increases the rate of fat oxidation during moderate-intensity exercise (1). Previous research has been conducted under highly standardized laboratory conditions which are different to real applicable contexts (2). Therefore, the objective of the present study was to determine the effect of caffeine intake on fat oxidation during a 1-h mountain bike session at Fatmax (i.e., the intensity at which maximal fat oxidation occurs). The hypothesis is that caffeine will lead to an increase in fat oxidation rate, as previously observed in laboratory settings (2). METHODS: A double-blind, randomized, counterbalanced and crossover experimental design was performed by 11 participants (male, healthy, recreational athletes with cycling experience, VO2max = 49.1 ± 9.0 ml/kg/min) Participants conducted a pre-experimental incremental test on a cycloergometer to determine VO2max and Fatmax. Cyclists ingested either 3 mg/kg caffeine or a placebo 60 min before completing a 1-h mountain bike test on a trail circuit at Fatmax in which O2 uptake and CO2 production was analysed through a portable gas analyzer. The circuit was designed by the research team with the aim of simulating a real mountain bike circuit. The intensity was fixed in both conditions using Global Position System (GPS) data, potentiometer pedals and split times Statistical Package for Social Sciences software (SPSS, v.25, IBM, United States) was used to conduct the statistical analyses, and t-tests for related samples and two-way repeated measures ANOVA were performed. For the post-hoc analysis, the DMS adjustment factor was used. RESULTS: No significant effects of caffeine on the amount of fat oxidized (31.43 ± 14.39 g vs. 28.40 ± 10.81 g; p = 0.23), and carbohydrates oxidized (86.05 ± 32.33 g vs. 88.86 ± 42.64 g) were found (p = 0.26). Differences between conditions were neither observed in heart rate (131.73 ± 16.8 bpm vs. 132.64 ± 22.60 bpm; p = 0.74) nor perceived exertion during the test (9.8 ± 1.83 a.u. vs. 10.32 ± 1.96 a.u.; p = 0.12). CONCLUSION: In conclusion, caffeine intake had no effect on fat oxidation during a 1-h mountain bike test at Fatmax. The differences observed between these results and those obtained using laboratory cycloergometers may be related to a reduced metabolic effect of caffeine provoked by the inclusion of an important technical component in the mountain bike test or altered by the different individual responses of participants. Future research with participants of a more homogeneous sport level and including both men and women would be of interest.

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**GREATER EXERCISE-INDUCED MUSCLE DAMAGE AFTER ECCENTRIC MUSCLE CONTRACTIONS WITH PRE-EXERCISE CAFFEINE SUPPLEMENTATION**

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INTRODUCTION: There has been recently growing interest among exercisers and researchers in the use of caffeine prior to resistance exercise as a "pre-workout supplement" and its effects on resistance exercise performance (1,2). This approach is based on the fact that caffeine acutely improves athletic performance, including muscular strength/power output (3). However, the higher eccentric exercise intensity involves the greater exercise-induced muscle damage (EIMD), which is accompanied by a reduction in muscle function and an increase in muscle soreness (4). Therefore, pre-exercise caffeine supplementation would increase EIMD by increasing the eccentric load during resistance exercise through improvements in eccentric contractile performance. We aimed to examine the impact of pre-exercise caffeine supplementation on EIMD after eccentric contractions.

METHODS: Fifteen healthy young males ingested 6 mg/kg of caffeine or placebo in a randomized, double-blind, counterbalanced, crossover design. Participants performed 100 maximal voluntary eccentric knee extensions using a dynamometer 1 h after the ingestion. Eccentric torque throughout the exercise was recorded and torque-time integral (TTI) was calculated as the exercise performance. Maximal voluntary isometric torque (MVIT) and muscle soreness were assessed before and 1, 24, 48 h after the exercise as indirect EIMD markers. Total TTI throughout the exercise task was compared between conditions with paired t test. The TTI in each set of exercise and the indirect EIMD markers were analyzed by two-way repeated ANOVA and paired t test or Wilcoxon signed-rank test (with Benjamini-Hochberg adjustment if necessary) as post hoc comparisons with effect size calculations.

RESULTS: Total TTI was significantly higher with caffeine compared to placebo (P=0.001, g=0.34). Time course analysis of TTI in each set showed a significant main effect of condition (P=0.001) and time (P=0.018), but no interaction (P=0.548), suggesting that caffeine maintained the improved eccentric contractile performance throughout the exercise. MVITs were significantly lower with caffeine than with placebo 24 h (Placebo: 90.4 ± 16.5%, Caffeine: 78.2 ± 23.5%, P=0.031, g=-0.54) and 48 h after the exercise (Placebo: 99.5 ± 14.8%, Caffeine: 82.4 ± 24.1%, P=0.016, g=-0.79). Muscle soreness was higher with caffeine than with placebo 24 h (P=0.005, r=0.72) and 48 h after the exercise (P=0.005, r=0.73).

CONCLUSION: Pre-exercise caffeine supplementation increases the EIMD after maximal voluntary eccentric knee extensions, i.e., greater reduction in voluntary torque and increased muscle soreness. Caffeine certainly acts as a "pre-workout supplement" to improve muscular performance during the bout of resistance exercise, but it should be applied to the resistance training with careful consideration for subsequent post-exercise conditioning.

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**EFFECTS OF CAFFEINE SUPPLEMENTATION AT DIFFERENT DOSES ON VERTICAL JUMP, WINGATE PERFORMANCE, AND 60M SPRINT IN MALE 100M SPRINTERS**

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INTRODUCTION: Caffeine (CAF) has been widely shown to enhance performance in various sports. However, most existing studies focus on team sports or prolonged repeated sprints, with limited attention given to high-intensity anaerobic exercises, such as sprints. This study aims to investigate the effects of different doses of caffeine supplementation on the performance of 100-meter sprinters, providing practical supplementation strategies for improving sprinter performance.

METHODS: Twenty-one male 100-meter sprinters (age: 20 ± 1.45 years, height: 181 ± 4.87 cm, weight: 74 ± 6.57 kg, 100-meter time: 11 ± 0.24 s) were recruited. A randomized crossover design was used, with three caffeine supplementation trials: placebo group (PLA, 0 mg/kg), CAF3 group (3 mg/kg), and CAF6 group (6 mg/kg), with a one-week washout period between each trial. Participants performed a warm-up 30 minutes after ingesting capsules and then completed a 60-meter sprint test 60 minutes post-ingestion. Performance indicators, including sprint time, reaction time, stride frequency, stride length, and rate of force development (RFD), were recorded. After a 10-minute rest, participants performed a counter-movement jump (CMJ) to measure jump height, followed by a 10-second Wingate test to assess peak power (PP) and mean power (MP). Repeated measures ANOVA was used to analyze all dependent variables, with a significance level set at $P < 0.05$.

RESULTS: The CAF3 and CAF6 groups showed significantly higher vertical jump heights compared to the placebo group (53.9 ± 1.1, 55.5 ± 1.1, and 51.4 ± 1.1 cm, respectively, $P < 0.001$). PP and MP were also significantly higher in the caffeine groups compared to the placebo group (PP: 867.4 ± 29.1, 871.0 ± 24.5, and 797.7 ± 30.9 W, $P < 0.001$; MP: 400.5 ± 31.7, 396.7 ± 28.0, and 282.5 ± 23.6 W, $P < 0.001$). The caffeine groups demonstrated significantly better 60-meter sprint times (7.094 ± 0.037, 7.042 ± 0.035, and 7.217 ± 0.044 s, respectively, $P < 0.001$). Reaction time was significantly reduced in the caffeine groups (0.162 ± 0.003, 0.161 ± 0.003, and 0.180 ± 0.003 s, $P < 0.001$). No significant differences were observed in stride length or stride frequency across groups (stride length: 1.44 ± 0.02, 1.44 ± 0.02, and 1.43 ± 0.02 m, $P = 0.593$; stride

frequency: 4.20 ± 0.05, 4.32 ± 0.50, and 4.28 ± 0.04 Hz, P = 0.449). The maximum and average RFD values were significantly higher in the caffeine groups compared to the placebo group (maximum RFD: 45.3 ± 0.9, 50.0 ± 1.2, and 40.3 ± 1.1 N/kg/s, P < 0.001; average RFD: 18.3 ± 0.9, 20.5 ± 1.0, and 15.1 ± 0.7 N/kg/s, P < 0.001).

CONCLUSION: Pre-exercise caffeine intake significantly improves CMJ, anaerobic capacity, and start performance in sprinters, but has no effect on stride length or stride frequency. There were no differences between 3 mg/kg and 6 mg/kg caffeine in enhancing anaerobic capacity and reaction time. However, 6 mg/kg caffeine is more effective than 3 mg/kg in improving CMJ, start speed, and RFD.

## Oral Presentations

### OP-MH39 Cardiovascular Disease

**INDIVIDUAL DIFFERENCE IN MOTOR UNIT FIRING RATE MODULATION IS ASSOCIATE WITH BLOOD PRESSURE RESPONSE DURING EARLY PHASE OF EXERCISE IN YOUNG MALE BUT NOT IN FEMALE**

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INTRODUCTION: Blood pressure (BP) response during exercise (Ex) exhibits significant variability, even among young normotensive individuals. One of the key mechanisms regulating BP during Ex is the exercise pressor reflex, which includes the mechanoreflex and metaboreflex. These reflexes are activated by mechanical and chemical stimuli induced by skeletal muscle contraction, which is regulated by motor unit (MU) behavior, particularly MU firing rate (MUFR) modulation. Notably, MUFR decreases in the early phase of Ex and subsequently increases in the later phase, although this pattern varies among individuals. Furthermore, the early phase of the BP response during Ex is primarily associated with the mechanoreflex, while the later phase is influenced by both the mechano- and metabo-reflex. Therefore, individual differences in MUFR modulation may be linked to variations in mechanoreflex-induced BP response during the early phase of Ex, and in mechanoreflex- and/or metaboreflex-induced BP response during the later phase in young normotensive individuals.

METHODS: Fifteen young males and seventeen females performed a 1-minute isometric knee extension Ex at 30% of their maximal voluntary contraction (MVC), followed by post-exercise muscle ischemia (PEMI). Beat-by-beat systolic BP (SBP) was continuously measured, and the slope of the linear regression between baseline and 30 seconds (early phase) and between 30 and 60 seconds (later phase) was analyzed for each individual. The change in mean arterial pressure (ΔMAP) from baseline to PEMI was calculated to assess individual differences in metaboreflex activity. High-density surface electromyography signals recorded during Ex were used to assess MUFR modulation. MUFR was analyzed via the slope of the linear regression between the start of Ex and 30 seconds (early phase) and between 30 and 60 seconds (later phase).

RESULTS: Although previous studies have reported that absolute knee extension torque can affect the BP response during Ex, no significant relationships were observed between MVC and BP response or MUFR modulation during Ex in either males and females (P = 0.195 - 0.974). In males, variability in SBP response was significantly associated with MUFR in the early phase of Ex (P = 0.005, r = 0.682), but not in the later phase (P = 0.242). Variability in ΔMAP was not associated with MUFR in both Ex phase (P = 0.791 and P = 0.290, respectively). However, ΔMAP was significantly associated with SBP response in the later phase (P = 0.003, r = 0.712). In females, no significant relationships were found between MUFR and BP response.

CONCLUSION: In males, individuals with a smaller decrease in MUFR exhibited a greater increase in the mechanoreflex-induced BP response during the early phase of Ex. In contrast, during the later phase, a greater increase in BP response was associated with higher metaboreflex activity rather than MUFR modulation. No significant relationships were observed in females.

**IN-HOME LOW INTENSITY INTERVAL EXERCISE LOWERS SUPINE BLOOD PRESSURE IN PATIENTS WITH RESISTANT HYPERTENSION AND RESTRICTED MOBILITY FOR CLAUDICATION: A SEX-ORIENTED COHORT STUDY**

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INTRODUCTION: This observational cohort study aimed to assess overall and sex-dependent variations in office blood pressure measurements (OBPM) in a cohort of patients affected by intermittent claudication (IC) and resistant hypertension (RH) enrolled in an in-home low intensity interval walking program.

METHODS: From a cohort of 1205 patients with IC consecutively enrolled between 2011 and 2023, those with RH were included. All patients performed the in-home Test in-Train out pain-free walking program [1] composed of eight bouts of 1:1 interval walk:rest ratio at a prescribed speed, weekly increased from approximately 60 to 100% of habitual gait speed. The exercise program was updated during three intermediate visits and lasted for approximately 6 months. The OBPM were collected at baseline (T0), at circa-monthly visits (T1, T2, T3) and at the end of the program (T4) by the same medical doctor with the patient laying in supine position for at least 5 minutes. Variations in drug therapy were also collected.

RESULTS: A total of 220 patients were affected by RH (aged 73±9 years; 170 males). All patients completed the exercise program (session completed 84±11%) without adverse events. Fourteen patients underwent changes in drug therapy during the follow up and were excluded. The remaining 206 patients presented a progressive decline of systolic blood pressure (SBP) (t = -7.11; p<0.001) from T0 to T4 with a mean decrease of -10±8 mmHg (from 159±17 to -149±17mmHg) and of diastolic pressure of -1±5 mmHg.

The repeated-measure analysis of variance excluded a significant sex per time interaction for both SBP (p=0.28) and DBP (p=0.44). In particular, women exhibited a significant decrease (p<0.001) in SPB from 162±17 to 152±16 mmHg; p<0.001) comparable to men (from 156±16 to 146±17mmHg; p<0.001).

CONCLUSION: In a population at high cardiovascular risk with claudication and RH, a low volume of structured low-intensity home-based exercise improved blood pressure control in both women and men, representing a favourable adjuvant to pharmacological therapy.

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**THE EFFECT OF A NOVEL 8-WEEK MULTI-EXERCISE, HOME-BASED ISOMETRIC RESISTANCE TRAINING PROGRAMME ON RESTING AND AMBULATORY BLOOD PRESSURE IN PRE- AND HYPERTENSIVE ADULTS**

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INTRODUCTION: Isometric resistance training (IRT) is an alternative, time-efficient approach to hypertension management [1]. Yet established methods have restricted exercise variability and present participation barriers, including access to and cost of specialised non-portable equipment [2]. A novel cost-effective isometric training band (ITB) has safely demonstrated significant blood pressure (BP) reductions [3]. However, efficacy in pre- and hypertensive adults in unsupervised environments is yet to be established. Therefore, the present study compared the effects of an 8-week, home-based multi-exercise ITB intervention to volume matched isometric handgrip (IHG) on resting, and ambulatory blood pressure in pre- and hypertensive adults.

METHODS: Using a parallel randomised control trial, thirty-eight pre-hypertensive (n = 17, sBP 135 ± 1 mmHg) and stage 1 hypertensive (n = 21, 147 ± 6 mmHg) adults were recruited into a control (CON, n = 13), IHG (n = 13) or ITB (n = 12) group. Resting systolic (sBP), diastolic (dBP), mean arterial pressure (mBP), heart rate (HR) and ambulatory BP (24-hour, daytime, night-time) were measured at baseline and following 4, and 8 weeks of unsupervised home-based IRT (4 x 2-min bouts, 3x week). Data were analysed using factorial ANOVAs (time [pre-, mid- and post-testing] x group [CON, ITB, and IHG]) to examine any significant within and between group differences, with post-hoc effect sizes calculated using Cohen's d.

RESULTS: After 4 weeks resting sBP significantly reduced in the IHG (10.2 ± 4.1 mmHg, d = -1.63) but not in the ITB group (1.8 ± 4.1 mmHg, d = -0.56). Following 8 weeks resting sBP significantly decreased for both training groups (ITB: 9.0 ± 3.2 mmHg, d = -1.36; IHG: 12.0 ± 3.1 mmHg, d = -1.48) compared to CON, although not significant between training groups (2.3 ± 3.2 mmHg, d = 0.32). Comparably, significant reductions in 24-hour (ITB: 7.6 ± 1.5 mmHg, d = 1.42; IHG: 6.9 ± 1.5 mmHg, d = 1.33), daytime (ITB: 7.3 ± 1.6 mmHg, d = 1.33; IHG: 6.3 ± 1.5 mmHg, d = 1.21), and night-time sBP (ITB: 8.5 ± 1.7 mmHg, d = 1.39; IHG: 8.8 ± 2.1 mmHg, d = 1.38) occurred for both training groups after 8 weeks. Whereas reductions in 24-hour (6.2 ± 1.4 mmHg, d = 1.2) and daytime mBP (6.7 ± 2.5 mmHg, d = 1.16) occurred in the ITB group only. No significant decreases in resting or ambulatory dBP or HR occurred for either group.

CONCLUSION: The BP reductions in both training groups provide further evidence for the efficacy of IRT, however, results suggest the onset of effects may vary depending on modality. Importantly, the equivalent sBP reductions between training groups at 8 weeks highlight the potential of the ITB as a versatile, cost-effective, and accessible approach to IRT for BP management in pre- and hypertensive populations.

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**EXAMINATION OF THE DOSE-DEPENDENT EFFECTS OF ISOMETRIC RESISTANCE TRAINING ON DECREASES IN BLOOD PRESSURE IN PRE- AND HYPERTENSIVE ADULTS**

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INTRODUCTION: Hypertension, a major risk factor for cardiovascular disease is near pandemic levels [1] with approximately 1.6 billion adults diagnosed worldwide [2]. Isometric resistance training (IRT) commonly performed thrice weekly (4 × 2-min contractions) is an established efficacious nonpharmacological intervention for the prevention and treatment of hypertension. A significant barrier to therapeutic exercise is time to undertake the intervention and despite the observed benefits, adherence and compliance remains low [3]. Whilst three times per week is the most commonly applied protocol there is no evidence to confirm that it is the most efficacious. Therefore, the study aim was to determine if a reduction in the weekly dose of IRT, would produce similar hypotensive responses to those reported with the more commonly used protocol.

METHODS: Thirty pre- and hypertensive individuals (Female, n = 16, age = 53 ± 9 yr; systolic blood pressure [SBP] range 133 – 161 mmHg; Male, n = 14, age = 52 ± 8 yr; SBP range 132 – 150 mmHg) were randomly assigned to perform IRT, once (IRT×1, n = 10), twice (IRT×2, n = 10), or thrice weekly (IRT×3, n = 10). Each training session consisted of 4 × 2-min contractions (upper, lower and whole body) at a perceived exertion (CR-10) of 4-5, with 2-min rest periods [4]. Resting and ambulatory blood pressure (BP; 24-hr, daytime, night-time) were measured prior to, at the mid-point and after a 10-week training period. A factorial ANOVA (time; pre-, mid- and post-training × group; IRT×1IRT×2, and IRT×3) was used to determine significant within- and between group differences, with post-hoc analyses undertaken using a Bonferroni correction.

RESULTS: Significant reductions in resting SBP were evident over time for both IRT×2 (mid-post, 5 ± 5 mmHg; p = 0.007, d = 1.01; pre-post, 9 ± 16 mmHg, p = 0.017, d = 0.55) and IRT×3 (mid-post, 5 ± 3 mmHg; p = 0.008, d = 1.80; pre-post, 9 ± 5 mmHg, p = 0.016, d = 1.82). Similarly, 24-hr SBP also significantly decreased in IRT×2 (mid-post, 8 ± 6 mmHg; p = 0.003, d = 0.82; pre-post, 7 ± 3 mmHg, p = 0.023, d = 1.66) and IRT×3 (mid-post, 6 ± 2 mmHg; p = 0.020, d = 2.78; pre-post, 8 ± 4 mmHg, p = 0.010, d = 1.73). There were no significant between-group differences at any time points (p > 0.05).

CONCLUSION: Both the twice and thrice weekly training protocols were identified as efficacious therapeutic exercise interventions to lower both resting and ambulatory SBP, which did not differ between groups at all three time points. The larger effects evidenced in IRT×3 resting and 24-h SBP indicate that thrice weekly training is the optimal for reducing BP, however twice weekly training can still reduce BP whilst overcoming time-related barriers.

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## Oral Presentations

### OP-MH38 Metabolic Flexibility

**ACUTE EFFECTS OF HIGH-INTENSITY INTERVAL EXERCISE IN HYPOXIA VS. NORMOXIA ON POST-EXERCISE OXYGEN CONSUMPTION AND LIPID OXIDATION IN INDIVIDUALS WITH OVERWEIGHT OR OBESITY: PRELIMINARY INSIGHTS.**

COUVERT, A., RANCE, M., SORG, M., GUILLEMIN, F.G., CHOMARAT, C., LE NY, E., DONNADIEU, V., LASSEIGNE, L., DECOSTER, A., BOISSEAU, N.

*UNIVERSITÉ CLERMONT AUVERGNE*

INTRODUCTION: High-intensity interval training (HIIT) effectively reduces fat mass (FM), including abdominal and visceral FM (1). Recent studies demonstrate that performing HIIT in hypoxia, compared to normoxia, enhances total and abdominal FM loss in individuals with overweight or obesity (2,3). However, the mechanisms underlying these body composition changes remain to be elucidated. This study therefore aimed to compare the acute effects of high-intensity interval exercise (HIIE) performed in hypoxia versus normoxia on oxygen consumption ($VO_2$) and lipid oxidation during the first two hours of recovery in normoxia.

METHODS: Seven fasted participants (67 ± 3 years; body mass index: 31 ± 5 $kg \cdot m^{-2}$) completed two HIIE sessions (normoxia vs. hypoxia) on a cycle ergometer (WattBike). The first session was conducted under normoxia and consisted of 60 repetitions of (8s at 80-85% HRMax + 12s deceleration), with power output recorded. In the second session, performed under hypoxia, participants completed the same HIIE while maintaining the same power output as in normoxia, ensuring that both sessions were matched for external load. Each session began with a 20-minute pre-exercise metabolic assessment, followed by a 10-minute standardized warm-up under normoxic conditions. HIIE was then performed either in normoxia (normobaric room, 21% $O_2$) or hypoxia (normobaric room, 15% $O_2$). The 2-hour post-exercise recovery took place under normoxic conditions. Heart rate (HR) and rate of perceived exertion (RPE) were recorded throughout exercise. $VO_2$ and $VCO_2$ were measured, allowing for the calculation of the respiratory exchange ratio (RER) and energy expenditure (EE) before, during, and for two hours post-exercise in normoxia. Substrate oxidation ($g \cdot min^{-1}$) was calculated during the recovery period.

RESULTS: Both normoxic and hypoxic sessions induced similar mean HR (p = 0.24), $VO_2$ (p = 0.31), EE (p = 0.24), RER (p = 0.49), and RPE (p = 0.67) responses during exercise. Mean $VO_2$ ($L \cdot min^{-1}$) was higher during the 2-hour recovery period than before exercise in both conditions (p = 0.02), with no session effect (p = 0.50). While 2-hour recovery EE did not differ between normoxic and hypoxic conditions (p = 0.50), lipid oxidation tended to be higher after HIIE performed in hypoxia (p = 0.06).

CONCLUSION: These preliminary findings suggest that performing HIIE under hypoxic conditions may promote greater lipid oxidation during recovery compared to normoxia, despite similar energy expenditure. However, these results should be interpreted with caution and require confirmation with the full sample (n=15).

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**THE EFFECTS OF INTERMITTENT HYPOXIC TRAINING STRATEGIES ON MAXIMAL OXYGEN UPTAKE: A META-ANALYSIS WITH META-REGRESSION**

KOHLBRENNER, D., GHAITH, A., KHOURI, CH., FOURNIER, J., CHACAROUN, S., ROBACH, P., MENDELSON, M., FLORE, P., MARILLIER, M., BRUGNIAUX, J., PÉPIN, J.L., TAMISIER, R., VERGES, S.

*GRENOBLE ALPES UNIVERSITY*

INTRODUCTION: Intermittent hypoxic training aims to enhance exercise performance and health, commonly expressed as maximal oxygen uptake (VO2max). Currently applied methods are live-high train-low (LHTL), live-low train-high (LLTH), and passive hypoxic conditioning (PHC). Despite a substantial amount of studies published on the topic, no consensus exists on which method is effective in augmenting VO2max. In addition, factors (i.e., hypoxic dose, exposure times) driving development of VO2max most effectively are unknown. This work aimed to determine the effect of LHTL, LLTH, and PHC on VO2max in healthy participants, and identifying factors associated with the amplitude of change in VO2max.

METHODS: We conducted a systematic review with random-effects meta-analysis and meta-regression. Studies were identified through PubMed, EMBASE, and Web of Science. We included controlled and uncontrolled studies, calculating weighted within-group mean changes and between-group standardised mean differences. Athlete and non-athlete populations were analysed separately.

RESULTS: Of the 13248 identified studies, 147 were included for analysis, resulting in a sample size of 2668 participants. Of these participants, 1449 were considered athletes and 1219 were considered non-athletes. Meta-analyses indicated that LHTL (athletes: MD = 0.72; 95%CI = -0.23, 1.68; non-athletes: 1.06; -0.31, 2.43) and PHC (athletes: -0.54; -1.69, 0.61; non-athletes: 0.60; -0.75, 1.94) did not increase VO2max significantly more than control. LLTH did increase VO2max significantly more than control, both in athletes (1.17; 0.29, 2.05) and non-athletes (1.38; 0.61, 2.15). Multivariate meta-regression of all studies identified sample size to be significantly associated to the change in VO2max (B = -0.15; 95%CI = -0.25, -0.05). The risk of bias in the included studies was substantial. We did not find evidence for publication bias.

CONCLUSION: LLTH showed a significant effect on VO2max in both athletic and non-athletic populations, while LHTL and PHC did not. Although a considerable number of studies on intermittent hypoxic training strategies exists, high-quality placebo-controlled trials are still warranted for definite conclusions. Further, future studies should target investigating which characteristics (i.e., length and magnitude of exposure) of the hypoxic exposure are most beneficial.

**UNRAVELLING THE IMPACT OF EXERCISE TIMING ON GLYCAEMIC CONTROL: A RANDOMISED CONTROLLED TRIAL**

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*UNIVERSITY BASEL*

INTRODUCTION: Impaired glycaemic control is a major risk factor for cardiovascular disease, the leading cause of death worldwide. Increasing physical activity is a key strategy to improve glycaemic control. The circadian system influences glucose metabolism, causing 24-hour fluctuations in plasma glucose with a peak later in the day. Metabolic responses may vary depending on the time of day during which exercise is performed. Evidence of diurnal variations in physical performance, combined with the timing of behaviours such as sleep and diet, suggests that the timing of exercise may influence adaptations and health outcomes. This study aimed to investigate the impact of exercise timing on glycaemic control and optimise metabolic health strategies.

METHODS: Sixty non-diabetic adults (36% female, mean [standard deviation] age 68 [6] years, BMI 24.1 [2.7] kg/m²) participated in this double-blind, randomised controlled trial. Participants were assigned to exercise at 8:00, 12:00, 16:00 or 20:00 (E-08, E-12, E-16, E-20) for 12 weeks, performing two strength and one endurance session weekly. A two-hour oral glucose tolerance test was performed before and after the intervention following an overnight fast. Serum glucose was measured at fasting and 10, 20, 30, 60, 90 and 120 min after ingestion of 75g dextrose. Glucose response was quantified as area under the curve (AUC) using the trapezoidal method. Treatment effects over time were analysed using analysis of covariance with estimated marginal means, adjusted for sex, age, lean mass and fat mass. Effect sizes were standardised using baseline standard deviations.

RESULTS: Fifty-two participants were analysed (E08: n=14, E-12: n=15, E-16: n=7, E-20: n=16), with most dropouts due to missing more than two serum glucose values. Exercise adherence was excellent with 93% of all sessions completed. AUC decreased more in the E-16 group than in the others, with effect sizes being E-08: -0.21 (-0.68 to 1.10), E-12: -0.29 (-0.56 to 1.15) and E-20: -0.30 (-1.15 to 0.54), all considered small. Negative effect sizes, indicating a reduction in AUC, are considered beneficial for metabolic health. However, there was considerable uncertainty about these effects. Comparisons between the remaining groups showed negligible effect sizes (< 0.10).

CONCLUSION: The timing of exercise appears to influence metabolic adaptations, with different patterns observed between exercise groups. The results suggest that exercising at a time of day when glucose metabolism is less efficient (e.g. E-16) may lead to greater adaptations. However, the wide confidence intervals indicate considerable uncertainty in these results. Further research is needed to improve our understanding of the underlying metabolic mechanisms and to provide a scientific basis for integrating exercise timing into health and metabolic management strategies.

Oral Presentations

OP-MH36 Respiratory Disease

**DECREASED MUSCLE OXYGEN SUPPLY AND EARLY FATIGUE DURING EXERCISE IN PATIENTS WITH SEVERE COPD AND HEALTHY INDIVIDUALS**

GUTIERREZ, S., MIRANDA, C., VALDES, O., JALÓN, M., MENDOZA, L., PEÑAILILLO, L.
*UNIVERSITY ANDRÉS BELLO*

INTRODUCTION: Chronic obstructive pulmonary disease (COPD) is a leading cause of death worldwide, with muscle dysfunction in the lower limbs being a significant extrapulmonary manifestation (1). Muscle dysfunction is characterized by loss of muscle mass and function, resulting in limited exercise capacity and reduced quality of life. Systemic inflammation and oxidative stress are common manifestations of COPD and could impair muscle energy metabolism and oxygen utilization (2). These factors compromise oxygen delivery to muscles during exercise, affecting exercise performance in patients. In COPD patients, these factors likely contribute to early fatigue and reduced maximal aerobic capacity. Near-infrared spectroscopy (NIRS) provides a non-invasive method to assess muscle oxygenation in real time, offering insight into oxygen supply and utilization during exercise (3). This study aimed to compare muscle oxygen supply and uptake during a submaximal time to exhaustion (TTE) cycling test in COPD patients and healthy individuals.

METHODS: A cross-sectional observational study compared 12 healthy individuals (64 ± 6.7 years and FEV1 104.67% ± 7.63) and 12 patients with severe COPD (65 ± 5.3 years and FEV1 40.67% ± 15.67). Maximal aerobic capacity (VO2peak) and power output (POmax) were measured using an incremental cycling test. The time-to-exhaustion (TTE) test was assessed with a constant-load test at 70% of the POmax. During TTE, muscle oxygenation was measured using NIRS in the vastus medialis, which assesses the concentration of total hemoglobin plus the concentration of myoglobin (tHbMb) in the muscle in real time and the percentage of muscle oxygen saturation (SmO2). Furthermore, deoxyhemoglobin (HHb) was calculated as the tHbMb multiplied by the $SmO_2$ fraction. The area under the curve (AUC) of the variables $SmO_2$, tHbMb, and HHb over time of TTE was calculated to represent the cumulative response. Additionally, heart rate, peripheral oxygen saturation (SpO2), and perceived exertion (Borg´s scale) were recorded during TTE. Data analysis was performed in RStudio using Student's t-test and analysis of variance (ANOVA).

RESULTS: COPD patients show a 29.1% lesser $VO_2$peak (p=0.02) compared to healthy individuals. COPD patients performed 43.6% lesser time in the TTE than healthy individuals. The AUC during exercise time in TTE of HHb was 44.9% (p=0.04) lower in COPD patients, likely due to the significantly shorter TTE duration (p<0.01). The SmO2 was similar (56.4% vs 51.2%, respectively) between groups (p=0.28). However, SmO2 at 10% of the total time was 15% lower (p = 0.02) in healthy individuals than COPD, indicating reduced muscle oxygen uptake. The tHbMb increased similarly in both groups (p=0.94), reflecting comparable vascular responses.

CONCLUSION: This suggests that COPD patients have a reduced capacity to sustain submaximal effort, potentially due to lesser maximal oxidative capacity and impaired muscle oxygen delivery and utilization during exercise, which may lead to early fatigue.

**EFFECT OF ADDING NEUROMUSCULAR ELECTRICAL STIMULATION TRAINING TO PULMONARY REHABILITATION IN PATIENTS WITH CHRONIC OBSTRUCTIVE PULMONARY DISEASE: RANDOMIZED CLINICAL TRIAL**

TRABELSI, Y., TABKA, O., MEKKI, M., PAILLARD, T., ZAOUALI, M.
*SOUSSE FACULTY OF MEDICINE*

INTRODUCTION: Numerous studies have demonstrated postural balance impairments in patients with chronic obstructive pulmonary disease (COPD). To address this, pulmonary rehabilitation (PR) has been recommended, either alone or combined with traditional muscle-strengthening exercises. However, no study has explored the use of electrostimulation (ES) to improve postural balance in COPD patients. This study aims to assess the effectiveness of neuromuscular electrical stimulation (NMES) combined with pulmonary rehabilitation in enhancing walking tolerance and balance in COPD patients.

METHODS: Forty-five COPD patients were randomly assigned to either an intervention group (n = 25) or a control group (n = 20). The intervention group received neuromuscular electrical stimulation in addition to pulmonary rehabilitation, while the control group received only pulmonary rehabilitation, both three times per week over six months. Assessments were performed at baseline and after six months using a stabilometric platform, the Timed Up and Go test, the Berg Balance Scale, the 6-minute walking test, and maximal voluntary contraction measurements.

RESULTS: The intervention group showed significant improvements in exercise tolerance, with a greater distance walked on the 6-minute walking test (619.5 ± 39.6 m) compared to the control group (576.3 ± 31.5 m). The intervention group also demonstrated significant improvements in the Timed Up and Go test, the Berg Balance Scale, and maximal voluntary contraction (P = 0.02, P = 0.01, P = 0.0002, respectively). Additionally, there were significant improvements in the center of pressure (COP) in both mediolateral and anteroposterior directions, as well as in the COP area, with both eyes open and closed, in the intervention group compared to the control group (P < 0.001).

CONCLUSION: The use of neuromuscular electrical stimulation of lower-limb muscles added to pulmonary rehabilitation is more effective in improving walking tolerance and generating a better control of postural balance for patients with COPD than pulmonary rehabilitation alone. These findings may assist clinicians in designing more effective rehabilitation programs for patients with COPD.

**GLOBAL HOTSPOTS AND TRENDS OF EXERCISE PRESCRIPTIONS FOR CHRONIC OBSTRUCTIVE PULMONARY DISEASE FROM 2000 TO 2024**

FU, T., LIU, H.

*HENAN UNIVERSITY*

INTRODUCTION: Chronic obstructive pulmonary disease (COPD), a progressive respiratory disorder marked by irreversible airflow limitation and dyspnea, significantly reduces life quality and imposes global health burdens. Its clinical progression spans early symptoms (chronic cough, sputum production), intermediate-stage dyspnea, and advanced systemic manifestations (cyanosis, cardiopulmonary dysfunction), with mortality rates ranking third worldwide. While exercise interventions improve lung function, cardiovascular health, and psychological well-being in COPD patients, debates persist regarding optimal exercise modalities, intensity thresholds, and long-term efficacy. Excessive exertion may exacerbate dyspnea, cardiopulmonary strain, and muscle fatigue, underscoring the need for evidence-based exercise prescriptions. This study employs bibliometric analysis (2000–2024) to map global research trends in COPD exercise interventions, examining publication patterns, collaborative networks, and thematic evolution. By identifying knowledge gaps and fostering interdisciplinary collaboration, we aim to optimize exercise strategies for COPD management.

METHODS: We searched the Web of Science Core Collection database for literature related to COPD exercise prescriptions . The manual screening criteria applied were as follows: date range, January 01, 2000, to June 01, 2024; language, English; article type, article and review article. Finally, 738 articles were included in this study. CiteSpace, VOSviewer, and Bibliometrix R-package software were used to analyze the literature.

RESULTS: Research output in the field of exercise prescriptions for COPD can be divided into four phases: the exploratory period (2000-2008), surge period (2009-2016), exponential growth phase (2017-2020), and fluctuation period (2021-2024). The US leads the world in terms of the total number of publications, while BMJ OPEN from the UK has the highest number of publications. The longest-standing research topic is dyspnea, and airflow limitation has been identified as the core issue in this field. Anxiety, oxidative stress, inflammation, and dynamic pulmonary hyperinflation are practical challenges facing this domain. Respiratory pattern training, including diaphragmatic breathing, Pilates breathing, unidirectional breathing, pursed-lip breathing, and paced breathing, constitutes the primary exercise prescription for patients with COPD.

CONCLUSION: The number of publications on COPD has grown rapidly. Key research areas include quality of life, dyspnea, lung rehabilitation, and lung capacity. Future research directions include exercise prescription, resistance training, muscle function, anxiety, evaluating intervention effects, and optimizing respiratory patterns. Future studies should prioritize macro-level integrated exercise prescriptions highlighting multiple types of exercise and micro-level specifications of resistance training intensity, density, frequency, and period.

**THE ROLE OF HIGH-INTENSITY INTERVAL TRAINING IN REDUCING LUNG INFLAMMATION AND APOPTOSIS FOLLOWING RENAL ISCHEMIA-REPERFUSION INJURY**

TANG, C., LAI, C., LEE, I., CHEN, J., YU, C.

*UNIVERSITY OF TAIPEI*

INTRODUCTION: Renal ischemia-reperfusion (I/R) injury is a common complication in kidney, cardiac, and vascular surgeries (1). Acute kidney injury (AKI) has been linked to damage in distant organs, including the heart, lungs, liver, and brain, contributing to its high mortality rate (2). Previous studies show that a four-week high-intensity interval training (HIIT) program can reduce renal I/R injury and protect the heart. With HIIT gaining popularity for its time efficiency, fat loss, and health benefits (3), this study examines whether HIIT can also alleviate lung injury from renal I/R, potentially informing future exercise prescriptions for health promotion.

METHODS: Thirty male Sprague-Dawley rats were assigned to three groups: Sham, Renal I/R, and HIIT. The Sham group underwent abdominal opening without further intervention, while the other two groups underwent 60-minute renal artery occlusion followed by 24-hour reperfusion. Lung injury was assessed using the wet-to-dry weight ratio and concentrations of tumor necrosis factor-α (TNF-α), interleukin-1β (IL-1β), and interleukin-6 (IL-6) in bronchoalveolar lavage fluid (BALF). Serum TNF-α concentrations were measured using enzyme-linked immunosorbent assay (ELISA). Lung tissues were analyzed via hematoxylin and eosin (HE) staining to assess histological damage and terminal deoxynucleotidyl transferase dUTP nick-end labeling (TUNEL) staining to evaluate apoptosis.

RESULTS: The Renal I/R group exhibited increased lung histological damage, a higher wet-to-dry weight ratio, and enhanced apoptosis. TNF-α, IL-1β, and IL-6 concentrations were elevated in both serum and BALF, along with increased TNF-α expression in lung tissue. In contrast, serum and BALF IL-10 concentrations were reduced. HIIT intervention alleviated lung histological damage, reduced the wet-to-dry weight ratio, and inhibited apoptosis. Additionally, it mitigated the elevation of TNF-α, IL-1β, and IL-6 concentrations while attenuating the reduction of IL-10. Western blot analysis showed an upregulation of B-cell lymphoma 2 (Bcl-2) and a downregulation of Bcl-2-associated X protein (Bax) in lung tissue, suggesting enhanced anti-apoptotic signaling.

CONCLUSION: A four-week HIIT intervention significantly reduced renal I/R-induced lung injury, likely by modulating inflammatory cytokine production and inhibiting apoptosis. Given its efficiency and accessibility, HIIT may be a cost-effective strategy for disease prevention. Its potential lung-protective effects suggest benefits for pulmonary resilience and reduced risk of inflammation- or oxidative stress-induced lung injury. Further studies are needed to explore its broader implications for respiratory health, particularly in conditions linked to lung inflammation or ischemic injury.

Reference:

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# Wednesday, 2 July 2025

## 08:00 - 09:15

### Invited Symposium

### IS-EX02 JSPFSM-ECSS Exchange Symposium: New perspective of exercise-cognition interaction

**OUR BRAIN IN TIME: WHAT ARE THE TIME DEPENDENCIES OF THE EFFECTS OF PHYSICAL ACTIVITY ON COGNITIVE PERFORMANCE?**

RONCA, F.
*KINGSTON UNIVERSITY*

It has long been established that physical activity has a positive impact on brain health. As the field of Exercise & Neuroscience develops, it is important to determine how the elements of time may impact such effects in order to support effective interventions and tailored recommendations in this context. Over the past years, our lab has investigated the effects of age, development, time of day and exercise duration on diverse aspects of mental health and cognitive function. We have identified strong effects of chronotype and time of day on executive function and mood, where the beneficial effects of physical activity on the brain may be time-dependent. Equally, we have queried how long do such effects truly last through naturalistic studies with school children, university students and adult shift workers. This talk will embark on a discovery journey, starting from the effects of age on the development of executive function, slowly unpacking how biological clocks, time of day, exercise duration and intensity may all contribute to our optimal brain performance.

**(PASSIVE) EXERCISE NEUROSCIENCE: REALISING UNTAPPED POTENTIAL TO SUPPORT COGNITION**

TARI, B.
*UNIVERSITY OF OXFORD*

Regular active exercise (i.e., volitional aerobic/resistance exercise) has numerous health benefits, including, but not limited to, improved functional abilities (e.g., mobility), reduced risk of developing disease, and improved brain health and cognitive performance. However, some individuals (e.g., those with spinal cord injuries, cardiorespiratory disease, and/or movement impairments) may not be able to tolerate regular exercise sessions. This is salient because it is these individuals who suffer from the highest rates of cognitive impairment and may derive the greatest benefit from exercise interventions. Accordingly, an alternative to a traditional "active" exercise intervention is passive exercise. Passive exercise entails movement of the limbs via an external mechanical force and thus does not require volitional muscle control. The majority of research surrounding passive exercise describes its benefits in the context of physical rehabilitation; however, promising initial results hint at its utility to also support brain health and cognition. In particular, passive exercise has been shown to support cognitive function immediately following exercise cessation, and this benefit persists for nearly 30 mins. As well, previous work has demonstrated that passive exercise buffers the negative effects of mental fatigue, and simultaneously supports cognitive function. Accordingly, potential exists for this modality to support cognitive and overall health in additional contexts. This discussion will aim to expand on this potential.

**ACUTE EXERCISE AND COGNITIVE PERFORMANCE: NEUROMODULATORY ROLE OF DOPAMINE**

ANDO, S.
*UNIVERSITY OF ELECTRO-COMMUNICATIONS*

It is well established that physical activity, or regular habitual exercise, has beneficial effects on a broad array of cognitive functions. A large body of evidence also indicates that acute physical exercise at low to moderate intensity improves cognitive performance, demonstrated by a reduction in reaction time (RT). Decades of research has explored the physiological mechanisms underlying RT improvement induced by acute exercise including, but not limited to, neurochemicals, neurotrophins, cerebral blood flow, and cerebral metabolism. However, the mechanistic understanding of how this occurs is elusive and has not been rigorously investigated in humans. Using positron emission tomography (PET) with [11C]raclopride, we have shown that acute exercise releases endogenous dopamine (DA) in the brain, and that endogenous DA release was correlated with improvements in RT of the Go/No-Go task. A critical step toward understanding how and why acute exercise improves RT is to identify what triggers RT improvement. Follow-up electrical muscle stimulation (EMS) studies demonstrated that EMS with moderate arm cranking improved RT, but RT was not improved following EMS alone or EMS combined with no load arm cranking. The novel mechanistic findings from these experiments suggest that endogenous DA is an important neuromodulator for RT improvement. Additional electrical muscle stimulation studies demonstrated that peripherally driven muscle contractions were insufficient to improve RT. Our novel findings extend our mechanistic understanding of neuromodulation in the human brain following acute physical exercise. The present findings are also likely to contribute to exercise prescription for neurological diseases as the DA systems are important to the

aetiology of neurobehavioural disorders including Parkinson's disease, attention deficit hyperactivity disorder, and schizophrenia.

## Oral Presentations

### OP-AP09 Training and Testing I - Running

**TRAINING ADAPTATIONS BY REPEATING 2000 M OR 10X200 M DISTANCES AT RUNNING**

USAJ, A.

*UNIVERSITY OF LJUBLJANA, FACULTY OF SPORT*

INTRODUCTION: Alterations in exercise performance follow the fluctuations in training characteristics in a complex and dynamic way. The aim of this study was to make a step towards a better determination of whether the different fluctuations in training velocities of short continuous or high-intensity interval running training are reflected in the adaptations achieved during repeated maximal and submaximal tests.

METHODS: Two groups of 9 and 10 recreational runners took part in a period of 20 training sessions in 5 weeks, consisting of: 2000 m runs (CR) or 10x200 m high-intensity interval training with 2-minute walking recoveries (HIIT). The training period was divided into phases based on the fluctuations in running velocities according to individual daily performance. Each training phase was characterised by its initial running velocity, the slope coefficient of the linear fit of the time course of the running velocities and the average sum of squared residuals calculated as the differences between the values from the linear fit and the actual running velocities. Adaptations were determined using the velocities of the maximal 2000 m trials (v2000) before and after the training period and by submaximal 2x1000 m tests on the treadmill in each training phase, at the same velocity as the first 2000 m trial. During these tests, the gas exchange and the acid-base characteristics of the blood were measured. Repeated comparisons between the measured data for each phase and training method were analysed using repeated measures ANOVA or paired t-test. Both were set to $p<0.05$.

RESULTS: The velocities of both training methods showed two phases, which were separated in CR and HIIT after about 10 training sessions. CR running velocity increased by 8% during the training period ($F=16.672$; $p>0.001$, power=0.998). Differently, HIIT running velocity increased by 6% only in the first phase ($F=11.023$; $p>0.01$; power=0.972) and remained stable until the end. CR increased maximal performance estimated by v2000 by 3% ($p=0.04$, power=0.52), while HIIT increased v2000 by 4% ($p=0.003$, power=0.909). During the submaximal 2x1000 m test, CR training lowered [LA] by approximately 21% ($F=7.717$; $p=0.005$; power=0.836), increased blood pH by 4% ($F=3.781$, $p=0.045$, power=0.462) and lowered Vo2 by approximately 6% ($F=7.532$; $p=0.005$; power=0.85). HIIT had no effect on [LA] or pH, but decreased submaximal Vo2 by 5% ($F=3.612$; $p=0.039$; power=0.474), but only in the first phase.

CONCLUSION: Both training methods influenced performance and other adaptations in different phases, which requires a more time sensitive testing design in the future. The decreased [LA] and increased blood pH during the submaximal test as an effect of the CR method could indicate effects on lactate metabolism, while the decrease in Vo2 with both methods could indicate possible effects on running economy, but not with both methods simultaneously.

**THE REPEATABILITY AND EFFICACY OF COMBINING FIXED-RATE AND SELF-PACED EXERCISE TO INDUCE THERMO-PHYSIOLOGICAL AND PERCEPTUAL STRAIN IN TRAINED RUNNERS**

HOFFMANN, S., DI DOMENICO, I., WARMINGTON, S., COLLINS, P.

*DEAKIN UNIVERSITY, AUSTRALIA*

INTRODUCTION: Studies assessing sports clothing and its ability to maximise thermoregulation, comfort, and performance have used a variety of exercise protocols and environmental conditions. This has led to much conjecture surrounding the ability for sports clothing to keep wearers cool and comfortable during exercise in the heat. This study aimed to develop a testing protocol combining fixed-rate and self-paced exercise for the practical assessment of sports clothing, evaluate its repeatability, and confirm the level of thermo-physiological and perceptual strain induced.

METHODS: Eleven recreationally trained male runners (mean ± SD, age: 26.8 ± 5.6 years; VO2max 59.2 ± 5.1 mL/kg/min; training volume 70.0 ± 26.6 km/wk) each completed two experimental trials in a climate chamber (temperature: 30.3 ± 0.2oC; relative humidity: 67.6 ± 1.6%). Each trial included a 30-minute fixed-rate run (FRR) on a motorised treadmill at 65% VO2max followed by a 5 km time trial (TT) on a non-motorised treadmill. Oxygen consumption, heart rate (HR), core temperature (Tcore), skin temperature, sweat loss, physiological strain index (PSI), rate of perceived exertion (RPE), and thermal sensation (TS) were monitored during the FRR. Duration and distance were recorded following the TT. A repeated-measures ANOVA was used to determine significant differences throughout the FRR. Relative reliability of TT distance and duration was determined using intra-class correlation coefficients (ICC) and 95% confidence intervals. Absolute reliability was determined using within-participant coefficient of variation (CV). Sufficient strain was achieved when participants reached 4 of the following 5 criteria during the FRR: ≥ 1.2oC increase in Tcore compared to rest; HR ≥77% of HRmax; PSI ≥7/10; RPE ≥15/20; TS of -3 indicating a 'hot' sensation.

RESULTS: No significant differences were observed between experimental trials for any thermal, physiological, or perceptual variables during the FRR ($p>0.05$). High relative reliability was confirmed for TT duration (ICC=0.98, 95% CI: 0.94, 0.99,

p<0.001). Moderate relative reliability was confirmed for TT distance (ICC=0.95, 95% CI: 0.83, 0.99, p<0.001). Sufficient absolute reliability was achieved for TT duration (CV=1.1 ± 1.1%) but not for TT distance (CV=2.1 ± 1.6%). Of the 22 experimental trials completed, 17 induced sufficient thermo-physiological and perceptual strain.

CONCLUSION: This study confirmed the reliability and sensitivity of a novel protocol to evaluate thermal, physiological, perceptual, and performance-based outcomes during exercise in hot and humid conditions. The results verified the suitability of the protocol to induce sufficient strain in recreationally trained runners. This research provides a platform for coaches, athletes, and researchers to apply and adjust evidence-based guidelines when evaluating the interaction between clothing, athletic performance, and the heat.

**THE INFLUENCE OF DRAFTING DURING AN INCREMENTAL SPEED TRACK TEST ON PERFORMANCE PHYSIOLOGICAL DETERMINANTS IN DISTANCE RUNNERS**

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INTRODUCTION: Speed during incremental track tests identifying physiological performance determinants in distance runners is typically set by matching sound signals and visual marks in the track (1). However, it requires from the subject being tested constant pace adjustments and overcoming the air resistance derived from speed and variable wind. Recent approaches include the use of a cyclist setting the pace in front of the runner to provide more reliable test outcomes without the interferences associated to the cost of the decision-making process involved in self-pacing and the absence of the drafting effect (i.e., reduction in air resistance derived from positioning just behind another athlete or cyclist) (2).

Therefore, the purpose of this study was to compare physiological performance determinants as well as the power exerted by runners, derived from an incremental track test in the presence and absence of drafting.

METHODS: A randomised, counter-balanced, crossover experimental design was performed. An incremental track test was performed twice by 20 male amateur and highly-trained distance runners (37 ± 11 years; 68.8 ± 6.9 kg; VO2max = 49.1 ± 9.0 ml/kg/min) in the presence and absence of drafting. This test followed the University of Montreal protocol, characterized by an incremental speed to exhaustion increasing 0.5 km/h every minute. Runners wore a backpack with a portable gas analyser (Metamax 3B, Cortex, Germany) to determine speeds associated to both ventilatory thresholds (VTs), VO2max and maximal aerobic speed (MAS), a heart rate (HR) sensor (H10, Polar, Finland) to measure HRs associated to both VTs, and a potentiometer (Strydwind new, Boulder, USA) on the right shoe to measure running power associated to both VTs. For the drafting condition, runners were positioned directly behind a cyclist who set the pace, while in the non-drafting condition, runners performed the test while adjusting the speed to sound signals and visual marks in the track. A related-sample Students t-test was used to compare physiological performance determinants derived from each condition.

RESULTS: MAS was significantly higher in the drafting vs non-drafting test (p = 0.020; d = 0.036), while no other statistically significant differences were found in the rest of performance determinants (p > 0.050).

CONCLUSION: Track incremental running tests may also be drafted by a cyclist whereby their outcomes could not be affected by external and internal factors such as pacing ability and drafting absence. However, the MAS obtained may be faster than that measured without drafting.

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**IS THE MINIMUM LACTATE STEADY STATE AN OVERESTIMATION OF THE MAXIMUM LACTATE STEADY STATE IN RUNNERS?**

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INTRODUCTION: Lactate thresholds are crucial for middle-distance training as they reflect the balance between lactate production and clearance. The minimum lactate steady state (MLSS), introduced in the late 20th century, is considered the highest intensity maintaining this balance (Heck et al., 1985). However, MLSS may overestimate the maximum lactate steady state (MLSSmax) in middle-distance athletes (Beneke, 2003). This study examines whether velocities below MLSS, determined via the lowest blood lactate concentration (Vlm), provide more reliable training benchmarks. We hypothesized MLSS overestimates MLSSmax and sub-Vlm velocities offer better lactate stability.

METHODS: Eight elite middle-distance runners (4 male, 4 female; age: 22 ± 4.2 years; weight: 66 ± 32.5 kg; height: 175 ± 3.5 cm; body fat: 10.8 ± 2.1%) participated. Anthropometric data were collected using a stadiometer (Seca, Germany) and a bioelectrical impedance analyzer (TANITA, Japan). Testing included a 3000m time trial to calculate V3000, a 500m sprint and 800m incremental test, six 800m bouts at 86–97% V3000 to determine Vlm, and 30-minute runs at Vlm and sub-Vlm with blood lactate sampling at 10, 20, and 30 minutes.

RESULTS: At Vlm, athletes were unable to maintain stable blood lactate levels within a one mmol/L range over 30 minutes. Lactate concentrations increased significantly at 10 (4.3±0.3 mmol/L), 20 (4.8±0.4 mmol/L), and 30 minutes (5.2±0.5 mmol/L; p <0.05). This finding suggests that Vlm overestimates MLSSmax. Conversely, velocities below Vlm demonstrated better lactate stability, with concentrations remaining within one mmol/L of baseline. The mean lactate concentration at MLSSmax was 4.2±0.4 mmol/L, compared to 4.5±0.3 mmol/L at Vlm.

CONCLUSION: The results indicate that MLSS, as determined by Vlm, overestimates MLSSmax in elite middle-distance runners. Velocities below Vlm offer a more accurate and practical threshold for training prescription. Coaches and sports scientists are encouraged to adopt individualized lactate testing protocols to optimize performance and minimize overtraining risks.

## Invited Symposium

### IS-MH03 Recent efforts by the International Ski and Snowboard Federation (FIS) to reduce the risk of injury in competitive snow sports for the Winter Olympic Games in Milano Cortina, Italy

**INJURY PREVENTION IN ALPINE SKIING: HOW CAN WE ENHANCE ATHLETE'S SAFETY THROUGH DEVELOPMENTS IN SMART BINDINGS, AIRBAGS, AND CUT-RESISTANT UNDERGARMENTS FOR WORLD CUP ATHLETES**

ELLENBERGER, L.

*ETH ZÜRICH*

Introduction In alpine skiing, equipment is crucial for both performance and safety. Given the high number of severe injuries in the World Cup, the International Ski and Snowboard Federa-tion (FIS) faces the challenge of performance enhancement while minimizing risk. To address athlete's health, FIS established the Athlete Health Unit (AHU), collaborating with scientists, industry leaders, and other stakeholders to reduce injury rates. The AHU's approach includes a focus on both performance and personal protective equipment. This presentation delves into three equipment projects at various stages of progress, examining their challenges and solutions. 1. Cut-Resistant Undergarment: Implementation Challenges of a Proven Technology Cut-resistant undergarments offer reliable protection against ski edges in falls or collisions. A five-star FIS rating system ensures high-quality protection, but widespread implementation in competitive skiing remains a challenge. After a period of limited progress, with few products on the market, the technology is now set to become mandatory by the 2025/26 season. A signifi-cant number of products have since been submitted for certification, a development driven by dialogue and mediation efforts led by the AHU, as community-driven initiatives alone proved insufficient for broader adoption. 2. Airbag with Back Protector: From Concept to Mandatory Gear This season marks a milestone with the introduction of mandatory back protectors integrated with airbags in World Cup Downhill events. Currently, these systems are equipped with sensors that activate upon impact. Future advancements involving AI-driven algorithms could enable earlier detection of imminent falls, allowing deployment prior to impact and providing a protec-tive buffer for the athlete's torso and spine. This section of the presentation will outline the jour-ney from concept to implementation, showcasing the technological and safety advancements that made it possible. 3. Smart Binding: A Visionary Step Towards Injury Prevention The concept of a "smart binding" represents a promising future direction in injury prevention. Unlike traditional bindings, which have remained largely unchanged since the 1980s, smart bindings aim to incorporate adaptive release mechanisms. These mechanisms respond to spe-cific fall dynamics and have the potential to set new safety standards in the sport. This section will introduce the project's initial research, potential design concepts, and the collaborative effort with manufacturers and stakeholders needed to bring this innovation to life. Conclusion This presentation offers an in-depth look at the interplay between equipment de-sign and injury prevention, set within FISs broader safety strategy. Through continuous innova-tion and collaboration with the skiing community, FIS aims to ensure that equipment not only enhances performance but also serves as a critical tool in reducing injury risk in competitive alpine skiing.

**MITIGATION OF INJURY RISK IN SNOW SPORTS THROUGH ENHANCEMENT OF THE ATHLETES PHYSICAL, MENTAL, AND SOCIAL RESILIENCE**

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In various snow sports disciplines governed by the International Ski and Snowboard Federation (FIS), injuries are relatively frequent compared with other Olympic winter sports. Athlete-related risk factors are a promising key area to address with tailored injury prevention measures. However, despite decades of research, snow sports-related evidence is scarce and is related mainly to injury epidemiology and aetiology. In contrast, only a few studies have focused on developing, implementing and evaluating injury prevention measures. Guided by a tailored mixed-method framework and mandated by the FIS Athlete Health Unit (FIS AHU), an international collaboration of leading scientists and snow sports experts has approached the issue of athlete-related injury prevention through reviewing the current scientific literature, a systematic exploration of current prevention real-world practices and the motivations behind those practices, and four key consensus initiatives on injury registration, warm-up and cool-down, training and testing, and return to sport in competitive snow sports. The first part of the presentation will summarize and scope the current research on injury prevention in competitive snow sports in dependency on contextual factors such as sport discipline, sex and competition level. In the second part of

the presentation, a systematic compilation of practical expert knowledge based on qualitative stakeholder interviews is provided. The underlying qualitative studies revealed a wide spectrum of general mindsets, best practices and contextual factors that may inform effective injury prevention. Finally, to translate the current research practical knowledge to the specific settings of snow sports, in the third part of the presentation, the methodology and results of four in-depth consensus processes on the FIS recommendations about injury registration, warm-up, training/testing and return to sport in snow sports will be presented, and the lessons learned from the example of snow sports and the transferability of the underlying methodological framework to other sports and settings will be discussed.

**MITIGATION OF INJURY RISK THROUGH COURSE DESIGN IN FIS ALPINE SKIING, SKI AND SNOWBOARD CROSS, BIG AIR AND SLOPESTYLE**

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Approximately 45% of all athletes participating in World Cup skiing are injured every winter (Florenes et al. 2009, 2012), and alpine skiing, cross and big air slopestyle are among the sports with the highest injury rates at the Olympic Games (Soligard et al. 2015). This leads to socio-economic costs and loss of value for FIS and stakeholders in the sports industry, as well as media value. Therefore, FIS is implementing several initiatives to reduce the risk of injury and unintentional events that compromise the integrity of athletes. Course design has been identified as a major contributor to injury risk in alpine skiing, cross and big air slopestyle (Levy et al. 2015; Randjelovic et al. 2014; Spörri et al. 2012, 2016). Previous research has shown that course design (course setting in alpine skiing, jump and rail section design in big air and slopestyle, snow built course features in ski and snowboard cross) is one of the main factors influencing gross biomechanical variables such as speed, forces, physical load and ground reaction force etc. (Gilgien et al. 2014, 2015, 2016, 2018, 2020, 2021; Kröll et al. 2016; Spörri et al. 2012, 2016; Supej et al. 2017), which in turn are related to injury risk. ). In alpine skiing, course setting has been shown to be an efficient regulator of skier biomechanics and is therefore probably the central regulator of aspects related to injury risk (Spörri et al. 2012, 2016). Recent research has shown that factors related to injury risk in alpine skiing, such as speed, forces, turning radius, can be manipulated by course setting adjustments (Gilgien et al. 2020, 2021; Spörri et al. 2012). In ski and snowboard cross, studies have shown that course design has different effects on injury risk for women and men, ski and snowboard. (Rieder 2022, Brusveen 2023) While the genders always compete on the same course, skiing and snowboarding do so occasionally, placing very high demands on the course builders who have to balance the course design to make it safe and challenging for each of the user groups. Similar relationships were found for big air and slopestyle, where women and men, ski and snowboard always compete on the same courses and jumps, placing high demands on the skills of course designers to meet these different needs for safety and attractive competitions for athletes and spectators (Linløkken et al 2024, in press). Since course design has been identified as an important factor influencing both injury risk and sporting challenge, and as the FIS regulates course design, the FIS AHU and the IOC have initiated and implemented a number of scientific projects in Alpine Skiing, Cross and Big Air, and Slopestyle to help course builders reduce injury risk through the improvement of course design using technology and scientific methods. In this presentation, the researcher who has conducted most of these projects over the last decade will provide insights into published and unpublished work on course design.

## Oral Presentations

### OP-PN02 Resistance Training and Nutrition

**RESISTANCE EXERCISE ELEVATES DAILY MYOFIBRILLAR PROTEIN SYNTHESIS RATES SIMILARLY IN MIDDLE-TO-OLDER AGED MALES AND FEMALES.**

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INTRODUCTION: The decline in skeletal muscle mass, strength and function (sarcopenia) is observed from the 4th decade of life and accelerates beyond 60 years of age. Sarcopenia is underscored by an impaired muscle protein synthesis (MPS) response to anabolic stimuli, including protein feeding and resistance exercise training (RET). Sex-based differences in acute MPS have been reported and may explain divergence in sarcopenia trajectories and muscle adaptation to RET between older males and females. A paucity of studies shows no differences in acute MPS have been reported in middle-aged males and females. Measurement of longer-term free-living daily MPS rates in middle-to-older aged males and females, consuming a typical diet with or without RET, would provide valuable insight on sex-based differences in muscle mass regulation.

METHODS: Healthy middle-to-older aged males (n=13, 60±7 y) and females (n=12, 63±5 y) completed a 10-day experimental investigation in which they consumed a controlled diet containing 1g/kg day-1 protein and completed high-volume unilateral knee extension RET every other day. Body fat was measured via dual x-ray absorptiometry (DXA). Deuterium oxide preload of 400ml and 50ml daily top ups was consumed, and muscle biopsy samples were obtained on days 0 and 10 to determine free-living daily myofibrillar protein synthesis (iMyoPS) rates in trained and untrained legs. Statistical

differences for sex only were identified using independent samples T-test or 2-way repeated measures ANOVA for sex and training differences. Statistical significance was set at P<0.05 with data shown as mean ± standard deviation.

RESULTS: Total deuterium body water enrichment was significantly higher in middle-to-older age males than females (0.63 ± 0.14 APE vs 0.78 ± 0.14 APE, P=0.012). DXA-derived body fat was significantly different between sexes (24.7 ± 5.3% males vs 37.2 ± 5.8% females, P<0.001). Training load in RET did not statistically differ between sexes (P=0.058), but weight lifted was significantly different (males 42.9 ± 16.9 kg vs females 31.5 ± 8.4 kg, P<0.001). Daily *i*MyoPS rates in the untrained leg did not significantly differ between sexes (1.26 ± 0.22 %day-1 for males vs 1.37 ± 0.26 %day-1 for females, P=0.246). Notably, in the trained leg, there was also no significant difference in daily *i*MyoPS rates between sexes (1.45 ± 0.16 %day-1 in males vs 1.48 ± 0.27 %day-1 in females, P=0.823). Daily *i*MyoPS rates in the trained leg were significantly higher than the untrained leg (8% higher in females, P<0.001 and 16% higher in males, P<0.001) with no significant difference between sexes (P=0.099).

CONCLUSION: Free-living daily *i*MyoPS rates did not differ between middle-to-older aged males and females consuming a typical protein-containing diet. RET elevated daily *i*MyoPS rates compared to the untrained leg in the middle-to-older aged males and females, with no differences observed between sexes.

**PRE-EXERCISE CAFFEINE INTAKE IMPROVES NEUROMUSCULAR ADAPTATION TO RESISTANCE TRAINING**

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INTRODUCTION: Numerous studies have demonstrated the ergogenic effect of acute caffeine intake in different sports actions. In resistance exercise, caffeine enhances velocity and power production at different loads and exercise types (e.g., bench press or back squat). However, it remains unclear whether the acute ergogenic effects of this supplement can accumulate over consecutive exercise sessions, specifically if prolonged caffeine intake before resistance exercise enhances neuromuscular adaptations. Therefore, this study aimed to evaluate the effect of pre-exercise caffeine intake during 8-weeks of velocity-based resistance training.

METHODS: Forty-eight resistance-trained participants (male/female: 24/24; age: 24±4 years; training experience: 3.8±3.3 years; 1RM/kg bench press: 1.1±0.3; 1RM/kg back squat: 1.6±0.6; caffeine intake: 50.5±50.9 mg/day) participated in a double-blind, randomized, placebo- controlled trial. Participants completed an 8-week, twice-weekly velocity-based resistance training for bench press and back squat exercises at progressive loads (70-85%1RM). Four sets were performed per exercise until a 20% velocity loss occurred. Sixty minutes pre-exercise, they ingested 3 mg/kg of caffeine or placebo. Pre- and post-training tests included 1RM, muscular strength and power tests at 25%, 50%, 75%, 90% 1RM, and muscular endurance at 65% 1RM performing one set until task failure. Movement velocity was monitored in all cases. Moreover, acute caffeine effects were assessed before and after the intervention.

RESULTS: Resistance training significantly increased 1RM in both bench press and back squat (13-19%, P<0.001), with caffeine supplementation resulting in greater improvements than placebo in bench press for both sexes (5.5%, P=0.043) and in back squat specifically for females compared to males (8% vs 2%, P=0.021). In bench press at 25% and 50%1RM, caffeine increased mean velocity (7% vs 14%, P=0.050; 0.5% vs 9%, P=0.010) and mean power (17% vs 38%, P=0.047; 12% vs 20%, P=0.041) compared to placebo. In back squat at 25%, 50% and 75%1RM, caffeine increased mean velocity (3% vs 20%, P=0.001; 1% vs 13%, P=0.001; 1% vs 16%, P=0.001) and mean power (4% vs 21%, P=0.006; 3% vs 15%, P=0.004; 6% vs 11%, P=0.049) compared to placebo. No sex differences were detected. Muscular endurance increased mean and peak power post-training in all groups (P=0.001). Also, similar acute caffeine effect was found pre- and post-training. CONCLUSION: Caffeine intake (3 mg/kg of body mass) before resistance exercise enhances 1RM and promotes a higher mean and peak velocity at 25-50% in bench press and 25-75% in back squat exercise after 8-weeks of training in both male and female participants. Therefore, prolonged pre- exercise caffeine intake accelerates neuromuscular performance adaptations to resistance exercise to a similar extent in male and female participants.

**THE EFFECTS OF 10 WEEKS OF TIME-RESTRICTED EATING, RESISTANCE TRAINING, AND THEIR COMBINATION ON LOW-GRADE INFLAMMATION IN PEOPLE WITH METABOLIC SYNDROME; A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Low-grade inflammation, characterized by elevated adipokines, is a hallmark of obesity and defining feature of metabolic syndrome (MetS).

Time-restricted eating (TRE, 8 hours eating/16 hours fasting) and resistance training (RT) are both effective strategies for reducing low-grade inflammation markers and improving metabolic health. Yet, their combined effects on low-grade inflammation among people with MetS remain unclear.

METHODS: In a randomized controlled trial, 76 adults with MetS (age: 50.4 ± 5.3 years, BMI: 31.4 ± 3.9 kg/m2) were assigned to one of three groups for 10 weeks: normal diet with RT (ND+RT), TRE alone, or TRE combined with RT (TRE+RT). The ND+RT group followed a standard, unrestricted eating pattern, while the TRE groups limited food intake to 12:00–8:00 PM. All groups adhered to iso-caloric diets with 1.5 g/kg/day of protein intake. conducted three times per week, with up to three participants per session, each lasting 60 minutes and comprising nine full-body exercises targeting major muscle groups. Body composition was assessed using dual-energy X-ray absorptiometry (DXA) and serum levels of leptin, TNF-α, and IL-6 were measured pre- and post-intervention. Statistical analyses included paired t-tests for within-group changes,

ANCOVA for between-group comparisons, and Pearson correlations to examine associations between inflammatory markers and body composition.

RESULTS: Of the 76 participants enrolled, 68 completed the study, with a 95% compliance rate; TRE alone (n=23), ND+RT (n=23), and TRE+RT (n=22). Only TRE+RT group exhibited significant reductions in IL-6 (-0.36±0.53 pg/ml, p=0.01) and TNF-α (-0.74±1.3 pg/ml, p=0.01) compared to baseline, with ANCOVA confirming greater reductions in TRE+RT compared to TRE alone (IL-6: p=0.01; TNF-α: p=0.03).

Fat mass decreased significantly in all groups (TRE+RT: -2.4 ± 1.1 kg, ND+RT: -2.1 ± 1.8 kg, TRE Alone: -1.4 ± 1.4 kg; p < 0.001 for all). However, significant leptin reductions were observed only in ND+RT (-1.40 ± 2.0 ng/ml, p = 0.003) and TRE+RT (-2.80 ± 2.0 ng/ml, p = 0.008), with ANCOVA indicating significantly greater reductions in TRE+RT compared to TRE alone (p = 0.03). Notably, a strong positive correlation between fat mass reduction and leptin decline was observed only in ND+RT (r=0.61, p=0.002), whereas in TRE+RT, leptin reductions occurred independently of fat mass changes (r=-0.12, p=0.39), suggesting a potential distinct regulatory mechanism for leptin in this intervention.

CONCLUSION: Combining TRE and RT result in more pronounced reductions in leptin, IL-6, and TNF-α levels. These findings suggest that TRE combined with RT may modestly reduce low-grade inflammation and improve metabolic health in individuals with MetS.

**POSTPRANDIAL AMINOACIDEMIA AND RESISTANCE EXERCISE-INDUCED SKELETAL MUSCLE ADAPTIVE REMODELLING WITH RECOMBINANT BOVINE B-LACTOGLOBULIN IN YOUNG ADULTS.**

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INTRODUCTION: Increasing concerns surrounding the long-term environmental impact of animal- and plant-derived protein production have instigated the search for sustainable alternative protein sources with properties to support skeletal muscle adaptive remodelling. In a series of complementary studies, the postprandial plasma amino acid response to a novel supplemental protein derived from recombinant bovine β-lactoglobulin (rBLG) was determined, alongside the muscle adaptive response to resistance exercise (RE), with dairy-derived whey protein (WHEY) as the comparator.

METHODS: Firstly, 8 healthy adults (M:F = 3:5; age: 24±4; BMI: 23.5±2.1 kg·m2) participated in a participant-blind randomised crossover study in which they ingested 0.3 g·kg-1·mass-1 of rBLG or WHEY with arterialised blood samples collected in the fasted state and over 240 min postprandially for measurement of plasma amino acid concentrations via UPLC-MS. In a separate double-blind randomised parallel group design, 24 healthy recreationally active men and women completed thrice-weekly progressive lower-body RE for 8 weeks, with twice daily supplementation of 0.3 g·kg-1·mass-1 rBLG (n: 12; age: 23±6; BMI: 25.6±3.4 kg·m2) or WHEY (n: 12; age: 25±6; BMI 25.1±3.1 kg·m2). RE sessions involved 3-4 sets of 8-12 repetitions of five exercises at 60-80% one repetition maximum (1RM). Training-induced changes in muscle strength and DEXA-derived leg lean body mass (LBM) were assessed.

RESULTS: Plasma essential amino acid (EAA) concentration increased following protein ingestion (P<0.001), with no difference between rBLG and WHEY (P=0.554). Plasma leucine concentrations increased to a greater extent following ingestion of rBLG at 45 min (mean diff (95%CI): 77 (31 to 124) µmol·L-1; P<0.001), 60 min (106 (59 to 152) µmol·L-1; P<0.001), 90 min (92 (45 to 138) µmol·L-1; P<0.001), and 120 min (47 (1 to 94) µmol·L-1; P=0.041), compared with WHEY. Mean plasma leucine incremental area under curve (iAUC) was greater following rBLG compared to WHEY (mean diff (95%CI) 10727 (7738 to 13716) µmol·240 min·L-1; P<0.001). Leg LBM and leg press 1RM increased following training (P<0.05), with no differences between rBLG and WHEY (P>0.05). Total training volume and dietary intake over RE training did not differ between rBLG and WHEY (P>0.05 for all). Data on the acute post-RE muscle anabolic response to rBLG and WHEY was not available at the time of writing but will be presented.

CONCLUSION: These novel data demonstrate that precision-engineered recombinant bovine β-lactoglobulin has the capacity to support skeletal muscle anabolism and adaptive remodelling in a manner that is comparable to dairy-derived whey protein.

**EFFECT OF A COMMERCIAL ECDYSTERONE AND DIOSGENIN PRODUCT ON BODY COMPOSITION, PERFORMANCE AND ENDOCRINE SYSTEM IN RESISTANCE TRAINED ATHLETES - A 12-WEEK RANDOMIZED CONTROLLED DOUBLE-BLIND STUDY.**

DISSEMOND, J., HELD, S.2, HAVERS, T.1, GEISLER, S.2, KOSTOV, T.3, DIEL, P.3, TUERSCHMANN, S.4, PARR, M.K.4, ISENMANN, E.1

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INTRODUCTION: Phytosteroids like ecdysterone (20-hydroxyecdysone, 20E) and diosgenin (DSG) are gaining attention due to promising results from in-vitro, animal, and human studies. Furthermore, combining different phytosteroids has become a common practice in supplementation. However, there is currently a lack of scientific data regarding the combined effects of 20E and DSG on performance, body composition, muscle thickness, liver and kidney function and endocrine system.

METHODS: To address this gap, a 12-week randomized controlled double-blind study was conducted with 24 healthy, resistance-trained men (31.1 ± 8.1 years; 182.0 ± 8,2 cm; 89.4 ± 13.9 kg). Participants were randomized into either the ecdysterone and diosgenin (EcDi) group or the placebo (Plac) group and performed free weight based resistance training

three times per week. The EcDi group consumed a commercial product containing ecdysterone and diosgenin three times daily. Assessments were conducted at four time points and included measurements of 1 repetition maximum (1-RM) for squat (SQ) and bench press (BP), body weight (BW), fat free mass (FFM), muscle mass (MM), fat mass (FM), and muscle thickness of the pectoralis major (PM) as well as along the proximal, middle, and distal regions of the anterior (i.e., M. rectus femoris and M. vastus intermedius; anterior quad) and lateral quadriceps femoris (i.e. M. vastus lateralis and M. vastus intermedius; Lateral quad). Liver and kidney function, as well as endocrine parameters, were measured pre- and post-intervention. Data were analyzed using a linear mixed model (LMM). Additionally, the 20E concentration of the product and its biological activity were evaluated using C2C12 cells after the intervention.

RESULTS: All 24 participants completed the study. Significant improvements in 1-RM SQ and BP were observed across both groups, indicating a time effect but no specific group effect. Similarly, for FFM, MM, FM, and muscle thickness (Mid quad at 30%, Lateral quad at 50%, and PM), significant time effect without group effects were identified. Supplement analysis revealed a content of 0.025% of the labeled 20E concentration, and no biological activity or hypertrophic effects were detected in the C2C12 cell line.

CONCLUSION: The substantial discrepancy between the reported and actual 20E concentration resulted in the absence of biological activity in C2C12 cells and may have contributed to the lack of group-specific effects. To improve research outcomes with phytosteroids, we recommend the following: (1) Verification of the actual concentration of active substance(s) in supplements, and (2) confirmation of their biological activity using in vitro models. Implementing these measures will help minimize inconsistencies and enhance the reliability of future studies.

## Invited Symposium

### IS-PN02 Power, Breath, and Beat: Exploring Female Muscular, Pulmonary, and Cardiovascular Physiology

**THE REGULATORY ROLE OF FEMALE SEX HORMONES ON SKELETAL MUSCLE AND ADAPTATIONS TO EXERCISE TRAINING IN FEMALES**

HANSEN, M.

*AARHUS UNIVERSITY*

Skeletal muscle mass is crucial for muscle function, metabolic health, and quality of life. In females, sex hormones play a significant role in the regulation of muscle mass. This presentation, based on human data, will demonstrate how estrogen plays a critical role in regulating muscle mass. The decline in estrogen levels during menopause is associated with reductions in muscle mass and function. Conversely, emerging human data demonstrate that estrogen enhances muscle hypertrophy during resistance training by increasing muscle protein synthesis, inhibiting muscle protein breakdown, and positively affecting satellite cell activation. Additionally, estrogen seems to have a positive influence on muscle strength. Taken together, the present data highlight that the female sex hormone profile may influence responsiveness to training. This presentation is aimed at sports scientists, exercise physiologists, healthcare professionals, and researchers interested in expanding their understanding of female-specific muscle physiology, particularly the role of estrogen in modulating skeletal muscle adaptations to exercise training.

**SEX DIFFERENCES IN THE RESPIRATORY PHYSIOLOGY OF EXERCISE**

SHEEL, B.

*UNIVERSITY OF BRITISH COLUMBIA*

With dynamic exercise there are increases in oxygen extraction and carbon dioxide production by the contracting musculature, and with heavy exercise, there are accompanying reductions in pH. An increase in ventilation is important when considering the ability to perform exercise as it serves to maintain blood gas homeostasis and regulate acid-base balance. Despite the biological need to match ventilation to metabolic demand, much of what we know is based upon studies that have primarily focused on young healthy men, whereas the response in young and older women has received limited attention. This proposed presentation will address this scientific gap by addressing two inter-related topics. First, in young athletic males a large alveolar-to-arterial oxygen difference develops and arterial oxygen tension, and oxyhemoglobin saturation fall with heavy exercise. Different from males, females demonstrate pulmonary gas exchange decrements during submaximal exercise intensities and at lower aerobic fitness levels, but this is controversial. In addition, the female master athlete has rarely been considered in this context, and recent findings in this rarely studied group will be presented. Second, in order to generate ventilation, the diaphragm and other respiratory muscles must contract cyclically. There are reports that in young females: (i) the diaphragm is resistant to fatigue and (ii) that cardiovascular response to high levels of respiratory muscular work is attenuated. Recent work that explores the interaction(s) between high levels of respiratory muscle work, the energetics of breathing, and diaphragm fatigue in young and post-menopausal females will be presented. The target audience is anyone interested in expanding their knowledge of female-specific respiratory physiology during exercise.

**THE INFLUENCE OF SEX HORMONES ON CARDIOVASCULAR HEALTH AND ADAPTATIONS TO EXERCISE TRAINING IN FEMALES**

HELLSTEN, Y.
*UNIVERSITY OF COPENHAGEN*

Whereas ageing is one of the strongest predictors of hypertension and cardiovascular events, physical activity is superior to any other alternative for maintaining cardiovascular integrity and health with age. Thus, although age per se is a factor, physical inactivity over many years is at least as detrimental to the cardiovascular system as is ageing. However, despite the fact that endurance training can have beneficial effects on cardiovascular health in both older males and females, evidence suggest that adaptive processes are slower in postmenopausal females compared to age matched males. The reason for this slower adaptation in older females is not fully clear but is thought to be related to the loss of estrogen at menopause. Estrogen has overall a marked impact on cardiovascular health, influencing aspects such as regulation of vascular tone, blood pressure, microvascular growth and antioxidant capacity. Consequently, when females loose estrogen at menopause, there is not only a reduced ability to adapt to training but there is also an accelerated decline in cardiovascular health. On the positive side, there is evidence indicating that; if females train at or shortly after, rather than many years after menopause, they adapt very well to training. And importantly, many of the positive effects of exercise are similar to those of estrogen. Although more research is needed in this area, these findings point at that sedentary females should be recommended to begin exercising at the menopausal transition to counteract the impact of estrogen loss. The talk addresses the influence of estrogen and estrogen loss on the cardiovascular system and the impact of exercise training in females. The target audience is anyone interested in cardiovascular physiology and in physical activity as a means of promoting healthy ageing, especially in females.

## Oral Presentations

### OP-AP03 Team Sports I

**A SINGLE, UPPER SPINE-PLACED IMU REVEALS INSIGHTS INTO DIFFERENCES IN MOVEMENT STRATEGIES BETWEEN PLANNED AND REACTIVE MULTIDIRECTIONAL MOVEMENTS IN ELITE MALE HANDBALL PLAYERS**

BÜCHEL, D., HEUVELMANS, P., GOKELER, A., BENJAMINSE, A., BAUMEISTER, J.
*PADERBORN UNIVERSITY*

INTRODUCTION: Handball is a high-intensity team sport that requires both physical and cognitive skills. Players must react to constantly changing game situations, executing rapid stop-and-acceleration actions. Reactive agility, the ability to move quickly in response to external cues, is crucial for performance. Developing accessible agility tests and informative outcome measures is essential for understanding athletes´ behavior on the court. In this study, we investigated differences between elite handball players' planned and reactive agility tasks, focusing on acceleration derived from a single upper-spine-positioned inertial measurement unit (IMU). For a complementary insight into the coordination underlying altered acceleration, we additionally assessed lower extremity joint kinematics.

METHODS: Thirty-three elite male handball players from the highest divisions in Germany and Denmark participated. Each player performed five trials of an agility task under planned and reactive conditions. The task required athletes to swipe LED sensors arranged in a trapezoidal setup as quickly as possible. Response times (RTs) were recorded using proximity sensors (Fitlights, Canada). Upper-body acceleration was measured using an upper-spine-mounted IMU (Myomotion/Ultium, Noraxon, USA), focusing on early and later acceleration components. Statistical analyses of RTs and acceleration were conducted using Wilcoxon signed-rank tests. Eight additional IMUs were placed on the feet, shanks, thighs, pelvis, and lower spine to further examine movement patterns and track lower limb kinematics. Statistical non-parametric mapping was used to identify timing and amplitude differences in knee, hip, and foot dorsiflexion between planned and reactive tasks. A significance level of $p < .05$ was applied to all comparisons.

RESULTS: Results indicated significantly slower RTs in reactive tasks compared to planned ones (~200 ms, $p < .01$). Early movement phases exhibited increased upper-body acceleration in the reactive condition (~9%, $p < .01$), whereas peak acceleration in later phases remained unchanged. Analyses of joint kinematics revealed delayed movement initiation, more upright starting posture and a greater range of hip and knee flexion in reactive movements ($p < .025$).

CONCLUSION: Our observations suggest that handball players adjust their acceleration strategies in response to cognitive demands. Increased upper-body acceleration in the early movement phase of reactive conditions may reflect compensatory mechanisms due to movement uncertainty . The observed changes in joint kinematics, including a more upright posture and greater range of motion, complement this observation. Together, it could be speculated reactive runs require specific adjustments to body posture, leading to increased upper body acceleration in the early phase of movements. Tracking acceleration metrics via upper-spine IMUs during handball-specific movements provides an accessible and valuable approach for studying movement strategies in athletes.

**USING COGNITIVE FUNCTIONS AND MACHINE LEARNING TO PREDICT SOCCER PLAYERS PERFORMANCE IN SMALL-SIDED GAMES**

MONTEIRO, R., CHINAGLIA, A., TAHARA, A., MONTEIRO, P., TORRES, R., SANTIAGO, P.

*UNIVERSITY OF SAO PAULO*

INTRODUCTION: Soccer is a dynamic team sport characterized by high cognitive demand, where quick and efficient decision-making is necessary. Cognitive functions are directly related to how we interact with the environment and make decisions. The present study aimed to identify the key cognitive functions that best predict the performance of youth high-level soccer players on different demands of small-sided games using machine learning algorithms to differentiate the best- and worst-performing players.

METHODS: Forty-four male athletes (16.51±0.57 years old) from the U-17 category of two soccer teams participated in the study. For on-field performance evaluation, a 28-round multiple small-sided games protocol was implemented, consisting of 4-minute 3 vs. 3 matches without a goalkeeper. Teams were mixed in every round. On-field performance metrics were: individual goals (IG) as a goal scoring measure, conceded goals (CG) for defensive performance, goals by teammates (GT) as a creativity measure; and net goals (NG) for overall performance. Cognitive flexibility, impulsivity, sustained attention, visuospatial working memory, and tracking capacity were assessed using the Psychology Experiment Building Language, and the Psychophysics software in Python. K-means clustering was applied to segment on field performance metrics into two groups: inferior and superior performance players. For identifying key cognitive functions that best predict different game demands, the five cognitive functions were combined in all possible ways, resulting in 31 datasets used to predict on-field performance levels with seven supervised machine learning algorithms. Grid search and cross validation were implemented for training and testing the algorithms. The 3 best models for each game demand were compared using one-way ANOVA and Tukey's post-hoc.

RESULTS: The standout machine learning models were K-nearest neighbors and neural networks (Multilayer Perceptron). The best models achieved balanced accuracies (BACC) between 69% and 72%, and overall accuracies ranging from 69% to 79%. For predicting IG, cognitive flexibility, and tracking capacity stood out (BACC: 69.6 ± 4.1 %). Sustained attention and visual working memory presented better results in predicting CG (BACC: 72.3 ± 1.1 %). Regarding GT, sustained attention, impulsivity and cognitive flexibility provided best predictions (BACC: 70.5 ± 5.9 %). Lastly, the combination of cognitive flexibility, impulsivity and visual working memory, precisely the executive functions, presented superior results in predicting NG (BACC: 69.3 ± 3.3 %).

CONCLUSION: Cognitive functions demonstrated the sensitivity to differentiate athletes performance in small-sided games and highlighted the cognitive functions combinations that better predicted different game demands. These findings demonstrate the potential of cognitive functions evaluation and machine learning application for sports performance analysis, athletes' selection, and research designs.

**THE RELIABILITY AND VALIDITY OF A NEW DIGITIZED TOOL FOR PREDICTING THE MATURITY STATUS OF YOUTH SOCCER PLAYERS**

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INTRODUCTION: Biological maturation reflects progress toward the adult state, involving structural and functional changes [1]. Growth spurt during adolescence is associated with an increased risk of injuries in youth soccer players. Hence, the monitoring of maturity status and the management of training load of youth players are necessary to avoid overload and injuries. The application of predictive equations to estimate maturity offset (MO) requires manual measurements, which are time-consuming and error-prone if applied at a large scale. Thus, the study aimed at assessing the reliability and validity of a computer vision model to automatically evaluate players standing and sitting height from individual photos, for the determination of the maturity status of elite youth soccer players.

METHODS: One hundred forty-six soccer players (age: 9–15 years) from an Italian elite soccer team were measured for standing and sitting height and weight, following ISAK protocols [2], and photographed twice in a standing position. Photos were processed to compute standing and sitting height using a computer vision algorithm (Ultralytics YOLO v9). Mirwald equation [3] was applied to calculate MO using manual heights measures and YOLO-derived heights. The internal consistency reliability of YOLO algorithms for the estimation of heights was assessed using Intraclass Correlation Coefficient (ICC), while absolute reliability was evaluated with coefficient of variation (CV) and standard error of measurement (SEM). Pearson product moment correlation was used to assess the strength of the association between MO calculated with manual heights measures (i.e., the criterion measure) and MO calculated with YOLO-derived heights, as a measure of concurrent validity. Bland-Altman plot was used to visually assess agreement between MO measures together with linear regression analysis for potential bias.

RESULTS: YOLO algorithms demonstrated excellent reliability for both standing (ICC=0.961; CV=1.98; SEM=0.531) and sitting (ICC=0.943; CV=3.49; SEM=0.518) height. Pearson correlation coefficient between MO calculated with manual heights measures and MO calculated with YOLO-derived heights showed a strong association (r=0.981; p<0.001). Bland-Altman plot inspection confirmed good data distribution within upper (0.723) and lower (-0.724) limits of agreement. Regression analysis revealed a significant B unstandardized coefficient (B=0.34; p=0.038).

CONCLUSION: The YOLO algorithms provided highly reliable and valid values for standing and sitting height, demonstrating a strong consistency and agreement with manual measurement of height. This approach offers a practical, time-efficient, and less invasive method for estimating maturity offset. Finally, a timely evaluation of the maturity status can also optimize the management of training load of soccer players.

1. Malina et al., 2015; 2. International Standards for Anthropometric Assessment, 2001; 3. Mirwald et al., 2002.

**IS THERE AN ALTERNATIVE TO QUANTIFY INTERNAL TRAINING LOAD? A COMPARISON BETWEEN AN ORIGINAL AND A MODIFIED SRPE SCALE IN PROFESSIONAL VOLLEYBALL PLAYERS**

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INTRODUCTION: Subjective measures are commonly used to monitor athletes [1] and session rating of perceived exertion (sRPE) is introduced to quantify internal training load in professional sports [2]. It was proved to be effective to monitor training load and adjust it during the training process [3]. Originally, sRPE scale was developed by Foster as a modification of Borg's scale and is typically used for internal training load measurements [4]. In this study, in addition to Foster's sRPE scale (S1) a novel, modified version (S2) was proposed to broaden the typically used scale with more detailed information. Therefore, the aim of this study was to compare two scales (original S1 and modified S2) and establish its reliabilities.

METHODS: Twelve professional male volleyball players (age: 21.8±2 years; volleyball training experience: 11±2.9 years, body height: 193.2±9 cm, body mass: 84±10.1 kg) and two coaches (working cooperatively for 5 years) participated in this study. The study took place during the preparatory period for the team and the athletes took part in 48 sessions (17 group and 10 individual technical/tactical trainings; 16 gym sessions; 5 friendly games) over six weeks. Before each training session the coaches discussed the volume, intensity and tactical/technical complexity of a training session and proposed an intended sRPE in two scales for a given session. Afterwards, 30-45 minutes after each session the players evaluated their sRPE. The results of coaches' and players' perspectives on rating sessions in two scales were therefore statistically compared. Multiple T-tests were introduced to assess the significance of the measurements (p was set at $<0.05$) and Intraclass Correlation Coefficient to assess the reliability of the measurements. Also, training load (quantified as sRPE x time of training sessions) within two scales was quantified.

RESULTS: Within all sessions, in S1 there was found a significant difference between coaches and players ratings ($p < 0.01$) and moderate reliability (ICC = 0.625). In S2 there were no significant differences ($p=0.448$) and good reliability (ICC = 0.764). Training load measurements indicated that while using S1 the players' internal training load was 4.6% lower than internal training load prescribed by the coaches. Respectively, while using S2 the players' internal training load was only 0.5% lower than coaches' internal training load.

CONCLUSION: This study provides a novel understanding for internal training load measurements in professional sports. Results of this study suggest that a modified version of Foster's sRPE scale (S2) can be an effective alternative to S1 to monitor and adjust internal training load in professional sports. However, the results of this study should be applied with caution as S2 was scientifically established for the first time and more studies of this type are needed to verify its efficacy.

REFERENCES:

1. Saw et al. 2016

2. Taylor et al. 2012

3. Impellizzeri et al. 2004

4. Foster et al. 2001

**TRAVEL AND SLEEP: INDIVIDUAL VARIABILITY IN ELITE AUSTRALIAN FOOTBALLERS**

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*CURTIN UNIVERSITY*

INTRODUCTION: Sleep is fundamental for athlete health and performance. Insufficient or poor-quality sleep impairs physiological and cognitive function, ultimately affecting athletic performance. Elite athletes face unique challenges that can compromise sleep, including intense training, night-time competitions, and frequent travel. Travel, particularly across time zones, can create circadian misalignment, reduce sleep opportunity and degrade sleep quality due to unfamiliar sleep environments and inconsistent routines. While prior research has examined the acute effects of travel on sleep, few studies have observed athletes over extended periods to elucidate the long-term effects on sleep behaviours following travel.

METHODS: This pre-registered longitudinal study investigated the effects of travel on sleep in elite male Australian Football League (AFL) athletes (n=22; age = 23 ± 4 years; experience = 46 ± 17 games), from the same professional club, across the full 2024 AFL Premiership Season period (24 weeks). Sleep duration (minutes) was measured using a commercial wearable (WHOOP 4.0). Intra-individual and between-person travel effects were assessed by comparing sleep duration between home and away fixtures. Sleep-travel relationships were analysed using Dynamic Structural Equation Model (DSEM) in Mplus.

RESULTS: Across 3228 observations, sleep duration averaged 442 ± 77 minutes (7.34 ± 1.3 hours). Season fixtures included 12 home and 11 away matches. The Bayesian DSEM converged successfully (PSR ≈ 1.00). At the within-person level, travel had a small, non-significant positive effect on sleep duration ($\beta = 0.060$, 95% CI: -0.001, 0.115, $p = 0.026$). At the

between-person level, frequent travel was associated with a minor reduction in overall sleep duration (β = -98.848, 95% CI: -1076.887, 987.966, p = 0.431), although not statistically significant.

CONCLUSION: Using a longitudinal sleep analysis, we observed that regular travel did not significantly impact sleep, however substantial between-person variance suggests individual differences in sleep responses. Accounting for both within- and between-person variability within the same cohort enabled detection of individual differences in sleep adaptation. These findings highlight the need for individualised athlete sleep strategies rather than generalised team-wide recommendations. Future research should examine factors driving between-person variability, including chronotype, training load, travel scheduling, and external lifestyle influences, to develop tailored interventions for optimising athlete recovery and performance.

## Oral Presentations

### OP-BM02 Neuromuscular Physiology I

**REGIONAL FASCICLE STRAIN AT BASELINE IS STRONGLY ASSOCIATED WITH INCREASES IN RESTING FASCICLE LENGTH BUT NOT MUSCLE THICKNESS AFTER ECCENTRIC EXERCISE TRAINING**

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INTRODUCTION: Eccentric exercise training has been suggested to increase resting muscle fascicle length (FL) through sarcomerogenesis, especially in distal regions, reducing injury risk and promoting distal hypertrophy [1-3]. Animal data indicates that a greater fascicle elongation (fascicle strain; εPRE) during exercise promotes greater FL increases after training [4], although this has yet to be tested in humans. Simultaneously, detailed assessments of muscle function, including shifts in the muscle length of peak force production and shortening velocity [1,2], could help to identify the structural factors underlying any FL increases [1]. The present study investigated the hypothesis that increases in FL and muscle thickness (MT) would positively correlate with εPRE and changes in muscle function.

METHODS: Distal and proximal tibialis anterior isokinetic eccentric εPRE, as well as resting architecture (via ultrasonography), and muscle function (via dynamometry), were assessed in 12 trained men (26 ± 4 y) before and after 18 unilateral isokinetic eccentric dorsiflexion training sessions (6 wk, 3/wk, 2-4 x 6-10 rep-max, 10°/s). Distal-proximal net architectural responses were computed as the distal minus the proximal relative changes. Dorsiflexion function was assessed through maximum voluntary isometric (5 angles) and dynamic (concentric, eccentric; 3 velocities) tests.

RESULTS: Similar responses were found between distal and proximal regions for εPRE (59% vs. 60%; P=0.90), FL (7% vs. 6%; P=0.47), and MT (11% vs. 7%; P=0.58), although the values substantially varied between regions within individuals. A strong correlation was observed between distal-proximal net εPRE and distal-proximal net changes in FL (r=0.79, P<0.01) but not MT (r=0.17, P=0.59). However, no association was observed between region-averaged εPRE and region-averaged FL (r=0.04, P=0.91) or MT (r=0.03, P=0.92). Training significantly (P<0.05) improved isometric peak torque at shorter and longer muscle lengths (12%) and broadened the torque-angle relation (14%). Rate of torque development was increased at longer (0-75ms: 52%; 0-250ms: 23%), but not shorter or moderate lengths (P>0.05). Concentric peak torque (20%) and work (12%), and eccentric peak torque (14%) were increased in all tests. Isometric peak torque angle and estimated maximum shortening velocity were not changed significantly (P>0.05).

CONCLUSION: Eccentric training increased FL and MT, which may influence both performance and injury risk [2], but changes were not specific to the distal region. Increases in FL were larger in regions with greater εPRE, whether proximal or distal, although individuals with greater εPRE did not exhibit greater increases in FL or MT. Serial sarcomere addition was likely not the primary driver of the FL increases, as some key functional adaptations were absent.

References:

1 Hinks et al. 2022; J Appl Physiol.

2 Timmins et al. 2016; Br J Sports Med.

3 Franchi et al. 2017; Front Physiol.

4 Butterfield and Herzog 2006; Pflugers Arch.

**CONTRACTION INTENSITY-SPECIFIC FLUCTUATIONS IN MOTOR UNIT BEHAVIOUR ACROSS THE MENSTRUAL CYCLE**

SPILLANE, P., JENZ, S., OHANLON, M., WIGBERS, A., BEAUCHAMP, J.A., BENEDETTO, A., NÉDÉLEC, É., HICKS, K.M., GOODALL, S., HECKMAN, C.J., PIASECKI, M., PIASECKI, J., PEARCEY, G.E/P., ANSDELL, P.
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INTRODUCTION: Motor unit (MU) behaviour is the foundation of force output and is influenced by persistent inward currents (PICs), which amplify and prolong synaptic inputs and allow gain control of motor output. Despite known sex differences in MU discharge rate (DR) (1) and the magnitude of PICs (2), little is known about whether gain control differs between the sexes or across the female menstrual cycle (MC). Recent work suggests fluctuations in oestrogen (E) and progesterone (P) might contribute to modulations in DR at low force output (3), but as contraction intensity rises, estimates of

PIC magnitude also increase (4). Examining MU behaviour during increasing intensity contractions might provide insight into the interactions between hormones and PICs. We hypothesised that DR and PICs would increase with contraction intensity, and intensity-specific increases will be enhanced when E concentration is elevated during the pre-ovulatory (OV) and mid-luteal (ML) phases; whereas elevated P concentration would blunt this increased gain in the ML phase.

METHODS: Thirteen females (27 ± 6 years) participated across three institutes, as part of a wider study. Participants reported a regular MC, confirmed by cycle tracking and urine ovulation testing, retrospectively verified with serum hormone concentrations. After one tracked cycle, participants visited the lab in three phases of the subsequent MC(s): early follicular (EF), OV, and ML. During each visit, participants performed triangular dorsiflexion contractions at 30, 50 and 70% maximum, and high-density electromyographic signals were sampled and decomposed into individual MU spike trains. Smoothed DRs were analysed for peak DR, and DR hysteresis (ΔF) using the paired MU analysis technique.

RESULTS: DR increased with contraction intensity, but was up to 10% higher during the ML phase compared to OV regardless of intensity (+0.74-1.99 pulses per second [pps]; $p \leq 0.043$). Estimates of PIC magnitude were modulated by MC phase and intensity. At 30%, ΔF was up to 12% greater at ML (5.89 ± 0.29 pps) compared to EF (5.19 ± 0.28 pps) and OV (5.33 ± 0.28 pps; $p \leq 0.003$) but not at 50 and 70% ($p \geq 0.139$). There was a significant interaction between phase and intensity ($p = 0.002$) whereby ΔF did not increase with intensity during the ML phase as it did in the other phases.

CONCLUSION: While DR was greater across all contraction intensities in the ML phase compared to OV, estimates of PICs across the MC were sensitive to contraction intensity, which presented as a saturation of PICs during the ML phase. This suggests that MC phase, and the associated fluctuations in E and P, do affect MU excitability, but these MC-related effects are diminished during higher intensity outputs. These data provide new mechanistic insight into motor output at a range of intensities across the MC.

1) Inglis et al., Appl Physiol Nutr Metab, 2020

2) Jenz et al., J Neurophysiol, 2023

3) Piasecki et al., Sports Med Open, 2023

4) Škarabot et al., bioRxiv, 2023

**HIT THREE TARGETS WITH ONE ARROW: ECCENTRIC TRAINING HAS GREATER POTENTIAL THAN STATIC STRETCHING FOR DECREASING PASSIVE STIFFNESS, NOT JUST INCREASING STRENGTH AND FASCICLE LENGTHS, IN THE HAMSTRINGS**

KAWAMA, R., OKUDA, Y., TAKAHASHI, K., NAKAMURA, M., WAKAHARA, T.

*DOSHISHA UNIVERSITY; NISHIKYUSHU UNIVERSITY*

INTRODUCTION: Hamstring strain injuries are common in high-speed running-based sports, with up to 80% of cases affecting the biceps femoris long head (BFlh) [1]. Recently, high passive muscle stiffness has been identified as a risk factor for strain injuries [2], alongside low muscle strength and short fascicle lengths. Passive muscle stiffness has traditionally been recognized to chronically decrease with repeated passive lengthening (e.g., static stretching); however, its actual efficacy remains controversial [3]. Instead, during active lengthening (eccentric contraction), the combination of externally applied tensile and internally generated contractile forces theoretically imposes greater mechanical stress on muscle fibers and connective tissues [4], potentially leading to further decreases in passive muscle stiffness than static stretching. Here, we examined chronic adaptations of passive stiffness in the biarticular hamstring muscles after long-term eccentric-only knee flexion training (ECC) versus knee-extended static stretching (SS).

METHODS: Eleven healthy young males participated in a 10-week intervention (three sessions per week) involving ECC for one leg and SS for the other. The ECC consisted of three sets of 10 repetitions performed at 50% of maximal eccentric torque, within 50 to 100% of the maximal range of motion, at an angular velocity of 5°/s. The SS involved three sets of stretching held for the same duration as ECC, at 100% of the maximal range of motion. Before and after the intervention, the shear moduli and architectures of the BFlh, semitendinosus, and semimembranosus (SM) were assessed using shear wave elastography and diffusion tensor MRI, respectively. Maximal isometric knee flexion torque was measured with a dynamometer. These variables were analyzed using the generalized mixed-effects models.

RESULTS: The maximal isometric torque increased after ECC (57% [mean value], $p < 0.01$), but not after SS. The volumes of the three muscles substantially increased after ECC (22 to 42%, all $p < 0.01$), whereas BFlh volume did not increase after SS. The fascicle lengths of BFlh (34%) increased after ECC ($p < 0.01$), but not after SS. Notably, both shear moduli of BFlh (–11%) and SM (–25%) decreased after ECC (all $p < 0.05$), whereas only SM shear modulus (–18%) decreased after SS ($p < 0.01$).

CONCLUSION: This study provides the first evidence that ECC has greater potential than SS for decreasing passive stiffness of a specific muscle, as well as increasing muscle strength and fascicle lengths within a matched intervention period. Our findings represent an important first step toward reconsidering the conventional approach to a chronic decrease in passive muscle stiffness and may offer practitioners a more comprehensive and time-efficient strategy aimed at preventing BFlh strain injury.

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1. Ekstrand et al. Sports Med (2012)

2. Miyamoto-Mikami et al. Med Sci Sports Exerc (2025)

3. Russell et al. Scand J Med Sci Sports (2024)

4. Crameri et al. J Physiol (2007)

**EXPERIMENTALLY-INDUCED THERMAL PAIN AND NATURALLY OCCURRING MUSCLE PAIN HAVE DIFFERENT EFFECTS ON FORCE PRODUCTION DURING A FIXED PERCEIVED EFFORT HANDGRIP TASK.**

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*UNIVERSITY OF EXETER*

INTRODUCTION: At fixed workloads, experimentally-induced or naturally occurring muscle pain increase perceived effort (PE) compared to innocuous conditions. However, potential differences or interactive effects between pain types on PE and motor behaviour are relatively unknown. We examined the changes in force production during a fixed PE task with concurrent experimental thermal pain and naturally occurring muscle pain. We hypothesised that both sources of pain would lead to a reduction in force during fixed PE tasks.

METHODS: Forty healthy active adults (50% female, 25 ± 4 years old) visited the laboratory twice to perform an intermittent (3s ON:OFF) isometric handgrip task performed at a light (13/100) or hard (50/100) PE intensity – visit order randomised. Each visit followed the same procedure, with an experimental and control condition interspersed by 2min rest – order randomised. Each condition involved two blocks (block 1 and block 2) of 5 contractions each, repeated 5 times. A painful thermal stimulation was applied specifically in block 1 of the experimental condition, while a non-painful warm stimulation (control) was applied in all other blocks. Participants rated thermal and muscle pain during a 30s rest period after each block on the category-ratio 100 scale. Force (peak and mean force, integral) and electromyographic (EMG) signals were continuously recorded. Data were analysed with repeated measures ANOVAs, with a-priori focus on i) the condition × block interaction to isolate the effect of thermal pain in block 1 of the experimental condition, ii) the intensity × condition × block interaction to determine the effect of PE intensity on thermal pain-related effects. Linear regression analysis was used to assess how muscle pain affected force production, while controlling for PE intensity, sex and their interaction.

RESULTS: The intensity effect on force and EMG (all $p < .001$) confirmed that participants understood the PE task. The condition × block effect revealed a higher force production (all $p < .002$, $\eta p2 > .212$) in the presence of thermal pain. There was no intensity × condition × block effect on force production (all $p > .570$, $\eta p2 < .003$). The linear regression analysis revealed that when muscle pain increased by one unit, there was a decrease of 0.37N peak force, 0.25N mean force, and 0.80N.s force integral (all $p < .001$).

CONCLUSION: Contrary to our hypothesis, when participants regulate their force production according to a fixed PE intensity, thermal pain leads to an increased force production. Alternatively, increased muscle pain is linked to a decrease in force production. The intensity of PE did not impact thermal pain-related effects on force production. When thermal pain is induced, exerting more force may be a distraction strategy that facilitates exercise-induced hypoalgesia. However, when experiencing muscle pain, increasing force is likely counterproductive as this would promulgate further muscle pain.

**THE DISCHARGE CHARACTERISTICS OF MOTOR UNITS IN PERONEUS LONGUS AND BREVIS DIFFER DURING FOOT ABDUCTION AND ANKLE PLANTAR FLEXION.**

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INTRODUCTION: Peroneus Longus (PL) and Peroneus Brevis (PB) are activated during abduction of the subtalar joint and plantar flexion of ankle joint. Previous studies have found that PL exhibits greater EMG amplitude during abduction than plantar flexion from low-to-moderate target forces[1]. Moreover, the conduction velocity of muscle fiber action potentials differs between two functions[2]. These results suggest that the discharge characteristics of Motor Units (MUs) discharge likely differs between the two functions. The purpose of our study was to compare the discharge characteristics of MUs from peroneal muscles during abduction of the subtalar joint and plantar flexion of ankle joint.

METHODS: Nine active males consented to participate in the study. Ultrasound recordings were used to ensure the appropriate placement of the grid electrodes over the PL and PB muscles. The experimental procedure comprised of isometric contractions of abduction and plantar flexion of the foot at five target forces (5, 10, 20, 40 and 60% of MVC) during which HD-EMG recordings were obtained from PL and PB.

Force fluctuations during the steady contractions were quantified as the Coefficient of Variation for force (CoV force) separately for abduction and plantar flexion. Moreover, the MU discharge characteristics comprised Recruitment Threshold (RT), Mean Discharge Rate (MDR), Coefficient of Variation of InterSpike Interval (CoV ISI) and Standard Deviation of filtered Cumulative Spike Train (SD fCST).

Linear mixed models were used to compare muscles and functions at five target forces. In all models, muscles, functions, and target forces were specified as fixed factors, and participants were assigned as random factor.

RESULTS: Significant effects were found for all five outcome variables: (1) CoV force during abduction was significantly greater than that during plantar flexion ($p < 0.05$); (2) RT of MUs in PL was significantly greater during abduction than plantar flexion across all target forces ($p < 0.05$), whereas RT of MUS in PB was greater during plantar flexion than abduction ($p < 0.05$); (3) MDR increased linearly with target force ($p < 0.05$); (4) CoV ISI was significantly greater during abduction than during plantar flexion for both muscles; and (5) the variability in neural drive (SD fCST) was significantly less during abduction than plantar flexion ($p < 0.01$) and for PB compared with PL ($p < 0.05$).

CONCLUSION: These results indicate that the discharge characteristics of MUs in the peroneal muscles differ during foot abduction and ankle plantar flexion. These findings suggest that the neural drive to the muscles differs during the two actions.

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# Oral Presentations

## OP-MH02 Clinical Population Groups

### AN IMMERSIVE AND HOLISTIC ONE-WEEK BLUE EXPERIENCE TO IMPROVE THE OVERALL WELL-BEING OF PERSONS WITH PARKINSON'S DISEASE: THE SAIL4PARKINSON PROJECT

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INTRODUCTION: The Sail4Parkinson (S4P) is a one-week adapted physical activity intervention program for persons with Parkinson's disease (PD), with the mission of combining physical training of water sports with the physical, emotional, and psychological stimulus that comes from contact with the sea and the lands around. The aim of this study was to investigate the acute effects of different innovative aquatic and mind-body activities on clinical, psychosocial, and motor symptoms in persons with PD after the S4P project week.

METHODS: Thirteen subjects (6M:7F, median Hoehn-Yahr: 2; range: 2-3) volunteered to participate in the one-week S4P project. From the second to the sixth day, several aquatic activities (i.e., sailing, surfing, paddling) were performed during the day after a daily session of mindfulness at sunrise, yoga, or tai chi at sunset. On the other hand, during the first (PRE) and the last (POST) day, main general and PD outcomes (i.e., anthropometrics, body composition, balance, muscular strength, upper-limb flexibility, heart rate variability, and quality of life) were assessed.

RESULTS: Repeated-measures ANOVA and adjusted post-hoc comparisons revealed significant changes in Fat-Free Mass (PRE-POST change: +1.80%; p=0.049) and Skeletal Muscle Mass (PRE-POST change: +2.69%; p=0.044). A significant reduction was observed in the time to complete the Five Times Sit-to-Stand Test (PRE-POST change: -14.75%; p=0.002) and the time to complete the Timed Up and Go Test (PRE-POST change: -15.93%; p=0.005). Balance evaluations showed a significant reduction in mediolateral oscillation length (PRE-POST change: -39.18%; p=0.020) and mediolateral oscillation velocity (PRE-POST change: -39.18%; p=0.020), both performed with open eyes. Non-parametric test run on clinical scores revealed a significant reduction in the Apathy Evaluation Scale (PRE-POST change: -20.61%; p=0.028).

CONCLUSION: Despite the short-term intervention, the S4P project demonstrated several beneficial effects on both motor and non-motor PD symptoms, reducing fall risk and apathy. Preliminary data suggest that these innovative activities may be valuable for this population, particularly in enhancing psychosocial well-being through teamwork and blue environmental stimuli. Therefore, promoting these activities to be repeated twice per year, for instance, and promoting similar training at home, could become an effective strategy for improving the management of PD and the overall quality of life of these persons.

### EFFECT OF A 12-WEEK LIFESTYLE INTERVENTION PROGRAM ON FREE-LIVING GLYCEMIC PROFILE AND CARDIOMETABOLIC HEALTH IN BREAST CANCER SURVIVORS WITH METABOLIC SYNDROME

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INTRODUCTION: Cancer treatments and a sedentary lifestyle increase the risk of type 2 diabetes (T2D) in breast cancer survivors (BCS). Lifestyle Interventions (LI), which provide physical activity (PA) and dietary guidance, may be an effective adjunctive treatment for BCS, but the impact of exercise training on glucose homeostasis remains inconclusive [1]. This study aimed to compare glucose variability indices between two groups of BCS participating in the MoviS clinical trial [2].

METHODS: BCS patients with metabolic syndrome (n=27, 52.3±8.6 yrs [mean ± SD]) were randomized into a control group (CG, n=12) and an intervention group (IG, n=15). All patients received recommendations on PA and Mediterranean diet before beginning a 12-week trial, during which they kept a daily log for PA. IG patients also underwent a 3-time-a-week aerobic training program with progressive increases in exercise intensity (40-70% of heart rate reserve) and duration (20-60 min). Before (T0) and after (T1) the trial, participants' body composition (BIA), cardiorespiratory fitness (GXT estimated VO2max), and cardiometabolic profile (routine laboratory parameters) were assessed along with glycemic variability (flash

glucose monitor - FGM), which was assessed over 14 days (12±1.8 days) after T0 and before T1. Glycemic variability was calculated with the EasyGV software (v.9.0.R2). Statistical significance (α=0.05) was determined using a Repeated Measures GLM (SPSS software v.17).

RESULTS: At T1, both groups significantly improved fat mass (CG -1.0%; IG -3.8%), triglycerides (CG -4.2% IG: -15.9%), insulin levels (CG -14.1%; IG -15.6%), and HOMA-IR (CG -13.7%; IG -16.3%). Cardiorespiratory fitness (GC +3.1%; IG +16.4%) and between-day glycemic variability index (CG +12.5%; IG -3.6%) significantly changed in both groups and resulted significantly better in the IG compared to the CG. Time spent within the normal glucose range (CG -11.0%; IG -1.8%) and with a glycemia above 180 mg/dL (CG: +1.1%; IG +0.7%) worsened at T1. Although time x group interactions were, respectively, nonsignificant and barely significant, CG changes were broader.

CONCLUSION: The LI program improved body composition and cardiometabolic health in BCS patients at high risk for T2D, with an overall, although nonsignificant, lower effectiveness in CG than in IG patients. Since aerobic training effectively increased cardiorespiratory fitness solely in the IG and given that selected parameters of the glycemic profile improved significantly more in the IG than in the CG group, improvements seem to be attributable to the supervised exercise as an adjunctive effect over guidance alone. However, other glycemic parameters did not improve in IG patients. Thus, further research is needed to support the role of aerobic training in improving glycemic profile in BCS at high risk of diabetes.

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**VIRTUAL REALITY-BASED EXERGAME FOR HOSPITALIZED CHILDREN WITH CANCER: AN EXPLORATORY STUDY ON COMPLIANCE, ACCEPTANCE AND EXERCISE INTENSITY.**

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INTRODUCTION: Pediatric cancers represent 2270 new cases each year in France [1]. The disease and its treatments cause significant symptoms (e.g., fatigue, reduced quality of life). Exercise is recognized as a non-pharmacological intervention in pediatric oncology to mitigate the numerous side effects [1]. However, exercise is often restricted by the constraints of cancer treatments and hospitalization (e.g., isolation in sterile room, amputation, fatigue) [1]. Virtual Reality-based exergames (VRE) have shown promise in promoting physical activity [2] but their application in pediatric oncology remains underexplored. This study aims to assess the feasibility of a VRE for pediatric cancer patients undergoing treatment in a hospital setting. Specifically, it evaluates compliance and acceptance while assessing exercise intensity to ensure alignment with WHO recommendations (> 3 MET).

METHODS: Thirteen pediatric cancer patients (diagnosed with leukemia or sarcoma) participated in VRE sessions proposed four times during afternoons per week over a two-month period in the pediatric oncology unit of Sud Hospital, Rennes. The VRE used in this study was developed by the lab team and designed to resemble Beat Saber with additional adaptability options. A total of 131 sessions were analyzed to assess compliance rates (number of sessions offered relative to those proposed), Technology Acceptance Model [3] was used to assess acceptance and exercise intensity was assessed with Lee et al. model [4].

RESULTS: The VRE showed a solid compliance rate of 68%, with individual variability influenced by factors such as age, prior VR experience, and intended use. Acceptance was high, with a strong user experience rating (5.36/6 ±0.51), and no serious side effects were reported. The average exercise intensity per child reached 4.44 ± 1.91 MET, exceeding the moderate-intensity threshold.

CONCLUSION: The key findings indicate that this VRE practice is feasible and well-accepted in a pediatric oncology setting, providing effective moderate-to-vigorous exercise levels in accordance with WHO recommendations while ensuring patient engagement, despite individual differences. Expanding the variety of VR content could better cater to the needs of diverse age groups, particularly adolescents. Furthermore, integrating autonomous adaptation based on physiological and kinematic data could improve the programs effectiveness and engagement by targeting specific intensity levels.

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**FUNCTIONAL EVALUATION AND EXERCISE TRAINING FOR PEOPLE LIVING WITH CEREBELLAR ATAXIA: THE ATAEXER TRIAL**

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INTRODUCTION: Cerebellar ataxia of various nature causes poor movement coordination; progressive deterioration of gait and balance control are the most disabling symptoms affecting independence in daily activities. No satisfying disease-specific treatment exists in neurodegenerative ataxias, and rehabilitation programmes are necessary. The ATAEXER Trial aims to provide a hybrid training intervention model, featuring a supervised outpatient training intervention, integrated with a home-based multicomponent exercise programme for people living with cerebellar ataxia. This study is the first to evaluate such a training model focused also on coordination and rhythm auditory stimulation in this population on clinical, functional and patient-related outcomes.

METHODS: Patients with mild neurodegenerative cerebellar ataxia still able to walk independently and healthy age-matched controls were included in this self-controlled clinical trial. Patients were assigned to an eight-week phase of usual care as control period (t0–t1) followed by an eight-week intervention phase (t1–t2) with an exercise training programme featuring four training sessions per week provided either in a supervised or non-supervised setting. The primary outcome was the change in the walking efficiency as cost of transport at the preferred walking speed, secondary outcomes were ataxia severity measured by clinical scales (SARA and Mini-BESTest) and patient-reported, as well as muscular endurance and strength, balance control and walking ability.

RESULTS: 7 individuals with mild cerebellar ataxia (spinocerebellar ataxia type 1=3, fragile X-associated tremor/ataxia syndrome=1, idiopathic cerebellar ataxia=3) and 9 healthy subjects completed the study. Adherence to the ATAEXER Trial was 100% and session attendance was 90%. Discriminability between ataxic and healthy subjects was a characteristic of almost all measured parameters, and the whole panel of outcome categories improved with the exercise programme. The cost of transport improved significantly only after the intervention phase (0.202 at t0, 0.206 at t1 and 0.183 mL·(kg·m)-1 at t2). Walking ability during a goal-oriented stress-walk at fast speed and corresponding spatio-temporal parameters, as well as muscular endurance appeared most strongly associated to measures of clinical and self-reported ataxia severity (Rho = 0.77 to 0.86), while static balance control and muscular strength appeared less correlated.

CONCLUSION: The ATAEXER trial proved effective in improving ataxia severity; our findings suggest that a specific, hybrid exercise training programme may be considered as a standard clinical intervention in patients with cerebellar ataxia regardless the specific underlying neurodegenerative disease. In addition, a set of evaluations has been recommended with focus on (i) discriminability between healthy and cerebellar ataxic individuals, (ii) association with ataxia severity and (iii) responsiveness to an exercise training programme.

**EFFECTS OF NORDIC WALKING TRAINING ON ENERGY COST IN PEOPLE WITH MULTIPLE SCLEROSIS**

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INTRODUCTION: Multiple sclerosis (MS) is a chronic neurological disease that leads to various functional impairments, including gait disturbances. These disturbances can alter walking mechanics, potentially increasing energy expenditure during locomotion in people with MS. In healthy individuals, gait economy follows a U-shaped curve, influenced by the pendular mechanism of walking, which may be impaired in people with movement disorders. Considering the influence of gait economy on cardiorespiratory capacity and the scarce information on the U-shaped curve modifications in people with MS, this study aimed to examine the effects of an 8-week Nordic walking training program on the cost of transport in the MS population. Additionally, training induced changes in gait-related parameters, including optimal (OWS) and self-selected walking speed (SSWS), and the locomotor rehabilitation index (LRI), were also investigated.

METHODS: Nine individuals (6 women; mean age: 39.8 ± 7.67 yr) with definite relapsing-remitting MS (EDSS mean 1.66 ± 0.55) met the inclusion criteria and were enrolled in this study. All participants were tested before and after an 8-week Nordic walking training period. The 10-meter walking test was performed to assess self-selected walking speed. To evaluate the cost of transport, oxygen consumption was measured while individuals walked at three different speeds on a motorized treadmill (1 km/h, 3 km/h, and 5 km/h). After determining the cost of transport, OWS and LRI were calculated accordingly. We applied a linear mixed model using alpha=0.05 (JASP software).

RESULTS: Regarding the overall training effects of energy cost at three-time speeds, no statistically significant effect of time ($p=0.30$) and interaction between time and speed ($p=0.139$) were found. However, there was observed a statistically significant effect of speed ($p<0.001$). Post hoc testing revealed a significant difference in energy cost at each speed ($p<0.001$). No significant pre- and post-training differences were found for the SSWS, OWS, and LRI.

CONCLUSION: The metabolic cost data showed a U-shaped trend similar to that reported in the literature for healthy individuals, which may be attributed to the low level of disability in the study sample. The maintenance of the cost of transport and LRI after the 8 weeks of Nordic walking may be due to the small sample size or the need for a longer training duration. However, further research on the energy cost of walking in individuals with MS is warranted, as it holds significant clinical implications, particularly for incorporating these parameters into the prescription of individualized exercise programs. This preliminary study provides noteworthy insights into the energetics and functionality of individuals with MS, highlighting the need for larger investigations to confirm these trends.

Oral Presentations

OP-PN13 Molecular Biology of Exersice and Diseases

**EFFECT OF HIGH-INTENSITY INTERVAL EXERCISE-CONDITIONED HUMAN SERUM ON BREAST CANCER CELLS**

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INTRODUCTION: Physical exercise, particularly high-intensity interval exercise (HIIE), has demonstrated anti-tumor effects, partly through the release of myokines—proteins secreted during muscle contraction that facilitate inter-organ communication and regulate essential biological processes. Previous studies have shown that HIIE-conditioned human serum (HIIE-HS) can reduce the viability and proliferation of breast cancer cells. However, the precise molecular mechanisms underlying these effects remain unclear, highlighting the need to investigate the impact of HIIE-conditioned serum exposure. Therefore, this study examines the mechanisms by which MCF-7 and MDA-MB-231 breast cancer cell lines respond to human serum collected before and after HIIE, focusing on cell viability, apoptosis, transcriptome analysis, and key signaling pathways involved in tumor progression.

METHODS: MCF-7 and MDA-MB-231 breast cancer cells were incubated with human serum for 48 hours. Subsequently, cell viability was assessed using the MTT assay, while Western blot analyses targeted components of the Akt/mTOR pathway, apoptosis markers, and inflammation-related proteins. Apoptosis was further evaluated by flow cytometry using Annexin V and propidium iodide staining to distinguish early and late apoptotic cells. RNA sequencing was performed to assess transcriptional alterations induced by HIIE-HS, focusing on proliferation, cell cycle regulation, apoptosis, cell adhesion, and other key biological processes.

RESULTS: The main findings indicate a decrease in 4EBP1 phosphorylation, with trends observed in Akt and P70S6K1. Additionally, increases in pro-caspase 9 and pro-caspase 3 were detected. However, cleaved caspase-3 was not observed, suggesting potential apoptosis resistance, which was confirmed by flow cytometry. Modifications were also observed in inflammation-related proteins such as MyD88 and NF-κB. RNA-seq analysis revealed an upregulation of apoptosis-related genes (e.g., TIPUH1) and negative regulators of cell proliferation (e.g., AZGP1), among others.

CONCLUSION: These findings highlight the molecular mechanisms through which HIIE-HS impacts breast cancer cells, enhancing the understanding of how physical exercise affects tumor progression. This evidence reinforces the need for further research into the therapeutic potential of physical exercise as an adjuvant strategy in breast cancer treatment.

**BLOOD LIPIDS AND OXIDATIVE STRESS MARKER IN RESPONSE TO A FATMAX TEST IN HYPERBILIRUBINEMIA SUBJECTS WITH GILBERT'S SYNDROME**

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INTRODUCTION: In several studies, moderately elevated unconjugated bilirubin levels (UCB), as observed in Gilbert's syndrome (GS), have been associated with a lower risk for cardio-vascular diseases. People with GS have been frequently described to have lower blood lipids. Furthermore, bilirubin is known to be a potent antioxidant in the human metabolism. Some studies also indicated that elite athletes show higher UCB levels than non-athletes. Considering all these observations it seemed interesting to look closer at the effect of acute exercise on blood lipid levels and some oxidative stress parameters in response to a graded cycle ergometer test in GS subjects and healthy controls.

METHODS: In a human case control study, where controls were age and gender matched, 40 GS subjects (UCB>17.1µmol/l) and 40 controls (C) between 18 and 65 years of age were included. All participants were healthy, moderately physically active and nonsmokers. After having fasted for 12 h overnight, all subjects completed a graded exercise test on a cycle ergometer, which was terminated at RER=1.00. Before and after the test venous blood samples were taken. Total (TC) and HDL cholesterol, as well as triglycerides were measured and LDL cholesterol was calculated with the Friedewald equation by a certified laboratory. UCB was measured via high performance liquid chromatography (HPLC). For oxidative stress parameters, photometric methods were used for the measurements of the ratio of reduced to oxidized glutathione (GSH:GSSG) and FRAP (ferric reducing antioxidant power). DNA-damage was assed using the comet assay.

RESULTS: At baseline, GS subjects (86.68 ± 20.234) had significantly (p=0.041) lower levels of LDL than C (96.23 ± 20.871). The rise in TC during exercise was significantly higher in C subjects (p=0.027). UCB levels rose significantly higher in GS subjects (p<0.001). Regarding oxidative stress parameters, the increase in the GSH:GSSG ratio was higher in C by trend (p=0.081). No difference between groups was observed in the other oxidative stress parameters, however all FRAP, GSH and GSSG increased in all groups, whereas DNA-damage decreased. When dividing into two age groups (cut-off 35 years) GS subjects in the older group had significantly lower LDL levels and a lower TC:HDL ratio as well as a lower LDL:HDL ratio (all p<0.05), whereas in younger subjects there was no significant difference at baseline. However, in younger subjects GSH levels were significantly higher in C subjects (p=0.037).

CONCLUSION: This study again shows that the effect of bilirubin and it´s metabolism on blood lipid levels becomes more important with age. Furthermore, it seems that the graded exercise test had no impact on blood lipid levels, blood glucose or oxidative stress parameters. UCB levels seem to have no impact on the influence of exercise on the analyzed parameters. However, it is interesting that bilirubin metabolism of GS subjects seems to be more triggered by exercise compared to the normo-bilirubinemic controls.

**THE ABSENCE OF CARNOSINE IMPACTS OXIDATIVE STRESS STATUS: A STUDY WITH CARNS1 -/- RATS**

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INTRODUCTION: Carnosine (ß-alanyl-l-histidine) is a dipeptide with important biological functions abundantly expressed in excitable tissues such as the nervous system and the skeletal muscle. Carnosine has anti-inflammatory, antioxidant, anti-glycation and reactive carbonyl-quenching properties. However, the functions played by endogenous carnosine remain poorly understood in the literature. We investigated the impact of carnosine absence on oxidative stress induced by an acute physical exercise session (PE), and by an experimental chronic kidney disease model (5/6 Nx), in CARNS1 knockout rats (KO) and wild-type controls (WT).

METHODS: 64 male 4 months-old wistar rats were used in two sub-studies: the PE study (WT Exercise: n=8, KO Exercise: n=8, WT Control: n=8, KO Control: n=8) and the 5/6 Nx study (WT Sham: n=8, KO Sham: n=8, WT 5/6 Nx: n=8, KO 5/6 Nx: n=8). The exercise protocol consisted of an acute 90-minute swimming session with a 3% body weight load attached to the tail. Kidney disease was induced by 5/6 nephrectomy, i.e., a full nephrectomy of the right kidney followed by the ligation of two branches of the left renal artery. The sham surgey served as a control. In the PE study, oxidative stress markers including superoxide dismutase (SOD) and catalase (CAT) activity, thiobarbituric acid reactive substances (TBARS), and protein carbonyl content were analyzed in the soleus muscle. In the 5/6 Nx study, these parameters were measured in kidney tissue, and GFR was assessed via inulin clearance (Cin). An one-way ANOVA was performed to compare groups and Mann-Whitney was used to assess GFR differences between WT and KO. All data are expressed as mean ± SD.

RESULTS: In the PE study, acute PE did not alter CAT, SOD, or TBARS concentrations but it increases protein carbonyl content, with no differences being observed between genotypes in the soleus muscle. The absence of carnosine led to a significant increase in TBARS levels after exercise in the KO control group compared to the WT control group (23.34±5.84 vs. 11.64±3.50 nmol MDA/mg protein respectively, p=0.0003). In the 5/6 Nx study, KO 5/6 Nx exhibited significantly higher SOD activity compared to WT 5/6 Nx (45.89±16.63 vs. 20.57±8.88 U/mg protein respectively, p=0.0019) and increased protein carbonyl content (1.87±0.09 vs. 1.66±0.13 mmol carbonyl/mg protein respectively, p=0.0079). A similar response was observed in KO sham vs. WT sham (1.74±0.09 vs. 1.51±0.14 respectively, p=0.0039). We found no diferences between genotypes in kidney TBARS concentrations. TBARS levels in plasma were significantly elevated in KO 5/6 Nx compared to WT 5/6 Nx (1.87±0.09 vs. 1.66±0.13 nmol/mL plasma respectively, p=0.0013). KO sham rats exhibited a markedly reduced Cin compared to WT sham (0.465±0.080 vs. 0.574±0.104 mL/min/100g respectively, p=0.085).

CONCLUSION: The absence of endogenous carnosine affects redox balance in both skeletal muscle and renal tissue. We identified a crucial role of endogenous carnosine in maintaining renal homeostasis.

**ACUTE AND CHRONIC CELLULAR MECHANISMS DRIVING CHEMOTHERAPY-INDUCED SKELETAL MUSCLE ATROPHY IN BREAST CANCER PATIENTS: THE PIVOTAL ROLE OF NF-KB**

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INTRODUCTION: Early breast cancer patients frequently receive (neo)adjuvant chemotherapy (CT), commonly involving sequential administrations of epirubicin–cyclophosphamide (EC) followed by paclitaxel (TAX). While this treatment improves survival rates, it also induces severe skeletal muscle atrophy with underlying mechanisms that remain poorly understood. This study aimed to investigate acute and chronic mechanisms of chemotherapy-induced skeletal muscle atrophy by distinguishing the specific effects of EC and TAX.

METHODS: Vastus lateralis muscle biopsies were collected from breast cancer patients before and 4 days after the first administration of EC (N=10) or TAX (N=10), or before and after the entire CT treatment (N=11). Histological analyses, western blotting, and RNA sequencing were performed. Cell culture experiments were conducted on human skeletal muscle myotubes (LHCN-M2) treated with EC or TAX, with or without sulfasalazine, a specific NF-kB inhibitor.

RESULTS: Muscle fibers cross-sectional area decreased post-EC (-33%; p<0.001) with no further reduction observed post-TAX or post-CT, suggesting that muscle atrophy at the end of treatment is primarily driven by EC administrations. RNA sequencing revealed a strong upregulation of NF-kB signaling, confirmed by increased p-NF-kB Ser536/NF-kB protein levels post-EC (+110%; p=0.016), post-TAX (+136%; p=0.033), and post-CT (+11%; p=0.042), along with increased p-IkBα Ser32/IkBα post-EC (+174%; p=0.049) and post-TAX (+360%; p=0.051). RNA sequencing also indicated an upregulation of proteasome-mediated degradation, supported by increased protein levels of MuRF1 and MAFbx post-EC (+176% and +29%; p=0.004 and p=0.016), post-TAX (+138% and +136%; p=0.026 and p=0.048) and post-CT (only MuRF1, +103%; p=0.019). Cell culture experiments showed that both EC and TAX induced myotube atrophy (-34% and -36%; p<0.001), increased proteasome activity (+335% and +263%; p<0.05), decreased protein synthesis flux (-80% and -26%; p<0.05),

and elevated the Bax/Bcl-2 protein levels ratio (+306% and +237%; p<0.01 and p<0.05), indicating apoptosis initiation. Notably, sulfasalazine fully prevented chemotherapy-induced myotube atrophy by attenuating proteasome activity and apoptosis but failed to restore protein synthesis.

CONCLUSION: By combining acute and chronic muscle biopsies with in vitro experiments, we provided a comprehensive analysis using histological, transcriptomic, and targeted protein expression analyses by Western Blot. Our findings highlight the pivotal role of NF-kB signaling and subsequent proteasome activation in driving muscle atrophy, while demonstrating that its inhibition fully prevents chemotherapy-induced atrophy. Further research is warranted to develop muscle-specific NF-kB inhibition strategies that preserve skeletal muscle function in chemotherapy-treated patients without interfering with the antineoplastic effects of the chemotherapy treatment.

**MUSCLE ABNORMALITIES IN NON-HOSPITALIZED PATIENTS WITH POST-COVID-19 CONDITION**

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INTRODUCTION: Post-COVID condition (PCC) affects ~10% of SARS-CoV-2-infected individuals and manifests as persistent symptoms such as fatigue, exercise intolerance, and muscle weakness. Our group has previously shown that >60% of non-hospitalized PCC patients show myopathic signs on needle electromyography. Therefore, the aim of the current study was to assess the skeletal muscle of this cohort, including changes in muscle histology, mitochondrial respiration, and global gene expression.

METHODS: Biopsies were obtained from the vastus lateralis muscle of 28 non-hospitalized PCC patients without concomitant diseases (75% women, mean age 46.4±10.4 years) and 28 age- and sex-matched healthy controls (79% women, mean age 46.6±8.7). The analysis included morphological and pathological alterations, fiber type composition, fiber cross-sectional area, capillarization, number of myonuclei, presence of developmental myosin, CD68+ cells, macroautophagy markers, mitochondrial respiration and RNA sequencing.

RESULTS: PCC patients, compared to controls, had a higher percentage of angulated fibers, (median (IQR) 0.43 (0.00-3.20) vs. 0.00 (0.00-0.00); P<0.001), small, rounded fibers (0.21 (0.00-1.20) vs. 0.00 (0.00-0.00); P<0.001), fibers expressing fetal myosin (0.26 (0.00-1.15; vs. 0.00 (0.00-0.17); P=0.015), and signs of fibrosis. Fiber cross-sectional area was significantly lower in PCC patients compared to controls (4031±1365 vs. 4982±1463 µm2; P=0.018), largely driven by differences in type 2 fiber size. There was a significantly lower number of myonuclei per fiber in PCC compared to controls (3.4±1.1 vs. 4.1±1.0; P=0.012). There was no difference in presence of CD68 per fiber (0.28±0.15 vs. 0.22±1.0; P=0.115), but there was a lower number of CD68 per muscle area in PCC compared to controls (P=0.004). No difference was observed in macroautophagy markers LC3B (P=0.232) or p62 (P=0.814) between the groups. Capillary-to-fiber ratio in PCC patients was lower for both type 1 (2.2±0.7 vs. 2.6±0.9; P=0.044) and type 2 fibers (1.8±0.6, vs. 2.2±0.8; P=0.022). The NADH-TR activity was generally lower in type 2 fibers in PCC patients, and the mitochondrial respiration was 11–28% lower in PCC patients, although not statistically significant. RNA sequencing revealed downregulation of 8 metabolic pathways, primarily related to oxidative phosphorylation (FDR<0.05).

CONCLUSION: Non-hospitalized PCC patients show signs of morphological and pathological muscle changes that indicate processes of degeneration and regeneration. The smaller overall fiber size, lower mitochondrial oxidative capacity, and lower capillarization in PCC patients may be a consequence of reduced physical activity levels. The presence of clusters of atrophied angular and round-shaped fibers, signs of inflammation and fibrosis, and increased expression of fetal myosin may reflect myopathic and neurogenic post-viral effects.

## Oral Presentations

### OP-MH04 Weight Loss I

**INFLUENCE OF THE MENSTRUAL CYCLE ON FAT METABOLISM DURING SUBMAXIMAL ENDURANCE EXERCISE IN ACTIVE, EUMENORRHEIC WOMEN.**

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INTRODUCTION: Almost 42% of female athletes report subjective impairments in various phases of the menstrual cycle (MC), but there is limited evidence for objective performance declines [1,2]. Fluctuations in oestrogen and progesterone may affect performance via changes in substrate metabolism [3]. Therefore, this study investigates the impact of the MC on oxygen uptake and fat metabolism in active, eumenorrheic women during submaximal endurance exercise.

METHODS: The study lasted three full natural MCs (1 observation, 2 test MCs), during which six submaximal cycling tests were completed (two per menstrual phase (MP), late follicular phase (LFP), and mid-luteal phase (MLP)). The tests consisted of a square-wave step-transition protocol (25% (transition 1) and 65% (transition 2) of the difference between VT1 and maximal power; 6 min each; 20 W baseline). Breath-by-breath data, oxygen uptake kinetics, substrate utilization and total

energy expenditure (TEE) were measured in both low-intensity (IL) and high-intensity (IH) intervals. Twenty-three of 27 interested women fulfilled the inclusion criteria with 18 completing the study. Finally, only 11 women (age: 26.9±4.7 yrs; BMI: 22.7±2.6 kg/m²; $VO_2$max: 45.7±4.9 mL/min/kg) showed a regular MC with ovulation and were included in the statistical analyses (means of the data from two MP, LFP or MLP measurements subjected to repeated-measures ANOVA).

RESULTS: Blood oestrogen levels differed significantly between MC phases ($p<0.001$, $\eta^2p=0.800$), with the highest levels in LFP, followed by MLP and MP (all $p<0.05$). Progesterone levels ($p<0.001$, $\eta^2p=0.919$) were higher in MLP compared to LFP and MP ($p<0.001$). However, fat ($p=0.478$, $\eta^2p=0.071$) and carbohydrate metabolism ($p=0.430$, $\eta^2p=0.081$), respiratory exchange ratio rate (ΔRER: $p=0.367$, $\eta^2p=0.095$), and lactate (Δlactate: $p=0.088$, $\eta^2p=0.216$) did not differ between cycle phases (MP, LFP, MLP). In addition, oxygen uptake kinetics (IL: $p=0.401$, $\eta^2p=0.079$; IH: $p=0.378$, $\eta^2p=0.093$), TTE (IL: $p=0.338$, $\eta^2p=0.094$; IH: $p=0.382$, $\eta^2p=0.080$), heart rate (IL: $p=0.647$, $\eta^2p=0.027$; IH: $p=0.727$, $\eta^2p=0.017$), gross efficiency ($p=0.789$, $\eta^2p= 0.023$), and RPE (IL: $p=0.147$, $\eta^2p= 0.175$; IH: $p=0.103$, $\eta^2p=0.203$) did not differ between phases at both intensities.

CONCLUSION: Although hormone levels varied, performance and substrate metabolism did not differ significantly.The study's three-month observation period was a strength; however, excluding irregular cycles (52%) resulted in a small sample size insufficient to detect small- to medium-effect differences. We suggest that, in addition to hormone levels, personalized (even subjective) measures should be considered to clarify the complex relationship between the MC and performance.

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**IS OBESITY A CONDITION ASSOCIATED TO OVERACTIVE BLADDER?: A COMPREHENSIVE ANALYSIS**

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INTRODUCTION: Overactive bladder (OAB) is a common syndrome causing urgency, frequent urination, and nocturia, significantly affecting quality of life (QoL). Obesity worsens symptoms by increasing intra-abdominal pressure and bladder sensitivity, while OAB-related inactivity can lead to weight gain, creating a vicious cycle. Addressing weight management is crucial for improving symptoms and well-being in OAB patients. This study analyzes the relationship between obesity, physical activity (PA), sedentarism, and sarcopenia with OAB symptoms and QoL.

METHODS: This observational study is nested in a randomized controlled trial (ClinicalTrials.gov NCT04357223). OAB symptoms and QoL were analyzed by the International Prostate Symptom Score (IPSS). Obesity indicators included body mass index (BMI), categorized as normal weight, overweight, and obese, measured by stadiometer (SECA 217, Hamburg, Germany) and bioimpedance analysis (MC780MA, Tanita, Tokyo); and waist-to-hip ratio (WHR), classified as normal or increased metabolic risk, calculated from waist and hip circumferences, measured by anthropometric tape, using standard procedures. According to European consensus, sarcopenia cut-off points when measured by handgrip strength dynamometer are <27kg for men and <16kg for women. Handgrip strength was measured by digital dynamometer (TKK 5401, Takei, Niigata) and sarcopenia was assessed according to European consensus. PA and sedentarism were measured by International Physical Activity Questionnaire-long form (IPAQ). The criterion for establishing physical activity and sedentarism cut-off points is that established by the World Health Organization. Statistical analyses were performed with Python 3.13 ($\alpha=0.05$).

RESULTS: 181 adults were recruited (34.8% women). Among all participants, 24.9% were sedentary and 3.9% had sarcopenia, while 28.9% were physically inactive. These results contrast with 54.5% who were overweight (32.6%) or obese (21.9%) and 52.8% who had an elevated WHR. Men showed high BMI and WHR (26.7±4.1 kg/m2 and 0.92±0.08, respectively), while women had BMI and WHR close to the upper limit, but within the normal range (24.8±4.8 kg/m2 and 0.79±0.07, respectively). No relationship with OAB symptoms and QoL were found between sarcopenia, PA and sedentarism. Nevertheless, BMI and WHR were significantly correlated to nocturia ($\tau=0.24$; $p<0.001$ and $\tau=0.17$; $p=0.027$, respectively) and QoL ($\tau=0.15$; $p=0.029$ and $\tau=0.17$; $p=0.027$, respectively). Nocturia and QoL were significantly different according to BMI ($H=12.87$; $p=0.001$; $\varepsilon2=0.06$ and $H=6.16$; $p=0.046$; $\varepsilon2=0.02$, respectively) and WHR ($U=1881.5$; $p=0.027$; $r=0.19$ and $U=1862$; $p=0.028$; $r=0.19$, respectively), showing those who had higher BMI or WHR worse scores in both questions. No differences were found for daytime voids or urgency symptoms.

CONCLUSION: Obesity and a high WHR were associated with lower QoL and more nocturia episodes but not with daytime voids and urgency. No relationship was found between sarcopenia, PA, or sedentarism with OAB symptoms.

**MULTISESSION TDCS AND AEROBIC EXERCISE SYNERGISTICALLY IMPROVES FOOD CRAVING, IMPULSIVITY, AND COGNITIVE FLEXIBILITY IN OVERWEIGHT AND OBESE WOMEN WITH FOOD CRAVING**

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INTRODUCTION: Overweight and obesity are rapidly becoming a global epidemic, and the WHO Acceleration Plan to Stop Obesity highlights the major global concern in this regard. Food craving is a strong desire to consume specific types of

food, identified as a major factor contributing to overweight and obesity (1). Evidence suggests that exercise induces beneficial psycho-cognitive changes, reducing food cravings and enhancing cognitive control over appetite (2). Alternatively, Transcranial Direct Current Stimulation (tDCS) has also targeted food craving and related neural mechanisms (3). Thus, incorporating a tDCS protocol into a physical activity program may yield synergistic effects, potentially leading to greater reductions in food craving. Therefore, we explored the effects of five sessions of tDCS followed by four weeks of aerobic exercise (AE) on food craving (FC), impulsivity (IMP), risky decision-making (RDM), and cognitive flexibility (CF) in overweight and obese women with food cravings.

METHODS: Thirty-six participants were randomly assigned to three groups (n=12 per group): 1) a-tDCS+AE; 2) Sham+AE; and 3) Control. In Phase 1, the a-tDCS+AE and Sham+AE groups received 5 consecutive sessions of anodal and sham tDCS, respectively. In Phase 2, both groups engaged in 3 sessions of moderate-intensity continuous AE per week for 4 weeks, while the control group received no interventions. Outcome variables were measured at baseline, after 5 days of tDCS, and after 4 weeks of AE. One month after the interventions concluded, FC and CF were also reported.

RESULTS: In Phase 1, FC decreased only in the a-tDCS+AE group. In Phase 2, FC decreased in both the a-tDCS+AE and Sham+AE groups; however, it returned to baseline levels for the Sham+AE group at follow-up, while it remained reduced for the a-tDCS+AE group. CF was higher in the a-tDCS+AE compared to the other groups and sham+AE compared to control after Phase 2. At follow-up, CF remained significantly increased only in the a-tDCS+AE group. IMP improved over time in the a-tDCS+AE group compared to the other groups. RDM significantly improved only in Phase 2 in a-tDCS+AE compared to the control.

CONCLUSION: We concluded that multisession anodal tDCS followed by four weeks of moderate AE could provoke synergistic effects causing greater and more lasting effects on food craving and its associated variables in overweight and obese females with food craving.

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**REGULATION OF FATMAX EXERCISE COMBINED WITH DIFFERENT MENSTRUAL CYCLE ON LIPID METABOLISM IN RECESSIVE OBESE WOMEN**

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INTRODUCTION: According to recent survey and supervision of health condition, at present the physical constitution of young people in our country came down, proportion of overweight and obesity increased significantly, especially in females. Since blood concentrations of ovarian hormones fluctuate according to the phase of the menstrual cycle and affect the utilization of energy substrates during exercise, this paper probes into the effect of a long-term intervention combining maximal fat oxidizing intensity exercise with different phases of the menstrual cycle on lipid metabolism in recessive obese women, to guide them to do exercise scientifically and prevent cardiovascular disease.

METHODS: Forty-eight eligible recessive obese women (21.0±2.3yrs) without training experience were recruited and screened, then participated in the study that was approved by IRB at Beijing Sport University. They were randomized into follicular group, luteal group and control group. There were sixteen women in each group. Baseline testing were performed for all participants, including body morphology, fasting blood markers, body composition (DXA), maximal oxygen uptake test and maximal fat oxidation (Fatmax) test. Then, an eight-week exercise intervention was initiated for all participants at a participant-individualized Fatmax intensity for 45 min per intervention. The control group exercised four times per week, and the follicular and luteal groups added three additional exercises to the control group in the late follicular phase and middle luteal phase of each menstrual cycle, respectively. The same indicators as at baseline were measured again after the intervention.

RESULTS: 1) After intervention, participants in the follicular group had a very significant decrease in waist circumference, hip circumference, percentage of body fat (2.34±1.88%) and fat mass ($P<0.01$), and significant decreases in body weight and body mass index (BMI) ($P<0.05$). 2) Participants in the luteal group had a very significant decrease in hip circumference ($P<0.01$), significant decreases in waist circumference, body fat percentage (1.12±1.56%) and fat mass ($P<0.05$), and ApoA Ⅰ to ApoB ratio (0.21±0.33) were statistically significantly higher ($P<0.05$). 3) In the control group, there was a very significant decrease in hip circumference, body fat percentage (1.79±1.16%) and fat mass ($P<0.01$), and significant decreases in waist circumference, body weight and BMI ($P<0.05$). The amount of change in body weight, waist circumference, body fat percentage and fat mass of participants in the follicular group was significantly superior to the change in the other two groups ($P<0.05$).

CONCLUSION: An eight-week personalized Fatmax exercise intervention is effective in improving the lipid metabolism of recessive obese young women. Increasing the amount of exercise during the follicular phase of the female menstrual cycle may have more beneficial effects on lipid metabolism than the luteal phase.

**CHANGES IN EXERCISE ECONOMY AFTER SLEEVE GASTRECTOMY IN WOMEN**

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INTRODUCTION: Sleeve gastrectomy (SG) has emerged as the most prevalent bariatric surgery for obesity, offering significant weight loss and improvements in comorbidities. However, an often-overlooked consequence of such procedures is the alteration in physical fitness and exercise economy (EE), which refers to the energy demand for a given intensity of physical activity. These changes can lead to a barrier to increasing physical activity levels post SG, undermining the long-term success of weight management and overall health post-surgery. Understanding the underlying mechanisms that contribute to the loss of EE after SG is essential for developing targeted rehabilitation strategies and enhancing recovery outcomes. This study aims to describe some physiological changes following SG. We will explore how these adaptations impact exercise performance.

METHODS: 24 women with obesity, mean age of 36 years old and BMI of 35 kg/m2 were evaluated preoperatively and three months after SG. Patients performed a submaximal cardiopulmonary test on a cyclo-ergometer to obtain peak oxygen consumption (VO2peak). Gas exchange was measured using a Cortex Metalyzer 3B. A gradual protocol was used, cycling at 60 rpm, starting at 0.5 Watts/kg of body weight with an increase of 20 Watts/2 min until the stopping criteria. EE was calculated dividing the peak work achieved (in Watts) by the absolute VO2 (ml/min). The paired T-test was used to detect statistical significance for changes in the studied variables and the Spearman correlation coefficient (Rho) for the association between variables. Data was analyzed using SPSS 24.0 software and this project was approved by the ethics committee of Universidad de Chile (149-2014).

RESULTS: Three months after SG there were significant changes in weight (-17.5±4.2 kg), waist circumference (-14.3±4.6 cm), absolute VO2 (-0.28±0.29 l/min), peak work achieved (-18.8±24.3 W) and EE (-0.012±0.014 W/ml O2) ($p<0.001$ in all cases) with no differences in peak VO2 relative to weight.

The change in EE had no statistical association with loss of weight (Rho:0.072, p:0.739).

CONCLUSION: The decrease in EE after bariatric surgery implies a deterioration in the ability of skeletal muscle to produce mechanical work (from a bioenergetic perspective). This suggests the need to implement physical training programs both before and after surgery to avoid the loss of EE.

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## Oral Presentations

### OP-SH12 Mental Health and Well-Being in Athletes

**SPORT FANTASY AND PSYCHOLOGICAL DISTRESS: ATHLETES' PERCEPTION OF DEFLATED REALITY MATTERS**

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Background: Fantasy-prone individuals tend to engage in conscious but immersive and imaginative experiences of fantasies, of which the fantasies are real as life and could suspend their disbelief in the nonreality associated with the fantasies (e.g., seeing imaginative experience as real despite knowing it is not). Excessive fantasy use contributes to one's overly inflated self-concept, addictive daydreaming, obsessive-compulsive behaviours and even psychopathology. However, little is known regarding the role of sport fantasy engagement and athlete mental illness.

Methods: Among 397 British University and College Sports (BUCS) athletes (aged 22.27 on average, 196 males, from 4 individual and 7 team sports), we examined the hypothesis that the magnitude of the relationship between sport fantasy proneness and psychological distress increases as athletes' perception of deflated reality in sport (i.e., pessimistic feelings towards one's sporting career involving training and competition) increase. Besides, we also hypothesised that increased sense of deflated reality underpins the relationship between sport fantasy and psychological distress (i.e., an indirect effect). We therefore assessed participating athletes' sport fantasy and perceived deflated reality as the exposure variables and measured psychological distress as the outcome variable. In order to adjust for the confound of sport-specific stress on psychological distress, we also assessed athletes' psychological strain in sport as a covariate in our analysis. Clustered mediated moderated analyses were performed to test our hypothesis whilst adjusting for the nested nature of the data to control for between-person differences in each sport (i.e., sport type as the cluster).

Results: Sport fantasy demonstrated a significant indirect effect on greater psychological distress via increased sense of deflated reality. However, the moderation of deflated reality on the relationship between sport fantasy and psychological distress was a mitigating rather amplifying effect, thus contrasting our moderation hypothesis. The nature of the moderation suggested that, after controlled for sport-specific strain, sport fantasy was not related to psychological distress when

perceived deflated reality was low but reduced psychological distress when perceived deflated realty was high. The significant and positive main effect of deflated reality on psychological distress was expected and noteworthy. The findings suggests that sport fantasy is not necessarily a bad thing and could even offer mental health protection especially for those high in deflated reality.

Conclusion: Sport fantasy is not as bad as one's impression. How engaging fantasy experience in sport may intervene with athletes' mental health is likely dependent on how the athletes perceive the 'reality' in their sport career. Researchers and practitioners would do well to tackle athletes' sense of deflated reality for promoting mental health.

**SELF-PRESENTATION CONCERNS AMONG INJURED CANADIAN AND FRENCH ADOLESCENT ATHLETES: A QUALITATIVE INVESTIGATION**

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INTRODUCTION: A growing body of evidence highlights the psychological impact of injuries on athletes. One psychological challenge that may be particularly salient, but which remains poorly understood, relates to self-presentation concerns. Self-presentation refers to individuals' efforts to shape or influence how others' perceive them. Although such preoccupations may be heightened during absences from sport participation – such as during an injury – this contention requires further empirical scrutiny. The purpose of this qualitative study was to explore the nature, antecedents, and implications of injured athletes' self-presentation concerns.

Method: The first author conducted semi-structured interviews with five competitive adolescent athletes (Mage = 15.6 years) who experienced a variety of serious injuries (e.g., anterior cruciate ligament tear, labrum tear) as a result of competing in judo, cycling, basketball, ice hockey and acrobatic skiing. Thematic analysis of transcript data was undertaken using the 6-step analysis procedures outlined by Braun and Clark (2021).

RESULTS: Participants' articulated concerns about being perceived as "acting" or "faking" their injury when relevant others (e.g., coaches, parents) doubted the presence of their injury. Additionally, adolescents lacking in self-confidence to return to pre-injury levels, reported concerns about being perceived as "useless" or "unreliable" when eventually performing in front of coaches or teammates. Furthermore, some participants who did not have a long-standing relationship with their coach, were worried that coaches felt they were using their injury as an excuse to avoid training or returning to competition. Such concerns led to subsequent apprehensions about the implications of negative coach evaluations for athletes' future sport participation (e.g., playing time). Finally, adolescents remarked that the aforementioned concerns often led to negative emotions such as anger and frustration. Despite experiencing self-presentation concerns, several participants indicated that they did not have specific strategies for managing such concerns.

Discussion: Building on past research, adolescents' highlighted novel factors (self-confidence, the length or quality of the coach-athlete relationship) influencing self-presentation concerns, as well as implications for psychological functioning during rehabilitation (negative emotions). These concerns can be targeted in cognitive-behavioral interventions aimed at optimizing injured adolescent's rehabilitation and return to sport.

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**EVALUATING A MENTAL HEALTH LITERACY WORKSHOP FOR ATHLETES: A CROSS-NATIONAL QUALITATIVE STUDY**

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Objectives. Studies have consistently shown that athletes are as likely as the general population to experience mental health issues (Poucher et al., 2021). Approximately half of all elite athletes report symptoms of at least one mental health disorder during their careers (Gouttebarge et al., 2019; Åkesdotter et al., 2020). Mental health literacy (MHL) plays a crucial role in determining whether athletes seek help when facing mental health difficulties (Bu et al., 2020). Effective MHL interventions can enhance athletes ability to recognize symptoms, access support services, and increase their intentions to seek help (Diamond et al., 2022). This study aimed to design and evaluate a culturally adaptable MHL intervention for athletes, implement it across diverse contexts, and explore its effectiveness through qualitative feedback. Methods. A workshop titled "Mental Health Matters" was developed to enhance athletes understanding of mental health, the impact of sport- and personal factors on mental health and well-being, and to promote self-care strategies through diverse pedagogical approaches and techniques. A total of 253 athletes from Slovenia, Belgium, and South Africa participated in the workshop. Post-intervention, six focus groups with 37 athletes (two per country) and semi-structured interviews with educators were conducted to gather qualitative feedback. Data were analyzed thematically to identify patterns and differences across cultural contexts. Results. Participants reported an increased awareness of mental health and a clearer understanding of how their athletic careers impact their mental health and well-being. They valued the self-care practices introduced during the workshop. Educators emphasized the importance of considering athletes age when implementing such interventions and highlighted the value of interactive components, particularly role-play exercises and group discussions. Cross-national analysis identified both shared themes, such as reduced stigma, and culturally specific differences, including variations in perceived barriers to seeking help. Conclusion. The intervention workshop proved to be an effective and well-received intervention for improving athletes mental health literacy across diverse cultural settings. The findings contribute to the broader discourse on mental health literacy programs for athletes and highlight strategies for enhancing their impact across different national contexts.

**THE PROVISION OF MENTAL HEALTH SERVICES FOR CHINESE NATIONAL TEAMS**

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China has consistently prioritized the advancement of competitive sports. In recent years, particularly with the International Olympic Committees increased focus on athletes mental health (Reardon et al., 2019), there has been a growing emphasis on mental health services for Chinese elite athletes. This study, conducted through a five-year field study during which the authors were involved in providing psychological services to multiple Chinese national teams, documented observations and interviews with participants. Grounded in critical realist epistemology (Bhaskar, 1998) and adopting both etic and emic perspectives, the researchers combined self-reflexivity with Grounded Theory (Charmaz, 2006) to propose a socio-cultural model for understanding elite athletes mental health challenges and development.

The authors identified a cultural environment within Chinese sports teams characterized by three key features: (1) "internal division and external harmony" (i.e., national teams were divided by fierce competition among athletes from different provinces, except during international competitions); (2) "action over words" (i.e., athletes and coaches prioritize actions and results over verbal expressions or plans); and (3) "hierarchy and rank" (i.e., team members were ranked based on secular values and collective interests, which significantly influenced their thoughts and behaviors). Within this cultural context, the study revealed several critical mental health challenges faced by Chinese elite athletes: (1) stigmatization and stealthiness in seeking help, (2) intrapersonal suffering, (3) complex historical roots of mental health issues, and (4) intricate interpersonal dynamics. Based on these findings, the researchers developed a comprehensive mental health management model for Chinese sports teams. This model encompasses four key components: (1) regular mental health assessments, (2) systematic mental health education, (3) accessible mental health counseling services, and (4) effective crisis intervention strategies. Recognizing the interconnected nature of team dynamics, the proposed mental health services are designed to benefit not only athletes but also coaches and all supporting personnel within the sports teams.

This study contributes to the growing body of literature on athlete mental health by providing a culturally-specific framework for understanding and addressing mental health challenges in the unique context of Chinese elite sports. The proposed model offers practical implications for sports organizations seeking to enhance their mental health support systems while considering the complex socio-cultural dynamics within elite sports teams.

## Oral Presentations

### OP-PN22 Cardiovascular Physiology I

**RESEARCH ON THE MECHANISM OF IMPROVING HEMODYNAMICS BY HIGH-INTENSITY INTERVAL TRAINING**

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INTRODUCTION: This study examines the influence of high-intensity interval training (HIIT) on hemodynamics, a critical factor in cardiovascular health. Given that arterial stiffness, significantly influenced by hemodynamics, is a major risk factor for cardiovascular disease, the study employs color Doppler ultrasound technology to assess the effects of both acute and long-term HIIT on hemodynamics in healthy male subjects. In addition to this, the research explores the relationship between HIIT and hemodynamics, which encompasses blood flow and shear force, and is essential for maintaining arterial integrity. Regular physical activity, particularly HIIT, can enhance cardiovascular function by inducing arterial remodeling and optimizing blood flow dynamics.

METHODS: Pre-experiment: Twenty male undergraduate students from the University of Westminster participated in a strength-oriented high-intensity interval training (HIIT) protocol to ascertain the optimal exercise loads for subsequent acute and long-term interventions.

Acute Experiment: The identical cohort of 20 male undergraduate students from the University of Westminster underwent pre- and post-HIIT assessments to quantify carotid artery hemodynamic parameters, utilizing color Doppler ultrasound technology.

Long-term Experiment: A total of 40 male undergraduate students from the University of Westminster were randomly assigned to either the experimental group (undergoing an 8-week HIIT program, three sessions per week) or the control group (sedentary). Comprehensive hemodynamic and cardiac function indices were measured in both groups prior to and following the intervention period.

RESULTS: Acute HIIT: Acute high-intensity interval training (HIIT) induced a substantial increase in end-systolic and end-diastolic blood flow velocities, blood flow shear force, and blood flow rate. Concurrently, it led to a significant decrease in the resistance index and common carotid artery diameter.

After 8 weeks of HIIT: Following an 8-week HIIT regimen, there was a notable increase in the E/A value, stroke volume, and cardiac output. However, no significant alterations were observed in the dimensions of the left ventricle. The HIIT group exhibited more pronounced improvements compared to the control group.

Long-term HIIT: Prolonged HIIT enhanced hemodynamics by improving left ventricular diastolic function and augmenting common carotid blood flow and diastolic blood flow velocity.

CONCLUSION: Acute HIIT: Acute high-intensity interval training (HIIT) elicits prompt favorable alterations in the hemodynamics of the carotid artery, such as an elevation in blood flow velocities and a reduction in the resistance index.

Long-term HIIT: Prolonged high-intensity interval training (HIIT) substantially augments cardiovascular function through the enhancement of hemodynamic parameters and left ventricular function, thereby establishing a foundation for its application in cardiovascular rehabilitation.

**RESTORING HEMOGLOBIN MASS TO PRE-TRAINING LEVELS DOES NOT ELIMINATE VO2MAX GAINS FROM ENDURANCE TRAINING**

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INTRODUCTION: Maximal oxygen consumption (VO2max) is strongly associated with total hemoglobin mass (Hbmass), red blood cell volume (RBCV) and blood volume (BV) in cross-sectional studies [1]. However, the extent to which hematological adaptations contribute to endurance training-induced VO2max increase remains debated. Montero et al. [2] and Bonne et al. [3] demonstrated that reverting RBCV and BV, respectively, to pre-training levels restored VO2max to baseline. In contrast, Skattebo et al. [4] observed that VO2max did not change despite the removal of training-induced Hbmass gains. These discrepancies may stem from variations in study design, including differences in the specific hematological component manipulated, training interventions, and notably, small sample sizes. To address the limitation of previous studies with small cohorts (n=9-16), the present study examined whether normalizing Hbmass to pre-training levels eliminates the VO2max increase following an 8-week endurance training program in a substantially larger cohort.

METHODS: Forty-nine middle-aged untrained adults (52±10 years; VO2max, 33±7 mL/min/kg; 24 females) completed an 8-week supervised endurance training program. Participants trained three 45 min sessions per week, which included intervals of high-intensity (4×5 min and 4×8 min) and moderate-intensity (6×6 min) cycling. After the training period, Hbmass was restored to pre-training levels using phlebotomy, during which a BV equivalent to the increase in Hbmass was removed, resulting in a hypovolemic state. VO2max was measured pre-training, post-training, and immediately after the phlebotomy procedure.

RESULTS: Ten participants did not increase Hbmass following the training period, leaving 39 for phlebotomy procedure. These participants exhibited increases in Hbmass (23±12 g, 3%), BV (221±217 mL, 5%), and VO2max (299±157 mL/min, 12%) from pre- to post-training (all $p<0.05$). Following phlebotomy, during which 154±81 mL of BV was removed to restore Hbmass to pre-training levels, VO2max decreased by 75±100 mL/min (2%; $p<0.05$) compared to post-training levels. However, VO2max remained 224±166 mL/min (9%, $p<0.05$) above pre-training levels. Notably, even participants who did not increase Hbmass during the training period experienced a VO2max increase (263±159 mL/min, 9%, $p<0.05$).

CONCLUSION: Restoring Hbmass to pre-training levels through phlebotomy reduces VO2max but does not fully return VO2max to pre-training levels. These findings indicate that adaptations beyond Hbmass contribute to the VO2max increase observed in middle-aged adults following the training intervention. Moreover, the VO2max increase in participants without Hbmass gains underscores the training program's effectiveness in enhancing VO2max independently of Hbmass changes.

References: [1] Oberholzer et al. (2024). Am J Hematol. [2] Montero et al. (2015). J Physiol. [3] Bonne et al. (2014). Am J Physiol - Regul Integr Comp Physiol. [4] Skattebo et al. (2020). Eur J Appl Physiol.

**DYNAMIC CEREBRAL AUTOREGULATION REMAINS INTACT FOLLOWING MAXIMAL SPRINT EXERCISE IN YOUNG MEN AND WOMEN**

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INTRODUCTION: Recent evidence suggests that the cerebrovasculature is better able to buffer acute increases, compared to decreases, in mean arterial pressure (MAP), and that dynamic cerebral autoregulation (dCA) may also be attenuated in females. Maximal sprint exercise induces large changes in systemic and cerebral hemodynamics, both during and following exercise. This may challenge dCA post-exercise, particularly during acute hypotension and in females, but this has not been studied. Therefore, the aim of this study was to 1) investigate the acute effect of maximal sprint exercise on dCA in healthy young adults, and 2) explore sex differences in dCA pre- and post-exercise.

METHODS: Twenty-one healthy adults (12 males (mean ± SD): 23.4±3.5 years, 177.7±5.5 cm and 73.3±9.7 kg; 9 females: 22.2±2.1 years, 166.9±5.9 cm and 63.1±9.9 kg) volunteered to participate in this study. During a single experimental visit, dCA was assessed at rest and 25 minutes following a maximal, 30 second Wingate test on a cycle ergometer. dCA was determined by forced oscillations in MAP during 5 minutes of repeated sit-stand manoeuvres, performed at 0.05 Hz. Middle cerebral artery blood velocity (MCAv) was measured using transcranial Doppler ultrasonography, and beat-to-beat blood pressure was measured using finger plethysmography. dCA was analysed using a multimetrics approach: 1) transfer function analysis (TFA), and 2) using a novel directional sensitivity metric, expressing the average time-adjusted (T, s-1) change in MCAv relative to MAP (ΔMCAvT/ΔMAPT) separately for each MAP direction. Two- and three-way ANOVAs explored the effects of exercise, sex and MAP direction on dCA.

RESULTS: There was no effect of sex on any TFA outcome (P>0.05), so all participants were subsequently pooled together to investigate the effect of the Wingate on dCA. There were no pre versus post-exercise differences in gain (0.74±0.30 vs 0.70±0.20 cm.s-1/mmHg, P=0.51), normalised gain (1.12±0.41 vs 1.21±0.33 %/mmHg, P=0.22) or phase (0.97±0.23 vs 1.05±0.24 rad, P=0.17), but coherence was significantly greater following the Wingate (0.83±0.12 vs 0.90±0.12, P=0.042). ΔMCAvT/ΔMAPT did not differ by sex in either MAP direction or at any time point (P=0.64). Pre-exercise, ΔMCAvT/ΔMAPT was significantly higher during acute hypotension versus hypertension (1.0±0.4 vs 0.9±0.3 cm.s-1/mmHg, P=0.034), and this persisted post-exercise (0.9±0.2 vs 0.8±0.2 cm.s-1/mmHg, P=0.017). Wingate exercise had no effect on ΔMCAvT/ΔMAPT in either MAP direction (P=0.15).

CONCLUSION: These novel findings: 1) Provide further support for hysteresis in the cerebral pressure-flow relationship, and show for the first time that these persist post-exercise, 2) Suggest that dCA remains intact following maximal sprint exercise in healthy young adults, and 3) Indicate males and females have comparable dCA, which are not differentially altered by acute maximal sprint exercise.

**MODIFYING INTERVAL EXERCISE INTENSITY AND DURATION TO OPTIMISE CEREBRAL BLOOD VELOCITY**

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INTRODUCTION: Cerebral blood flow (CBF) preservation is of fundamental physiological importance for brain health and function longevity (1). As humans age, CBF declines, but these reductions are offset by regular physical activity (2). The acute exercise-induced adjustment of CBF has been suggested as a key neuroprotective mechanism linked to improved brain vascular health (3). CBF (and by proxy, velocity (CBv)), has therefore been examined in different models of exercise, including moderate continuous and time-efficient interval exercise (4). High intensity interval (HIIT) and sprint interval training (SIT) elicit distinct acute responses – greater absolute CBv and active recovery CBv rebound, respectively (4). This study aimed to examine this rebound at lower intensities, akin to HIIT, at similar durations to SIT, and hence attempt to establish an optimal CBv enhancement combination – a HIIT and SIT hybrid.

METHODS: 7 healthy participants (4 female, 22±4 yrs) completed 4 interval exercise sessions of varied intensity and duration in a randomised, cross-over manner. Sessions involved 4 exercise bouts with participants cycling at either 80% or 120% of maximal workload (Wmax) for 30 s or 60 s, interspersed with 4.5 minutes active recovery bouts. CBv was determined as an index of CBF via measures of middle cerebral artery velocity (MCAv). Corresponding partial pressure of end tidal carbon dioxide (PETCO2) was recorded by continuous breath-by-breath gas analysis. The CBv rebound response was calculated using MCAv within the final 30 s of exercise and first 30 s of recovery.

RESULTS: MCAv change across time was significantly different for the 120% Wmax for 30 and 60 s sessions compared to their 80% Wmax duration match (p<.05). In 120% Wmax for 60s, MCAv was lower (p<.05) in exercise bouts 2, 3 and 4 compared to bout 1. Similarly, recovery bouts 2 and 4 were lower (p<.05) than recovery bout 1. MCAv reduced between exercise bout 1 and 2 (p=.02) at 80% Wmax for 60 s, before recovering in exercise bouts 3 and 4 (p>.05 vs bout 1). MCAv increase was elevated (p<.05) compared to pre-exercise resting values in 80% for 30 s at recovery bouts 1, 3 and 4. However, in 120% Wmax for 30 s, MCAv was only greater in recovery bout 2 (p<.05). Rebound response magnitudes were not significantly different between the 4 conditions (p=.070); with an absolute MCAv rebound observed at each recovery bout except for bout 1 in 120% Wmax for 60 s (-1.2±7.0 cm/s).

CONCLUSION: These pilot data indicate that 80% Wmax interval protocols produce an optimal combination for exercise-induced changes in MCAv, with greater elevation throughout the session and comparable rebound responses. Thus, lower intensity hybrid protocols may have greater potential to enhance acute exercise-induced CBv elevations.

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**ENDURANCE TRAINING REDUCES METABOREFLEX ACTIVATION AND CENTRAL DRIVE AT SUBMAXIMAL EXERCISE**

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INTRODUCTION: Cardiovascular response and regional blood flow during aerobic exercise are under the regulation of central command, muscle metaboreflex and functional sympatholysis. It is supposed that these mechanisms act to match oxygen delivery with metabolic demands and to increase arterial blood pressure to assure adequate blood perfusion to the working muscles. Regular endurance training is known to induce lower cardiovascular activation under a given exercise intensity. The purpose of this study was to examine whether endurance training and the subsequent increase in aerobic capacity attenuates metaboreflex activation and central command during aerobic exercise, thus contributing to a lower cardiovascular response.

METHODS: Sixteen male distance runners (age: 34.1±5.1 yrs, weight: 70.8±4.1 kg) participated in the study. Training consisted of two high-intensity interval sessions (90-100% VO2max) and three continuous sessions (70-80% VO2max) per week for two months. Pre and post training measurements of VO2max in running and cycling took place to assess aero-

bic capacity. Then, a 10-min submaximal cycling at an intensity 5% under the individual anaerobic threshold was executed to measure respiratory and cardiovascular response, as well as the EMG activity of the vastus lateralis. At the end of exercise, total blood flow occlusion was applied for 5 min in both legs using pressure cuffs (250mmHg) to measure blood pressure as an index of metaboreflex activation.

RESULTS: Weekly running volume was 80.4±3 km. Training increased running VO2max (PRE: 55.2±1.2 vs POST: 58.8±1.8 ml/kg/min, p<0.01) and maximal aerobic velocity (vVO2max) (PRE: 18.3±0.9 vs POST: 19.3±0.9 km/h, p<0.01). Cycling VO2max (PRE: 51.1±2 vs POST: 54.3±2.2 ml/kg/min, p<0.01), as well as peak power output (PRE: 290±12 vs POST: 307±15 watt, p<0.05), also increased after training. Throughout the 10-min submaximal cycling exercise, there was a significant decrease (p<0.05) in cardiac output, stroke volume, heart rate and systolic blood pressure, while systemic vascular resistance increased (p<0.05). EMG decreased (p<0.05) during exercise, while arterio-venous oxygen difference and exercise economy (Watt/L) increased (p<0.05). Post-exercise blood lactate levels were lower after training (PRE: 4.3±0.9 vs POST: 3.1±0.7 mmol/L, p<0.05). Finally, systolic blood pressure, throughout the occlusion period, was lower by 10 mmHg (p<0.05) after training.

CONCLUSION: As the aerobic capacity improves with training, a given exercise intensity elicits lesser perturbation to the system, leading to attenuated cardiovascular response via decreases in metaboreflex activation and central drive.

## Oral Presentations

### OP-PN21 Gut and Microbiome

**TWELVE WEEKS OF MULTI-MINERAL RED ALGAE SUPPLEMENTATION REDUCES EXERCISE-INDUCED GASTROINTESTINAL SYNDROME AND ENHANCES EXERCISE ECONOMY IN RECREATIONALLY ACTIVE RUNNERS.**

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INTRODUCTION: Endurance exercise is commonly associated with gut disturbances and barrier dysfunction, which can negatively impact performance. Dietary supplementation is one potential therapeutic strategy to alleviate these effects. Aquamin (Aq), a marine-derived multi-mineral complex, rich in bioavailable calcium and trace minerals, may support gut integrity (1) and attenuate exercise-induced gastrointestinal syndrome (EIGS) due to its mineral content and prebiotic potential (2), though its effects remain largely unexplored. This study investigated whether 12 weeks of Aq supplementation could improve the physiological response to endurance exercise and enhance exercise tolerance, improve gastrointestinal symptoms, and blood biomarkers of intestinal integrity in active individuals.

METHODS: Thirty-six healthy, recreationally active participants (30.5 ± 7.3 yrs; peak oxygen uptake ($VO_2$peak): 52.1 ± 6.7 mL/kg/min) completed a 12-week double-blind, randomised placebo-controlled trial. Participants received either multi-mineral marine red algae, Lithothamnion species (Aq, 2.66g; 800 mg/day calcium) or placebo and were assessed pre-intervention (wk 0), mid-intervention (wk 6) and post-intervention (wk 12). Participants' cardiopulmonary and perceptual responses to a 60-min moderate-intensity treadmill run (90% gas exchange threshold; GET) were monitored and immediately followed by a time-to-exhaustion (TTE) test at 50% of the difference between the GET and VO2peak (Δ50%), with venous blood-samples collected pre- and post-exercise.

RESULTS: Linear mixed models revealed a trial by group interaction for heart rate and oxygen consumption ($\dot{V}O2$) during the moderate-intensity run with Aq supplementation eliciting a lower heart rate at post-intervention compared to placebo (3.4%; p<0.001), and at post-intervention compared to mid-intervention in the Aq group (p=0.006). Post-intervention $\dot{V}O2$ was lower in the Aq group compared to placebo (6%; p=0.002), and at post compared to mid-intervention (p=0.01). Gastrointestinal symptoms improved across time in the Aq group (p=0.05), with reductions in both upper and lower symptoms (p=0.03) at post-intervention, while no changes were observed in the placebo group across time (p>0.05). Gut damage biomarkers were lower post-exercise in the Aq group, with reductions in soluble cluster of differentiation 14 (sCD14) from mid- to post-intervention (p=0.002) and group by time effects for intestinal fatty-acid binding protein (i-FABP; p<0.001).

CONCLUSION: Aq reduced heart rate and $\dot{V}O2$ during a 60-min moderate-intensity run, indicating a potential improvement in exercise economy. Aq also reduced gastrointestinal symptoms and post-exercise levels of sCD14 and i-FABP (markers of gut damage), supporting its role in mitigating EIGS. Future research should focus on elucidating the mechanisms behind these effects to better understand Aq's role as a therapeutic strategy for supporting gut health (1,2) and exercise performance.

1. Aslam et al. (2021), 2. Felice et al. (2021)

**PROBIOTICS IN FOOTBALL (SOCCER): A SURVEY ON PRACTITIONER'S CURRENT PERCEPTIONS AND PRACTICES**

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INTRODUCTION: Probiotic supplementation is attracting attention of the sports community to promote good health, training and exercise performance. Probiotics, when administered in adequate amounts, are widely considered to be health-promoting microorganisms. However, investigation of perceptions and practices is still lacking.

Purpose: To gain knowledge on the beliefs and practices of football practitioners applying probiotics supplementation in elite soccer players.

METHODS: Forty football practitioners (30 performance nutritionists, 4 head of performance, 1 physician, 3 sport scientists, and 2 strength & conditioning coach) from 5 different countries participated in a study consisting of a survey including 5 domains: demographic and professional characteristics (Who); perceptions about probiotics for health and performance (Why); real-life practices about probiotics supplementation (When); methodological procedures about probiotics (What); and effectiveness of common supplementation strategies (How). Survey's Inclusion criteria were: voluntary participation, > 18 years old, adequate experience working in an elite sporting environment (>2 years), be physician, nutritionist, head of performance, sport scientist or Strength & conditioning coach, currently working in elite professional level (First league or second league during season 24-25), currently working with the first team Men or Women or both.

Data were analyzed using a combination of descriptive statistics, generalized mixed effects, and multinomial logistic regression models.

RESULTS: Data revealed 5 main findings: (1) overall agreement on the importance of probiotics for soccer players (63.2%) and on the consumption under the practitioner's supervision (84.2%); (2) lack of consensus about the effects on athletic performance and recovery; (3) strong agreement on the use of probiotics to treat diarrhea (65%) and gastrointestinal symptoms (70%); (4) choice of multi-strain and specie probiotics supplements (86.5%); and (5) frequency of probiotics supplementation of 1 dose every day (77.8%) and in capsules formulations (77.8%).

CONCLUSION: This study provides actionable insights into the implementation of probiotics supplementation in elite soccer players. While practitioners recognize the importance of probiotics for soccer players on gut health, further research and professional debate are warranted to develop empirical knowledge and provide pragmatic recommendations about the effects of probiotics and athletic performance, sleep and recovery.

**THE CYCLISTS' GUT: IMPACT OF A TRAINING CAMP ON THE GUT MICROBIOME OF FEMALE, WORLD TOUR CYCLISTS**

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INTRODUCTION: The gut microbiome has emerged as a potential factor influencing endurance performance, yet its interaction with elite-level training and racing remains largely unexplored. This study investigates the impact of a World Tour cycling season on the gut microbiome of elite female cyclists. With, in this first study, focus on the effect of a two-week training camp after the off-season. It is hypothesised that the changed training volume and intensity, combined with an altered diet during the training camp will affect the gut microbiome composition and function.

METHODS: 14 elite female cyclists (26.4±4.0 yrs, 56.7±2.9kg, Functional Threshold Power 4.71±0.35 Watt/kg), from a World Tour team participated in this quasi-experimental study. Faecal samples, dietary intake, training data and physiological markers were collected at baseline and after the training camp (POST). Gut microbiome composition and function are being analysed using 16S rRNA sequencing and metabolic profiling. Mixed effects regressions were used to assess differences between baseline and POST.

RESULTS: Due to laboratory issues, only the metadata could be included in the current abstract. During training camp, training volume and intensity on the bike significantly increased from 13.3±4.1 to 22.5±1.86 hours/week ($p<0.001$), with an average Training Stress Score of 98.3±35.8 before and 133.4±42.7 POST ($p=0.018$). The amount of strength training (2.5±1.1 to 0.7±0.5 hours/week) was decreased during the training camp. The amount of sleep was not significantly different during the training camp (7.8±0.5 hours to 7.6±0.6 hours ($p=0.356$)). Their average heart rate variability was also not significantly different ($p=0.367$) during the training camp (85.8±31.1msec) compared to before (98.2±40.1msec). No significant changes were reported concerning faecal sample composition, as well as for gastrointestinal symptoms. The average caloric intake increased significantly during the training camp, with an average intake of 2835±411kcal/day, compared to before the training camp, with an intake of 2440±248kcal/day. The amount of carbohydrates increased from 309.0±53.0g to 394.0±68.0g ($p=0.006$). Within carbohydrates, sugar intake increased from 120.8±39.7g to 169.6±40.9g ($p=0.013$), however, no significant decrease in absolute fibre intake was found (27.8±7.3g to 25.2±9.59g). Lastly, protein intake increased from 105.9±13.8g to 130.5±21.0g ($p=0.001$).

CONCLUSION: This study provides a first insight into the training load, physiological responses and dietary adaptations of elite female cyclists during a two-week training camp after the off-season. With significant increases in training volume, intensity and caloric intake, effects on the gut microbiome are expected. Future studies should follow up longitudinally on the effects of a World Tour season (i.e. one-day races, grand tours, altitude camps) on the gut microbiome of female cyclists.

**GUT MICROBIOTA ENHANCES SUPPRESSION OF INNATE IMMUNE RESPONSE AFTER EXHAUSTIVE EXERCISE**

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INTRODUCTION: Temporary immunosuppression occurs immediately after high-intensity exercise, increasing the risk of upper respiratory tract infections (URTI) and other infectious diseases. The effect of gut microbiota on this phenomenon remains unclear, however. The aim of this study was to investigate the effect of gut microbiota on lipopolysaccharide (LPS)-induced tumor necrosis factor (TNF)-α production immediately after the exhaustive exercise.

METHODS: In this study, we conducted two experiments. In the first experiment, C3H/HeN male mice were divided into 4 groups: sedentary control (SC, n=10), antibiotic treatment & S (ABS, n=10), exercise (Ex, n=10), and AB & Ex (ABEx, n=12). The antibiotic cocktail consisted of ampicillin 1 g/L, neomycin 1 g/L, metronidazole 1 g/L, vancomycin 0.5 g/L, and artificial sweetener Splendor 2.5 g/L. The cocktail was given ad libitum for 7 days. Then, Ex and ABEx mice were run on the treadmill until exhaustion. Exhaustion was defined as the point at which a mouse refused to run despite being given mild touches. Electric shock was not used during the treadmill run. Immediately after the exhaustive exercise or sedentary condition, mice were stimulated by LPS (1mg/kg, i.v.). Blood samples were collected before exercise, and at 1, 3, and 6 h after LPS injection in mice under Isoflurane anesthesia, and plasma TNF-α concentrations were analyzed using an ELISA kit. In the second experiment, partially hydrolyzed guar-gum (PHGG) fed mice were stimulated with LPS after exhaustive exercise, in order to investigate the effect of gut microbiota, which were stimulated by dietary fibers, on exercise-induced TNF-α response to LPS. The mice were divided into 3 groups: non-fiber diet (NF, n=12), control diet (CD, n=11) and 5% PHGG diet (PHGG, n=14).

RESULTS: After the exhaustive exercise, plasma TNF-α concentration in AB mice prior response to LPS was significantly higher than that in control mice ($p<0.01$). PHGG intake, moreover, attenuated to increase in plasma TNF-α concentration in response to LPS compared with both non-fiber and control diet intakes ($p<0.01$).

CONCLUSION: In this study, we observed that AB accelerated and PHGG attenuated the LPS-induced TNF-α production after exhaustive exercise. Thus, it was suggested that stimulation of gut microbiota induces the changes in the innate immune system after exhaustive exercise in mice. We previously showed that PHGG treatment attenuated plasma TNF-α concentration after LPS stimulation, compared with control diet intake, and then this phenomenon was deleted by AB treatment before PHGG intake. Although this was just an experiment in the sedentary condition, that might strongly support our results. Conclusion: These results suggest that LPS-induced TNF-α production immediately after the exhaustive exercise is regulated by gut microbiota.

**COMPARABLE AMINO ACID PROFILE AND INTRAMUSCULAR SIGNALLING RESPONSES FOLLOWING CONSUMPTION OF MICROFLORA COMPARED WITH WHEY PROTEIN POST-RESISTANCE EXERCISE IN YOUNG ADULTS**

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INTRODUCTION: Microflora refers to a group of micro-organisms including bacteria and fungi. Microflora protein (MIC) has been marketed as an 'environmentally friendly dairy-identical' protein. Hence, MIC is suggested to represent an innovative source of dietary protein to closely mimic the amino acid (AA) composition of high-quality proteins, whilst potentially mitigating some environmental and ethical consequences and limitations purportedly associated with large-scale intensive agriculture, and ultimately support the increasing global demand for food. Therefore, the aim of this study was to compare the AA composition of MIC to a high-quality whey protein (WHEY) and assess the efficacy of MIC in supporting skeletal muscle anabolism.

METHODS: In a double-blind, crossover, randomised and counter-balanced trial, we investigated the anabolic potential of MIC designed to mimic 'high-quality' WHEY. Twelve, physically-active young adults (sex: M=6, F=6; age: 21.1 ± 3.0 years; body fat: 21.1 ± 7.3%; fasting glucose: 4.3 ± 0.4 mmol·L-1) consumed 0.3 g·kg-1 (of body mass) of MIC (dose: 29.8 ± 7.3 g) or WHEY (dose: 27.7 ± 7.5 g) protein concentrate in an overnight postabsorptive state immediately following single-leg resistance exercise (~80% of 1 repetition maximum). The AA compositions of MIC and WHEY were analysed in accordance with food industry standards. Postprandial plasma AA concentrations (0-4 h, by liquid chromatography-mass spectrometry) and intramuscular signalling responses (1 h postprandial, by immunoblot) to exercise were determined. Diet and physical activity were monitored and replicated prior to each experimental visit.

RESULTS: A comparable pattern of AA composition was observed between protein sources (Sum of determined Essential-AAs: 30.5 vs. 34.8 g/100g for MIC and WHEY, respectively). Leucine content was, however, notably higher in MIC compared with WHEY (9.1 vs. 7.8 g/100g). Postprandial plasma AA, glucose and insulin concentrations and intramuscular signalling (i.e., p-mTOR, p-4E-BP1, p-Akt, p-RPS6, p-eEF2, p-ERK1/2) significantly increased from baseline but responses were largely comparable between WHEY and MIC across the postprandial period with the exception of plasma leucine, whereby significantly higher plasma concentrations were observed with MIC compared with WHEY across the postprandial period (Area under curve: +39%, P=0.002).

CONCLUSION: These data provide preliminary evidence suggesting that MIC could be a viable alternative protein source with a comparable quality to WHEY, potentially supporting skeletal muscle remodelling in young, healthy, active individuals. Further research is, however, needed to assess the broader efficacy and applicability of MIC.

## Oral Presentations

### OP-MH40 Exercise Therapy / Bedrest

**GENDER DIFFERENCES IN RESPONSE TO A HOME-BASED BODYWEIGHT RESISTANCE TRAINING PROGRAM FOR SARCOPENIA.**

MARMONDI, F., GALLI, L., CERIZZA, C., ANNICCHIARICO, G., BAGLIVI, A., DELLA TORRE, L., CASTAGNA, A., BANFI, G., CINQUE, P., FAELLI, E., BONATO, M.

*UNIVERSITY OF GENOA*

INTRODUCTION: Sarcopenia is a geriatric pathology associated with an increased risk of disability and adverse health outcomes. The study aim was to investigate the effects of a 48-weeks, app-monitored, home-based, bodyweight resistance training program in improving muscle health in sarcopenic persons, both in general population (GP) and in persons with HIV (PWH). We here investigate gender-specific responses of physical tests, body composition, and cognitive parameters after 12 weeks (W12).

METHODS: Subjects, aged >50 years (PWH) and >60 years (GP), with sarcopenia, defined by low appendicular skeletal muscle mass index (ASMMI) by bioimpedentiometry and/or low muscle strength by handgrip strength (HGS), were randomized (1:1) into an Experimental Group (EG), performing 4 training session/week with increasing number of repetitions and sets every 6 weeks, or a Control Group (CG), without specific exercise prescription. Assessments were conducted at baseline, after 12 weeks (W12), and after 48 week, including HGS, chair stand test (CST), 6-minute walking test (6MWT), Mini-BESTest, right and left leg maximal isometric strength (RLE, LLE), ASMMI, fat mass (FM), fat-free mass (FFM), and cognitive outcomes [Trail Making A (TMA), and B (TMB), and Digit Symbol (DS)]. Within-group changes were assessed using Wilcoxon signed-rank tests. Comparisons between genders and between the EG and CG were conducted using Mann-Whitney U tests.

RESULTS: A total of 165/196 participants [98 males (EG:49, CG:49) and 67 females (EG:34, CG:33)] completed W12. In males, significant differences were observed in physical tests [HGS: EG (P=0.0124); CST: EG (P<0.0001), EG vs CG (P=0.0066); 6MWT: EG (P=0.0068), CG (P=0.0025); Mini-BESTest: EG (P=0.0089), CG (P=0.0276); LLE: EG (P=0.0085)], in body composition [ASMMI: EG (P=0.0044); FFM: EG (P=0.0038), EG vs CG (P=0.0422); FM: EG (P0.0011)], and in cognitive outcomes [TMA: EG (P=0.0020), CG (P=0.0124); TMB: EG (P=0.0198); DS: EG (P=0.0088), CG (P=0.0124)]. In females, significant differences were observed in physical tests [HGS: EG (P=0.0064); CST: (EG (P=0.0004), EG vs CG (P=0.0359); Mini-BESTest: EG (P=0.0359); RLE: EG (P=0.0176), EG vs CG (P=0.0497)], and in cognitive outcomes [TMB: EG (P=0.0153); DS: EG (P<0.0001), CG (P=0.0168)]. In gender-differences, significant changes were observed in EG in body composition [FM (P=0.0011)], and in CG in physical test [6MWT (P=0.0071)]. No other gender-differences were observed.

CONCLUSION: At W12, significant improvements were found in physical tests, body composition, and cognitive function in both males and females. While both genders benefited, males showed greater improvements in body composition and some physical performance measures. No gender differences were observed in cognitive outcomes.

**EVALUATING THE ASSOCIATIONS BETWEEN MUSCLE, PHYSICAL ACTIVITY, AND PERFORMANCE-RELATED FACTORS AND BONE STRENGTH IN ENDURANCE-TRAINED INDIVIDUALS**

FERREIRA, S., LEVEE, J., SEVINC, A., GARDY, S., LINARDATOS, J., AMATO, A., CHURCHWARD-VENNE, T., GIBBS, J.

*MCGILL UNIVERSITY*

INTRODUCTION: Bone fragility is pervasive in endurance athletes due to their high-volume training and elevated nutritional demands. Muscle size and quality has been shown to positively influence bone strength in various populations, however, few studies have investigated this relationship in endurance athletes. Further, there is limited research on the association between endurance sport-specific factors (e.g., physical activity/training, performance) and peripheral quantitative computed tomography (pQCT) measures of bone strength. Our primary objective was to evaluate the relationships between calf muscle size and density and tibial bone strength and volumetric bone mineral density (vBMD) in male and female endurance-trained individuals. We also explored whether physical activity and performance-based tests of muscle strength and cardiorespiratory fitness were associated with bone outcomes.

METHODS: 50 participants (31 males/19 females) aged 18-35 years running >3 hours/week for the past 6 months completed one-time measures. Total, trabecular, and cortical vBMD, bone compressive strength (BSI) and stress-strain indices (SSI) at the tibia (4%, 38%, 66% sites), and calf muscle density and cross-sectional area (MSCA) were measured using pQCT. Body composition was measured using dual-energy X-ray absorptiometry. Upper and lower body muscle strength were determined by handgrip and knee extensor isometric tests. Aerobic capacity (VO2peak) was measured via an incremental cardiorespiratory fitness test to volitional exhaustion. Physical activity levels were assessed using accelerometers (i.e., moderate-to-vigorous physical activity (MVPA)) and the Bone-specific Physical Activity Questionnaire (BPAQ). Multivariable linear regression analyses between muscle (MCSA and muscle density), physical activity (MVPA, total, current and past BPAQ), and performance (VO2peak, muscle strength) variables and bone parameters were adjusted for age, sex, and body weight.

RESULTS: Participants had a mean (95% CI) age of 26.0 years (24.6 – 27.4), body fat of 19.9% (18.0 – 21.9), VO2peak of 55.9 ml/kg/min (53.1 – 58.7), and maximum knee extensor and handgrip strength of 262.3 N*m (232.0 – 292.7) and 43.5 kg

(40.2 – 46.8), respectively. Mean MVPA and total BPAQ scores were 12 hours/week (10.9 – 13.1) and 24.0 (19.0 – 29.1), respectively. Multivariable linear regression analyses revealed weak-to-moderate associations between MCSA and BSI 4% (B=0.285, p=0.044, R2=0.606), BSI 66% (B=0.426, p=0.018, R2=0.372), and cortical area 66% (B=0.339, p=0.009, R2=0.674). Muscle density and strength, VO2peak, MVPA, and BPAQ scores were not significantly associated with bone parameters after adjusting for confounding variables.

CONCLUSION: In endurance-trained individuals, calf muscle size was positively correlated with tibial bone strength independent of age, sex, and body weight, particularly at proximal sites. Muscle size may represent an important modifiable target to improve bone strength in endurance athletes.

**PROGRESSIVE RESISTANCE TRAINING TO VOLITIONAL MUSCULAR FAILURE IMPROVES MUSCLE STRENGTH IN FRAIL COMMUNITY-DWELLING OLDER ADULTS REGARDLESS OF TRAINING INTENSITY: A RANDOMIZED CONTROLLED TRIAL**

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*AMSTERDAM UNIVERSITY OF APPLIED SCIENCES*

INTRODUCTION: Progressive resistance training is effective against the age-related decline in muscle strength and physical limitations in older adults. However, the optimal resistance training intensity for frail community-dwelling older adults remains unclear, with concerns about high-intensity exercise limiting participation. Emerging evidence suggests that training to volitional muscular failure may achieve similar benefits across various intensities. This study aimed to assess the optimum level of progressive resistance training intensity for enhancement of muscle strength in frail community-dwelling older adults.

METHODS: This 12-week randomized controlled trial included 295 frail community-dwelling older adults (≥65 years) and were randomized into 12 training intensity groups, categorized into four clusters: low (25-35%), low-medium (40-50%), medium-high (55-65%), and high intensity (70-80% of one-repetition maximum). Twice-weekly, one-on-one progressive resistance training sessions were conducted, with all participants training to volitional muscular failure. The outcome was lower-extremity muscle strength, assessed using the leg press. Linear mixed models were used to examine overall improvements in muscle strength, and to analyse if there were linear or quadratic relationships between training intensity and improved strength, as well as between the training intensity clusters and improved strength.

RESULTS: All participants demonstrated significant improvements in lower extremity muscle strength following the 12-week progressive resistance training, increasing from 101±27 kg at baseline to 126±35 kg at follow-up (+25 kg, p<0.001). No linear or quadratic relationship was observed between training intensity and improvements in muscle strength. Compared to the high intensity cluster, muscle strength improvements were +7±4 kg (p=0.045), +4±3 kg (p=0.222), and +9±3 kg (p=0.010) in the low intensity cluster, in the low-medium intensity cluster, in the medium-high intensity cluster, respectively.

CONCLUSION: Progressive resistance training to volitional muscular failure effectively improves muscle strength in frail community-dwelling older adults. In this randomized study we did not find a clear optimum level of training intensity for improvement of muscle strength. The high intensity training appeared suboptimal compared to lower levels of training intensity.

**CAN VIRTUAL REALITY ENHANCE KINESTHETIC MOTOR IMAGERY? PRELIMINARY RESULTS FROM A 10-DAY BEDREST STUDY**

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*SCIENCE AND RESEARCH CENTRE KOPER*

INTRODUCTION: Physical inactivity has profound detrimental effects on the human body, impacting multiple subsystems, including the musculoskeletal, cardiovascular, and respiratory systems, as well as motor control, perception, and overall well-being. These effects are particularly pronounced in older individuals, where recovery is often slower and more challenging. Understanding the mechanisms driving these changes is critical, as is the development of effective interventions to mitigate deterioration and enhance recovery of functional abilities. Recent advancements in virtual reality (VR) offer innovative, non-physical strategies to counteract bedrest-induced effects (1). While motor imagery (MI) has shown promise in addressing these challenges (2), its integration into VR-based interventions for functional decline remains underexplored. This study investigates the potential of VR to enhance non-physical strategies, specifically its impact on MI ability. Using the Movement Imagery Questionnaire-3 (MIQ-3), we evaluated changes in internal, external, and kinaesthetic imagery to determine VRs efficacy in supporting cognitive-motor recovery during bedrest.

METHODS: Twenty healthy older adult males (68±3 years) participated in a 10-day horizontal bedrest study. Participants were randomized into an intervention (INT) group and a control (CON) group. The INT group engaged in daily 25–30 min VR sessions using an Oculus Quest 2 headset, combined with 30 days of exercise prehabilitation and a leucine-rich, high-protein diet. The VR protocol simulated resistance training in a fully immersive environment, providing cognitive and sensory engagement without physical exertion. The CON group passively observed the same VR environment. MI efficiency was assessed in both groups before and after the intervention using the MIQ-3.

RESULTS: A significant time*group interaction effect (p<0.001) was observed for kinaesthetic imagery, with no significant changes in internal or external visual imagery. Post-hoc tests revealed the INT group improved in kinaesthetic feeling (p=0.007), while the CON group experienced a decline in performance (p=0.016).

CONCLUSION: These preliminary findings indicate that the VR intervention enhanced specific cognitive functions, particularly the perception of body movements, by effectively engaging kinaesthetic MI. Future research will determine whether the combined intervention also mitigated other bedrest-related declines or produced similar effects across different functional domains.

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**RESISTANCE VIBRATION EXERCISE IN ARTIFICIAL GRAVITY: A POTENTIAL COUNTERMEASURE FOR DEEP SPACE MISSIONS**

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INTRODUCTION: Prolongued exposure to weightlessness induces loss of musculoskeletal mass in the lower limbs. Current exercise countermeasures do not fully prevent these adaptations, which has instigated a programme of research coordinated by the European Space Agency to explore alternative exercise strategies. We are currently investigating the efficacy of a novel countermeasure combining artificial gravity (AG) with resistance vibration exercise (RVE). In this regard, the objectives of the present study were: 1) Compare the activation of thigh and calf muscles during upright triple extension squat exercise without (URE) and with vibration (URVE); 2) Assess vibration transmission (VT) during supine RVE conducted without (RVE) and with artificial gravity (AGRVE); 3) compare the effectiveness of URVE, HRVE and AGRVE on the basis of a 2-wk training programme.

METHODS: A total of 54 healthy active males participated in the study. The activation of thigh and calf muscles during URE and URVE was determined with magnetic resonance imaging (MRI) using T2 relaxation time (N=15). VT was determined during RVE and AGRVE with accelerometers attached to the vibration plate, pelvis and forehead (N=15). The efficacy of a 2-wk training programme (N=24) with upright and supine RVE was compared to AGRVE on the basis of muscle strength (isokinetic dynamometry), power (jump test) and volume (MRI) and body composition (DEXA). The rotational vibration/force platform allowed the ground reaction force to be maintained at similar levels in all trials. The vibration frequency was 20 Hz and the displacement was between 3 and 4 mm.

RESULTS: Muscle water and metabolite accumulation increased ($p < 0.0001$) following RE and RVE, with no difference between them. Vibrations were attenuated in the lower limbs in RVE and AGRVE ($p < 0.0001$), with greater attenuation occurring in the latter ($p = 0.001$). A 2-wk training programme resulted in greater muscle volume ($p = 0.01$) and strength gains ($p = 0.001$) during AGRVE compared to upright and supine RVE with no differences in muscle power and body composition.

CONCLUSION: Vibration did not enhance muscle activation during the squat exercise and its transmission to the upper body was significantly attenuated. AG enhanced the outcome of RVE training (AGRVE), demonstrating that it is a promising modality and exercise strategy for mitigating loss of muscle and bone mass during deep space mission.

ACKNOWLEDGEMENTS: The study was supported by the European Space Agency (ESA) contract No. 4000138718/22/NL/DB. We are indebted to Jack Fortune, Dr. Urša Ciuha, Dr. Adam McDonnell, Dr. Leonidas Ioannou, Miro Vrhovec, Saša Repanšek, Katja Romarič and Tina Robida for their assistance.

## 09:30 - 10:45

## Oral Presentations

### OP-AP10 Team Sports II - Fatigue and Recovery

**LOCOMOTOR EFFICIENCY REDUCES DURING MATCHES IN HIGH LEVEL MALE AND FEMALE SOCCER PLAYERS**

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*SPORT SERVICE MAPEI S.R.L.*

INTRODUCTION: Many authors reported changes in Total Distance (TD, measured by GPS) and Dynamic Stress Load (DSL, measured by accelerometry) at the end of soccer matches, suggesting the possible influence of fatigue (Bradley PS et al., 2009). Fatigue induces many changes in the pattern of movement, such as increased ground contact time and stride frequency, reduced stride length and a flatter centre of mass trajectory (Small K et al., 2013). Some authors reported reductions in Locomotor Efficiency (LE), calculated as the ratio between DSL and TD (Barrett S et al., 2016), at the end of basketball matches (Vazquez-Guerrero J et al., 2019) and Oliva-Lozano et al. (2020) also reported lower LE in the second half compared to the first half. It was suggested that LE might be able to capture some of the fatigue-induced changes in the bio-

mechanics of movement, due to the higher reductions in accelerometer-derived load compared to TD. Thus, the aims were to investigate: the within-match changes in LE and the differences in LE between starters and substitutes.

METHODS: Under 19 male (n=35, 17.8±0.4 yrs, 72.1±4.9 kg, 179.7±6.7 cm) and adult female (n=33, 24.3±5.6 yrs, 61.4±5.8 kg, 168.5±6.0 cm) players from a professional Serie A soccer club participated in this study. Using a GPS that included an accelerometer on board (Apex model, STATSports Technologies, USA), TD, DSL and LE were measured in 60 matches of the 2022–23 season (34 U19 and 26 senior female matches) collecting 639 individual match data. Mixed models were used to analyse differences between the six 15-minute time frames (T1 to T6). Tactical role, match location, opponent's rank and soccer match result were included in models to control for contextual variables.

RESULTS: For males and females, TD and DSL were higher in Q1 than all other time frames (all $p<0.015$) and were higher in Q2, Q3 and Q4 than Q5 and Q6 (all $p<0.004$) . For males and females, LE was higher in Q1 than Q3, Q5 and Q6 (all $p<0.021$) and was higher in Q4 than Q5 and Q6 (all $p<0.001$). These results indicate that the reduction in DSL was higher compared to the reduction in TD. LE of substitutes in Q6 was higher than starters ($p=0.005$), suggesting that LE might reduce under fatigue.

CONCLUSION: Compared with the beginning, LE was reduced at the end of the soccer match, suggesting a biomechanical running pattern change (Buchheit M et al., 2015) which might be partially related to the development of players' fatigue during games. In comparison with substitutes, starters players showed lower LE at the end of matches, which might indicate that they alter their biomechanical running pattern, possibly due to fatigue, not experienced by substitutes due to their reduced match time exposure.

**IS THE OMNI-RATING OF PERCEIVED EXERTION SCALE USEFUL IN DETERMINING TRAINING LOAD IN NON-ELITE ADOLESCENT TEAM SPORT?**

SAINSBURY, D., DOWNS, J., MCKENNA, L., NETTO, K.

*CURTIN UNIVERSITY*

INTRODUCTION: High training load (TL) is a potential risk factor for injury in non-elite adolescent team sport. A valid, easily applied measure of TL in this population is required where access to more sophisticated measures may be limited. TL may be calculated from the product of a rating of perceived exertion (RPE) score from a Borg CR-10 or CR-100 and session duration. There is limited research into the validity of this approach to determine TL in adolescent populations in field settings using paediatric specific scales of RPE. This study aimed to investigate the validity of the paediatric OMNI-RPE scale as a tool to calculate TL when compared to heart rate (HR) and velocity derived measures of TL in non-elite adolescent team sport athletes.

METHODS: Part A involved completion of both an easy and hard version of a simulated team game circuit (each consisting of warm up, two sets of 5-minute intermittent running circuits and a cool down). Part B involved observations during usual team games. An OMNI-RPE (0 "not tired at all" to 10 "very very tired") was taken 30 minutes post session. An OMNI TL, expressed in arbitrary units, was calculated as a product of the OMNI-RPE and session duration. This score was compared against other measures of TL namely, Edward's Training Impulse (TRIMP), time spent in heart rate (HR) zones 4 and 5 (80-100% HR peak) and time spent in 0-25%, 25-50%, 50-70% and >70% velocity peak (VP). Heart rate and velocity were measured using Catapult Optimeye S5 units and compatible Polar T31 heart rate units.

RESULTS: Twenty (age14.2±1.7 years; eight female) team sport athletes participated in Part A. For both the easy(E) and hard(H) versions of the circuit, low to moderate correlations were observed between OMNI TL and Edwards TRIMP (E r=0.2, H r=0.18) time in HR zones 4 and 5 (E r=0.33, H r=0.19), time spent in 25-100% VP (E r=0.46, H r=0.37), 50-100% VP (E r=0.39, H r=0.37) and 70-100% VP (E r=0.05, H r=-0.23). 34 different athletes (age15.2±1.5 years; 16 female) participated in Part B. Moderate to large correlations were observed between OMNI TL and Edwards TRIMP (r=0.53) time spent in HR zone 4/5 (r=0.45) time spent in 25-100% VP (r=0.42) and time spent in 50-100% VP (r=0.51). A low correlation was observed between OMNI TL and time in 70-100% VP (r=0.28).

CONCLUSION: The larger correlations between OMNI TL and the HR and velocity derived measures of TL in the team game suggest OMNI TL may have greater utility in monitoring TL in a naturalistic setting rather than simulations. Compared to similar studies using Borg CR-10 or CR-100 RPE scales (perceived exertion from extremely weak to extremely strong), lower correlations between OMNI TL and HR derived measures of TL were observed in this study. This may be because the OMNI-RPE scale is anchored in perceptions of tiredness making it sensitive to weariness or fatigue, so may be influenced by other physical and psychosocial factors such as poor sleep and performance stressors.

**THE POWER OF BELIEF: INVESTIGATING THE PLACEBO EFFECT IN POST-EXERCISE RECOVERY STRATEGIES FOR FOOTBALL PLAYERS**

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*1, LITHUANIAN SPORTS UNIVERSITY; 2, UNIVERSITY OF ROME FORO ITALICO.*

INTRODUCTION: The demanding nature of team sports can generate substantial fatigue, with recovery strategies being widely employed by practitioners to counteract fatigue accumulation during the competitive season [1]. However, the effectiveness of such strategies may partly stem from the placebo effect, which has been shown to produce moderate-to-large benefits on measures of performance (e.g., strength, aerobic/anaerobic capacity) [2,3] and well-being (e.g., muscle soreness) [4]. Despite the evidence linking the placebo effect to performance improvements, limited research is available regarding its role in post-exercise recovery strategies. Therefore, the aim of this study was to compare measures of per-

formance, physiological and perceptual recovery between a placebo (PLA) and passive rest intervention (CON) after football matches.

METHODS: Using a crossover design, 18 high-level, youth (i.e., under-16) male players completed two full-length (2x45-min halves) friendly football matches, followed by either PLA or CON. Specifically, PLA involved the use of a non-invasive vagus nerve stimulation device (Pulsetto, Vilnius, Lithuania) as a sham intervention, where no actual stimulation was delivered. To assess between-intervention differences, countermovement jump height (CMJ), 10 and 20-m sprint times, heart rate variability (Ln-rMSSD), perceived fatigue, static and dynamic (i.e., measured during a squat) muscle soreness were recorded at pre-match, post-match, post-recovery (i.e., shortly after PLA/CON) and 24 h post-match. Two goalkeepers participated in each match, but were not included in the analyses.

RESULTS: Match-play induced substantial fatigue, with our main findings revealing significant deteriorations ($p < 0.003$) in CMJ (small-to-large effect size [ES]), 10- (moderate ES) and 20-m sprinting (moderate-to-large ES), Ln-rMSSD (moderate ES), perceived fatigue, static and dynamic soreness (large ES for all perceptual measures) in both interventions at post-match and post-recovery, compared to pre-match. Although no significant between-intervention differences were found for any variable at any time point ($p > 0.05$), perceived fatigue [ES (r) = 0.40] and dynamic soreness [ES (r) = 0.32] were moderately lower in PLA than CON at post-recovery.

CONCLUSION: Our findings suggest that the placebo intervention did not directly affect the recovery of performance or heart rate variability. It did, however, show moderate benefits in reducing perceived fatigue and dynamic muscle soreness at post-recovery, compared to passive rest. While caution is warranted – due to the lack of statistically significant differences – these results highlight the importance of considering the placebo effect when designing research on recovery strategies and when employing them in applied settings, as even small effect sizes may offer meaningful benefits for athletes using placebo interventions [2].

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**EFFECTS OF A SLEEP HYGIENE INTERVENTION PERIOD ON THE PHYSICAL PERFORMANCE INDICATORS OF MALE UNIVERSITY-LEVEL FOOTBALL PLAYERS DURING A TOURNAMENT**

BROODRYK, A., PREVOO, G., KRAMER, M.

*PHYSICAL ACTIVITY, SPORT AND RECREATION RESEARCH FOCUS AREA*

INTRODUCTION: In football, performance indicators (PIs) are frequently utilized to give coaches and players clear information to maximize performance. Sleep is said to be the most crucial recuperation tool for peak performance. Unfortunately, due to multiple factors, football players frequently experience sleep deprivation, which affects these crucial performance indicators and game results.

METHODS: This study aimed to determine the effect of a sleep hygiene protocol (SHP) on various football match PIs. Sixteen male university-level football players (average age: 22.2±3 y; stature: 167.6±6.4 cm; mass: 62±6.6 kg) participated in the study. Their matches were recorded and analyzed according to various offensive and defensive key performance indicators over 14 matches, consisting of five games (no-sleep intervention - nSHP), four matches (sleep intervention - SHP), and again five matches of nSHP. They also completed the Pittsburgh Sleep Quality Index (PSQI) before and after the SHP. During the intervention period, players had to adhere to at least ten sleep hygiene requirements daily, for four weeks.

RESULTS: Following the sleep extension phase, the PSQI results revealed a significant improvement in global PSQI scores (Meandiff = 2.00, $p = 0.028$, $g = 0.58$), which was driven by the sub scores of sleep latency ($p = 0.05$, $g = 0.51$) and hours slept ($p < 0.001$, $g = 0.96$). Those completing the SHP would complete 1.89 more dribbles ($p = 0.004$, ES = 1.89) compared to the nSHP condition. Similarly, under the SHP condition, 1.61 times more network passes ($p < 0.001$, ES = 1.61), 1.4 times more offensive crosses ($p = 0.02$, ES = 1.4), and 1.28 times more successful passes ($p < 0.001$, ES = 1.28) were completed compared to the nSHP condition. The SHP also demonstrated significantly more positive relationships between PI's compared to the nSHP. Firstly, between successful passes and 1.) successful passes in the opposition half ($r = 0.97$, $p = 0.02$), 2.) more network passes ($r = 0.99$, $p = 0.004$), and 3.) shots on target ($r = 0.99$, $p = 0.006$). Furthermore, a strong relationship was observed between successful passes in the opposition half and 1.) more network passes ($r = 0.99$, $p = 0.01$), and 2.) shots on target ($r = 0.99$, $p = 0.005$). In addition, the number of network passes also demonstrated a strong relationship with the number of shots on target ($r = 0.99$ and $p = 0.001$).

CONCLUSION: Inadequate sleep can impact visual-spatial intelligence (VSI) and visual perception. Therefore, cognitive tasks (looking where the pass comes from and knowing where to pass the ball) that involve the frontal-parietal network, such as VSI (to scan for information in the context of a football match), can be influenced by sleep or a lack thereof. Although the acute SHP did not appear to influence the match outcomes, it did influence key factors that may increase the probability of a favorable outcome, such as the number of dribbles, network passes, successful passes, and offensive crosses during matches.

**CRITERION VALIDITY OF SLEEP QUALITY SCALES IN YOUNG ELITE SOCCER PLAYERS**

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*UNIVERSITY OF BOLOGNA*

INTRODUCTION: Sleep is essential for cognitive function, recovery, and athletic performance. Sleep deprivation negatively affects performance and overall health, with athletes sleeping less than 8 hours per night exhibiting a 70% higher injury risk (1). To evaluate sleep quality and disturbances, the General Sleep Disturbance Scale (GSDS) has been recently validated against the Pittsburgh Sleep Quality Index (PSQI)(2, 3). For the same purpose, a daily wellness questionnaire is often used in the field (4). To assess the validity of the GSDS and the wellness score in competitive soccer players, this study aimed to analyze the relationships between the actigraphy and the PSQI questionnaires (objective and subjective criterion measures) compared with the wellness scores and the GSDS score.

METHODS: 35 elite soccer players (age 17.7±0.8 y, stature 184.7±5.2 cm, body mass 82.9±6.8 kg) voluntarily participated in the present study. Athletes wore an actigraphy accelerometer (Actigraph Spectrum Plus, Philips, Pittsburgh, USA) for seven consecutive days to track selected sleep parameters and completed a daily wellness questionnaire. The GSDS and PSQI questionnaires were administered at the end of the same monitored week. The parameters collected with the actigraphy accelerometer were: total sleep period, total activity counts, sleep onset latency, sleep efficiency, wake time, and sleep time. Spearman's correlation coefficients were calculated to determine the relationships between the objective (Actigraphy) and the subjective (PSQI) criterion measures and the GSDS and the wellness questionnaire. Significance was set at $p < 0.05$.

RESULTS: The GSDS questionnaire score showed a positive relationship with sleep onset latency ($r_s(34) = 0.376$, 95% CI [0.049, 0.630], $p = 0.026$), and a negative relationship with sleep efficiency ($r_s(34) = -0.447$, 95% CI [−0.679, −0.133], $p = 0.007$) of the actigraphy accelerometer. Furthermore, The GSDS questionnaire score showed a positive relationship with PSQI scores ($r_s(34) = 0.590$, 95% CI [0.319, 0.771], $p < 0.001$). Conversely, the sleep item in the wellness questionnaire showed no correlation with any actigraphy parameters ($r_s(34) = -0.145 - 0.206$, $p > 0.05$) or the PSQI questionnaire scores ($r_s(34) = 0.100$, 95% CI [−0.242, 0.419], $p = 0.569$).

CONCLUSION: These findings support the weekly use of the GSDS questionnaire for assessing sleep quality in elite soccer players. However, despite its widespread use in field settings, the use of wellness questionnaires is not supported for measuring athletes' sleep quality based on these results. Further research is needed to determine the validity and reliability of these sleep monitoring tools in athletes

## Invited Symposium

### IS-BM02 The power of eccentric contractions on muscle adaptation, remodeling, and function in old age: The positives of negatives

**MOLECULAR RESPONSES TO ECCENTRIC EXERCISE ACROSS AGE**

DEANE, C.
*UNIVERSITY OF NOTTINGHAM/ BOURNEMOUTH UNIVERSITY*

Traditional resistance exercise involves both shortening (concentric) and lengthening (eccentric) contractions. Compared to concentric contractions, isolated lengthening eccentric contractions represent a potential therapeutic intervention for combating muscle decline in ageing as they are the least metabolically demanding for a given load and produce the most force. However, the safety and efficacy of eccentric exercise as a training mode is often questioned, especially for ageing populations, due to the associated muscle "damage". This talk will describe the physiological and molecular responses to eccentric exercise across age drawing upon both animal and human evidence. This first part of this talk will describe, with high temporal resolution, the physiological and targeted molecular responses to a bout of eccentric exercise in young and older exercise naïve males. Unpublished observations from our lab demonstrate that functional decline and recovery trajectories are similar across age, yet there was a general pattern of blunted anabolic signaling in older versus younger adults, which might provide the molecular basis for impaired functional adaptations over repeated eccentric exercise bouts. The second part of this talk will explore the application and utility of omics for gaining deeper insight into the age-related molecular responses to eccentric exercise. Using a transcriptional approach, we identified contraction 'responsive' modules (related to 'cell adhesion' and 'transcription factor' processes) that correlated with the magnitude of post-eccentric exercise muscle strength decline, and thus may be novel molecular candidates of functional relevance to ageing muscle adaptation. The third and final part of this talk will explore the impaired adaptability of ageing muscle to eccentric exercise training. Using a mouse model, we found 5 weeks of eccentric training increased strength in younger but not older mice, which was associated with downregulated cellular respiration/oxidative phosphorylation, and upregulated extracellular matrix organization, gene responses in older mice. These molecular signatures may reveal, in part, why older muscles do not appear to be as adaptive to eccentric exercise training as young muscles. Combined, our data detail physiological and molecular responses to acute and chronic eccentric exercise, highlighting several potential molecular candidates worthy of further research as potential therapeutics for optimising adaptation to eccentric exercise.

**HUMAN MUSCLE ADAPTATIONS TO ECCENTRIC EXERCISE THROUGH AN INTEGRATIVE PHYSIOLOGY APPROACH: MATCHING MORPHOLOGY TO CONTRACTILE PERFORMANCE**

FRANCHI, M.
*UNIVERSITY OF PADOVA*

Eccentric exercise is regarded as one of the most potent stimuli for muscle remodelling owing to the marked tension produced during eccentric contractions. Nevertheless, within the last decades, a limited number of studies have focused on eccentric contraction-induced remodelling with an integrative physiological approach (from the macro-to-the-micro), trying to unravel either with models or in humans the possible connections between changes in structure and function. The first part of this talk will provide an up-to-date description of evidence for the mechanisms responsible for regulating muscle structural and molecular adaptations to different modalities of eccentric training, where I discuss the role of mechanotransduction in muscle remodelling in young and older age. The second part of the talk will present unpublished data on muscle morphological, functional and molecular response to concentric vs. eccentric loading in young vs. older age. This part will be linked to the first talk by Dr Colleen Deane, as data in older males on downregulation of cellular respiration/oxidative phosphorylation to eccentric training will be presented in support of Dr Deane's data in animal models. In fact, skeletal muscle aging is not only characterized by loss of muscle mass and power but also by mitochondrial impairments and reduced oxidative function. Despite the positive effect on muscle mass and strength, our data point towards dampened mitochondrial biogenesis, reduced mitochondrial content, and promoted fission in older males in response to moderate-load eccentric training. This is of particular interest, as eccentric training often shows positive neuromuscular adaptations in elderly populations but may not be entirely suitable for counteracting reductions in oxidative function. I will conclude with unpublished data related to muscle structural and functional adaptations to 6 weeks of conventional resistance training (concentric + eccentric phase) performed with or without the use of eccentric overload. Using ad hoc ultrasound protocols during ramped isometric contractions and synchronized High-Density EMG, I will discuss changes in architectural behaviour of fascicles at rest and during contraction, and their relation to motor unit properties and muscle function. From our pilot data, it appears that distinct structural adaptations provided by eccentric overload match differences in muscle fascicle behaviour and mechanical function. This topic Is of broad interest for sport scientists, kinesiologists, biomechanics professionals and researchers, physiologists, and will complement Dr Deane's talk, while laying the ground for Dr Geoff Power's work on how sarcomerogenesis can influence muscle mechanical function in older age. Our intention is to provide the most updated view on eccentric loading in skeletal muscle.

**IMPLICATIONS OF ECCENTRIC EXERCISE-INDUCED SERIAL SARCOMEROGENESIS IN OLD AGE ON MUSCLE MECHANICAL FUNCTION**

POWER, G.
*COLLEGE OF BIOLOGICAL SCIENCES, UNIVERSITY OF GULEPH*

My Lab is interested in the effects of chronic changes to muscle fascicle length on mechanical function in old age. Here we use a F344BN aged rodent model (~32 month) to explore how eccentric exercise may stimulate sarcomerogenesis - the addition of sarcomeres in series – for improvement of muscle mechanical function. Understanding muscle design helps predict functional changes and counteract effects of aging. Muscle fascicle length gets shorter with age due to the loss of sarcomeres aligned in series. This loss of serial sarcomere number (SSN) contributes to declining muscle mechanical function including reduced active force, power, and increased passive stiffness. Due to the relationship between SSN and biomechanical properties of muscle, interventions promoting the addition of sarcomeres in series have been suggested to mitigate age-related impairments in muscle mechanical function. A common intervention for serial sarcomerogenesis is resistance training biased to active lengthening (i.e., eccentric) contractions. In young healthy rats and rabbits, eccentric training has increased SSN by up to 8%, and in humans SSN adaptations have been mostly assumed by increases in FL as measured by ultrasound. Through a series of studies, we investigated the ability for aged muscle to add sarcomeres in series and improve muscle mechanical function during re-ambulation after casting and following eccentric training. In 3 studies age-related differences in sarcomerogenesis and mechanical function were investigated following: (1) 2 weeks of plantar flexor immobilization then 4 weeks of ambulatory recovery; (2) 4 weeks of maximal eccentric plantar flexion training; and (3) 4 weeks of submaximal eccentric training. The soleus was assessed for SSN via laser diffraction. In-vivo measures of strength, passive stiffness, and power assessed changes in mechanical function. (1) Immobilization induced similar losses of SSN (-20%) and isometric strength (-40%) in young and old. Both young and old recovered SSN following immobilization, however, old took twice as long as young, and only young recovered strength. (2) Following maximal eccentric training, young exhibited increased SSN and strength, however, old exhibited no changes in SSN and became 35% weaker, 63% less powerful, and 51% stiffer. (3) Following submaximal eccentric training SSN increased 11%. Training also shifted optimal torque production towards longer muscle lengths, reduced passive torque 42%, and increased peak isotonic power 23%. Our results indicate that old retain the ability to re-add SSN following disuse, but did not increase SSN following maximal eccentric training. Impressively, submaximal eccentric training brought SSN in old back to the level of young rats and improved muscle function. Our results show, for the first time, that aged muscle retains the ability for serial sarcomerogenesis, making SSN an appealing target to improve mechanical function in older adults. Supported by: NSERC

Invited Symposium

IS-MH04 Why is elite athlete oral health so poor and what can we do to reverse the performance impacts?

**ORAL HEALTH, INFLAMMATION, ELITE ATHLETES AND PERFORMANCE MEDICINE**

NEEDLEMAN, I.
*UCL EASTMAN DENTAL INSTITUTE*

Our studies across Olympic games, elite squads and sports federations show a remarkably consistent pattern; elite athletes have high levels of oral diseases which are higher than non-athlete populations despite being easily preventable. Importantly, we have also shown that oral health negatively affects self-reported athlete performance with new data indicating impacts on objective laboratory parameters such as VO2max. These observations are consistent with other effects of oral health such as impairment of glycaemic control. This presentation will summarise what we know about oral health in elite athletes and its determinants. It will also review what we know about the mechanisms linking oral health with systemic health and performance. Finally, the presentation will review what we know about how best to promote oral health within high performance sport including interventions developed in partnership with athletes. The topic is directly relevant to the health, daily wellbeing and performance of athletes. The target audience includes not only sports medicine clinicians and scientists but also athletes and their support staff.

**EXERCISE, ORAL MICROBES, AND PERFORMANCE: A COMPLEX INTERPLAY**

BURLEIGH, M.
*THE UNIVERSITY OF THE WEST OF SCOTLAND*

Emerging research demonstrates the complex relationship between exercise and the oral microbiome, revealing that exercise can influence oral health both positively and negatively. Oral health is closely tied to microbial composition and function and is an often overlooked, yet critical, component of an athlete's performance and overall well-being. While factors such as high-carbohydrate diets, frequent energy drink consumption, dehydration, and immune suppression following intense training can compromise oral health, recent data from our laboratory, suggest that physically active individuals—those habitually meeting the minimum exercise recommendations—tend to have healthier oral microbiome profiles compared to sedentary individuals. Active individuals exhibit a balanced microbial environment, which may contribute to improved oral and systemic health. This stands in contrast to previous research that shows elite athletes, particularly those involved in high-intensity training, often suffer from poorer oral health outcomes, likely due to the cumulative effects of dietary choices, reduced salivary flow, and the heightened physical demands of their training regimens. The oral microbiome is highly sensitive to changes in diet, hydration, and immune function—all of which are influenced by exercise. Regular, moderate exercise appears to promote microbial diversity, supporting a healthier balance of bacteria in the mouth. However, in elite athletes, the stress of demanding training, coupled with other risk factors, can lead to an environment that fosters pathogenic bacteria, increasing susceptibility to oral diseases such as dental caries, gingivitis, and periodontitis. This dual impact of exercise on the oral microbiome underscores the need for a nuanced understanding of the relationship between exercise and oral health. While the focus of this lecture is on the general athlete population, female athletes present a compelling area for future research. Hormonal fluctuations related to menstruation, pregnancy, and menopause may further influence the composition and health of the oral microbiome. Female athletes, especially those at risk of relative energy deficiency in sport (RED-S), may experience compounded oral health challenges due to nutritional deficiencies and compromised immune function, warranting further investigation. This talk will detail the current understanding of how exercise affects the oral microbiome, examining both the positive and negative outcomes associated with different levels of physical activity. We will explore the implications for athlete oral health management and suggest areas for future research, particularly in understanding female-specific factors that could influence oral microbial balance. The session will be of interest to athletes, sports scientists, oral health professionals, the athlete support team and anyone involved in athlete support and well-being.

**NO LIMITS? THE POTENTIAL OF DIETARY NITRATE SUPPLEMENTATION TO IMPROVE ORAL HEALTH IN ATHLETES**

EASTON, C.
*UNIVERSITY OF THE WEST OF SCOTLAND*

Nitric oxide is a key signalling molecule that regulates a multitude of physiological processes, including immune function, vascular tone, and neurotransmission. Nitric oxide is generated endogenously via nitric oxide synthase enzymes, but this process is downregulated with ageing and underpins progressive endothelial dysfunction and a range of other age-related disorders. However, circulating nitric oxide levels can be enhanced via the ingestion of nitrate-rich vegetables, including beetroot. The nitrate is converted to nitrite by certain species of bacteria in the mouth and further reduced to nitric oxide when certain physiological conditions prevail. There is now a plethora of research which demonstrates that increasing nitric oxide levels through dietary nitrate supplementation can improve cardiovascular health and exercise performance. There is also emerging evidence to suggest that nitrate supplementation can improve markers of oral health. Data from our lab, for example, has shown that nitrate-rich beetroot juice can increase the pH of saliva and significantly alter the composition of the oral microbiome in favour of oral health. We have also shown that beetroot juice atten-

uates the decline in salivary pH following the ingestion of sugar-rich and acidic sports supplements. Dietary nitrate, therefore, may provide athletes with both an ergogenic advantage and an effective means to protect their oral health. This presentation will discuss the role of the oral microbiome in the regulation of nitric oxide availability and will review the emerging evidence on the potential of dietary nitrate supplementation to reduce the incidence of oral health issues in athletes or treat those where oral disease is already present. This talk will be of interest to athletes, support teams, and sporting bodies with a commitment to athlete well-being in addition to academics with research interests in immune function, sport nutrition, and nitric oxide physiology.

## Oral Presentations

### OP-PN03 Endurance Physiology I

**HABITUAL EXPOSURE TO EXERCISE-INDUCED HYPOHYDRATION ATTENUATES THE DECLINE IN RUNNING PERFORMANCE WHILST HYPOHYDRATED IN MALE ENDURANCE RUNNERS**

CABLE, T., FUNNELL, M., MEARS, S., JAMES, L.

*LOUGHBOROUGH UNIVERSITY*

INTRODUCTION: Exercise-induced hypohydration (EIH) impairs endurance performance, with field data suggesting well-trained runners regularly experience EIH during training and competition. It is unclear if habitual exposure to EIH in such athletes attenuates the hypohydration-induced performance decline. Thus, this study assessed the impact of habitual exposure to EIH on performance and physiology responses whilst hypohydrated in runners habituated (H) and non-habituated (NH) to EIH.

METHODS: 11 habituated (H: VO2peak 63 ± 9 mL/kg/min) and 10 non-habituated (NH: VO2peak 60 ± 7 mL/kg/min) athletes completed familiarisation (ad-libitum water intake) and 2 experimental trials, involving a treadmill preload (PL; 8-11 x 6 min at 70% VO2peak, 1 min rest; standardised within participant) and a 3 km time-trial (TT) in 28°C. Water replacement (80% mass loss; EU) or minimal water intake (100 mL; HH) was provided during PL, aiming for ~3% total body water (TBW; via bioelectrical impedance) loss in HH. Venous blood and nude mass measures were made pre-PL, post-PL and post-TT, with gastrointestinal (GI)/skin temperature, heart rate, perceptual responses and oxygen uptake measured throughout. 3 km TT performance was the primary outcome.

RESULTS: Post-PL relative TBW loss in EU (H -1.1 ± 0.4%; NH -1.0 ± 0.2%) and HH (H -3.4 ± 0.8%; NH -3.2 ± 0.2%) was not different between groups ($P \geq 0.227$). Hypohydration increased heart rate, RPE and thirst ($P \leq 0.046$), decreased body mass and plasma volume ($P \leq 0.003$), but did not alter GI or skin temperature, oxygen uptake, running economy, GI comfort or thermal sensation ($P \geq 0.129$). However, there were no trial*time*group interactions for any physiological or perceptual variables during PL ($P \geq 0.198$). There was a trial*group interaction for 3 km TT performance (P=0.041), with NH athletes 4.2% slower in HH (EU 817 ± 43 s; HH 855 ± 60 s; P=0.013), but H athletes not different between trials (EU 703 ± 83 s; HH 708 ± 78 s; P=0.658). During TT, there was a mean effect of group where NH had a 0.4°C greater GI temperature compared to H (P=0.004). During familiarisation, NH drank more water ad-libitum (H 0.50 ± 0.24 L; NH 0.85 ± 0.42 L; P=0.031), meaning hypohydration was greater in H athletes (H -1.6 ± 0.4%; NH -1.1 ± 0.4%; P=0.021).

CONCLUSION: These data demonstrate that EIH impairs endurance performance in non-habituated athletes only, but no differences were observed between groups for physiological or perceptual variables. Interestingly, during TT, NH athletes had a greater GI temperature, indicating impaired thermoregulation during running performance, potentially exacerbating the effects of hypohydration. The greater ad-libitum water intake and lower hypohydration in NH runners indicates differences in hydration behaviour that might explain some of the observed performance effects. These results suggest that regular exposure to and familiarisation with EIH may attenuate the expected decline in performance whilst hypohydrated.

**EFFECT OF HYPOXIC EXPOSURE AT DIFFERENT TIMINGS ON IRON REGULATION AND HEMATOPOIESIS AFTER ENDURANCE EXERCISE**

LIN, C., NATSUI, T., TOMIISHI, C., TSUYUKI, M., GOTO, K.

*RITSUMEIKAN UNIVERSITY*

INTRODUCTION: Strenuous exercise increases circulating hepcidin levels during post-exercise, potentially contributing to the reduced iron storage in individuals who engage in regular physical activity. While prolonged exposure to hypoxia, lasting days to weeks, suppresses hepcidin levels and enhances iron absorption, interest is growing in short-term exposure to hypoxia that can be integrated into athletes' training routines. The present study aimed to examine the effects of acute hypoxic exposure at different timings on exercise-induced hepcidin responses.

METHODS: Twelve healthy individuals (5 women, 7 men; age: 23 ± 2 years; height: 169.9 ± 8.3 cm; body mass: 62.4 ± 8.1 kg) participated in a single-blind, randomized, cross-over design study. They completed high-intensity interval running under three different conditions on separate days: (1) normoxic control (CON; resting in normoxia before and after exercise), (2) pre-exercise hypoxic exposure (Pre-HYPO; 2-hour exposure to hypoxia before exercise), and (3) post-exercise hypoxic exposure (Post-HYPO; 2-hour exposure to hypoxia after exercise). The fraction of inspired oxygen was 12.5% in the hypoxic environment and 20.9% in the normoxic control environment. The exercise protocol consisted of eight sets of 4-

minute running intervals at 85% of maximal oxygen uptake in a normoxic environment. Venous blood samples were collected at 2 hours before exercise (baseline), immediately before, immediately after exercise, and 3 hours post-exercise. Blood analyses included measurements of serum iron, ferritin, erythropoietin (EPO), and hepcidin levels.

RESULTS: Serum EPO levels increased significantly immediately after exercise and 3 hours post-exercise in both Pre-HYPO and Post-HYPO trials ($p < 0.05$ vs. baseline). The immediate post-exercise EPO response was greater in Pre-HYPO trial (45.7 ± 15.9% increase from baseline) than in the CON trial (3.4± 17.5%, $p < 0.05$). At 3 hours post-exercise, EPO was still higher in both Pre-HYPO trial (53.0 ± 31.5% increase from baseline) and Post-HYPO trial (50.0 ± 24.1%) than in CON trial (11.9 ± 16.8%, $p < 0.05$). Serum hepcidin elevated at immediately after exercise and 3 hours post-exercise compared to baseline ($p < 0.05$). However, the serum hepcidin level did not differ significantly among the three trials at any time points ($p > 0.05$). No significant differences among the trials were observed for serum iron or ferritin ($p > 0.05$).

CONCLUSION: Both "pre-exercise hypoxic exposure" and "post-exercise hypoxic exposure" enhanced EPO secretions in young women and men. However, despite the increased erythropoietic responses, exercise-induced elevations in serum hepcidin were not suppressed with pre-exercise hypoxic exposure or post-exercise hypoxic exposure.

**INDIVIDUAL RESPONSES TO 8 WEEKS OF AEROBIC INTERVAL TRAINING ARE PARTIALLY REPRODUCIBLE**

ODDEN, I., HAMARSLAND, H., URIANSTAD, T., HAMMARSTRÖM, D., ROGNEFLÅTEN, T., HANSEN, J., ELLEFSEN, S., RUSTADEN, A.M., NYGAARD, H., RØNNESTAD, B.R., LUNDBY, C., MØLMEN, K.S.

*INLAND NORWAY UNIVERSITY OF APPLIED SCIENCES LILLEHAMMER*

INTRODUCTION: The ability to adapt to exercise training varies among individuals, raising concerns about the uniformity of health benefits derived from training interventions [1]. Central to this issue is the concept of high- and low-responders to exercise training, which assumes that the ability to adapt to a specific exercise prescription is a fixed trait of individuals [2]. However, when small groups (n=10-19) of young, moderately trained individuals are repeatedly exposed to identical aerobic training programs, individual training responses are not consistent [3-6]. Whether these observations extend to other populations and larger sample sizes are currently unknown. Hence, the present study examined whether individual responses to two identical aerobic training interventions are reproducible in middle-aged, untrained males and females.

METHODS: Forty-two untrained but healthy men and women (♀ 21; ♂ 21; age, 54±9 years; maximal oxygen uptake (VO2max), 32±7 mL/min/kg) underwent two identical 8-week aerobic training interventions (ET-1 and ET-2), separated by an 8-week wash-out period. ET-1 and ET-2 included 24 supervised 45-min interval sessions, alternating between high-intensity (4×5 min and 4×8 min) and moderate-intensity (6×6 min) cycling exercise. Participants´ VO2max, maximal 1-min power output during the VO2max test (MPOVO2max), and maximal 15-min mean power output (MMPO15min) were determined before and after each intervention period. The reproducibility of pre-test values and change scores across ET-1 and ET-2 was determined using intraclass correlation coefficients (ICC). Pearson correlation coefficients (r) were used to evaluate the strength and direction of the relationships between scores. 95% confidence intervals (CIs) were calculated to interpret the results.

RESULTS: At the onset of ET-1 and ET-2, VO2max, MPOVO2max, and MMPO15min demonstrated excellent reproducibility and very strong associations between training interventions (ICC = 0.96-0.98, r = 0.97-0.98, 95% CIs not including zero). Changes in MPOVO2max and MMPO15min during ET-1 and ET-2 exhibited some level of reproducibility (ICC = 0.35 and 0.29, respectively) and weak associations (r = 0.38 and 0.32, respectively), with 95% CIs not including zero. In contrast, changes in VO2max were neither reproducible nor correlated (95% CIs including zero).

CONCLUSION: When exposed to two identical aerobic training interventions, individual changes in MPOVO2max and MMPO15min were partially reproducible in middle-aged, untrained males and females. In contrast, VO2max changes were not. These findings challenge the notion of fixed high- and low-responders to exercise training and question the predictability of individual responses to exercise training prescriptions based on the observed response to a single training period.

References

[1] Joyner & Lundby 2018. Exerc Sport Sci Rev. [2] Senn 2004. Bmj. [3] Del Giudice et al. 2020. JSAMS. [4] Jacques 2023. EJSS. [5] Islam et al. 2021. JSAMS. [6] Voisin et al. 2019. Exerc Sport Sci Rev.

**SIX WEEKS OF LOW INTENSITY ENDURANCE RUNNING TRAINING IMPROVE TRADITIONAL PERFORMANCE MARKERS BUT NOT VASTUS LATERALIS OXYGEN SATURATION**

SKOTZKE, P., SCHWINDLING, S., VOLKAMER-KIEN, B., ZWIENER, L., RICHRATH, O., MEYER, T.

*SAARLAND UNIVERSITY*

INTRODUCTION: Recent technological developments have enabled measuring local muscle oxygen saturation (SmO2) non-invasively during exercise. Changes in traditional performance markers following endurance training like the first and second lactate threshold (LT1, LT2), maximal velocity (vmax), running economy (RE) and VO2peak during a graded exercise test (GXT) are well documented. The Bohr effect provides a physiological link between lactate and SmO2. Still, it remains unclear how submaximal SmO2 and muscle deoxygenation (SmO2min) at the end of a GXT change following endurance training.

METHODS: In a within-subject repeated-measures design, n = 46 healthy sport science students (26 m, 20 f, 21.8 ± 1.5 yrs, 71 ± 10 kg, VO2peak 48.3 ± 5.6 ml/min/kg, recreationally active to trained) completed a 6-weeks running training pro-

gram (END) after a control period of normal training (CON). During END, participants performed 18 (± 3) 45 min runs (90% compliance) at the heart rate corresponding to their first lactate threshold (± 5 bpm) in addition to their normal training. Training diaries were used to document training load as duration x sRPE (in arbitrary units, AU). GXTs (6 + 2 km/h every 3 min) were performed before (T1) and after CON (T2) as well as after END (T3). SmO2 at the vastus lateralis muscle (VL) was measured using continuous-wave near-infrared spectroscopy (NIRS, Moxy Monitor) as well as capillary lactate concentration and VO2.

RESULTS: Weekly training load during END increased significantly by 24% compared to CON (+280 AU/wk, $p < 0.01$). Repeated measures ANOVA showed significant ($p < 0.01$) overall effects of time for LT1 , LT2 and vmax, but not VO2peak ($p = 0.06$). Post hoc analysis revealed significant differences between T2 and T3 for LT1 (+0.6 km/h, $p < 0.01$, $d = 0.88$), LT2 (+0.8 km/h, $p < 0.01$, $d = 0.95$) and vmax (+0.7 km/h, $p < 0.01$, $d = 0.68$). No differences were found between T1 and T2 ($p>0.05$). A linear mixed model revealed a significant fixed effect for timepoint: RE increased for all submaximal stages from T1 to T2 (-1.5 ml/min/kg, $p<0.01$) and from T2 to T3 (-1.6 ml/min/kg, $p<0.01$). Neither submaximal SmO2 ($p = 0.61$, T1 = 53.6 ± 12.9 % ,T2 = 55.1 ± 14.8 %, T3 = 56.0 ± 12.3 %) nor SmO2min ($p = 0.054$, T1 = 37.3 ± 18.6 %, T2 = 33.6 ± 16.3 %, T3 = 28.6 ± 17.4 %) showed a significant change.

CONCLUSION: The intervention was sufficient to induce adaptations in classical performance markers, but SmO2 parameters remained unchanged. This suggests that SmO2 – unlike lactate kinetics – might not be altered by 6 weeks of low intensity endurance training in moderately trained sport students. Whether SmO2 shows no changes following endurance training or if a longer intervention duration or higher training intensity are necessary to elicit adaptations requires further research and should consider the influence of adipose tissue thickness on SmO2. The improvement in vmax despite lacking changes in VO2peak can be explained by an improved running economy.

**CONCURRENT STRENGTH AND ENDURANCE TRAINING IMPROVES CYCLING POWER OUTPUT IN YOUNG MALE CYCLISTS WITHOUT AFFECTING $VO_2$MAX OR STRENGTH MEASURES**

ŽITNIK, J., ŠARKO, P., SMAJLA, D.

*UNIVERSITY OF PRIMORSKA - FACULTY OF HEALTH SCIENCES*

INTRODUCTION: Concurrent training involves combining resistance and endurance exercises within a structured training program (1). While some studies have investigated its effects in children (2,3), to our knowledge, no studies have explored concurrent training in young cyclists. Our aim was to evaluate the effects of a 7-week concurrent training intervention on endurance performance, body composition, and lower-body strength and power in young male cyclists.

METHODS: Fourteen young male cyclists (11–14 years; intervention: n = 8, control: n = 6) with ≥2 years of regular training (≥2 days/week) participated (age: 12.3 ± 0.4 vs. 12.7 ± 1.0 years; height: 151.8 ± 7.0 vs. 162.7 ± 7.7 cm; body mass: 40.6 ± 4.9 vs. 48.8 ± 7.7 kg; maximal oxygen uptake [$VO_2$max]: 56.3 ± 6.2 vs. 57.2 ± 6.9 mL/kg/min, control vs. intervention). Baseline assessments included body composition (bioelectrical impedance), lower-body strength (maximal voluntary contraction [MVC] for knee extension and flexion), lower-body power (countermovement jump [CMJ] and squat jump [SJ] height), and an incremental cycling test to determine maximal power output (Pmax), time to exhaustion (Tlim), and $VO_2$max (indirect calorimetry). The 7-week intervention consisted of concurrent endurance and strength training (intervention: 2 × 1 h strength + 2 × 1.5 h endurance sessions/week; control: endurance training-only with matched duration and intensity). Post-intervention, all tests were repeated. Linear mixed models were used to assess changes over time, with baseline values included as covariates. Relative change score differences between groups were also evaluated. Data are presented as mean ± SD. Significance was set at $p < 0.05$.

RESULTS: The 7-week concurrent training intervention resulted in significant improvements in maximal power output Pmax (+7,3%, $p = 0.027$, $d = 1.33$, 95% CI [0.99, 13.68]) and PmaxRel (+6.2%, $p = 0.044$, $d = 1.19$, 95% CI [0.20, 12.19]) in the intervention group compared to controls. No changes were observed in Tlim (+9.5%, $p = 0.075$, $d = 1.03$, 95% CI [-1.13, 20.11]) in the incremental test. $VO_2$max showed no significant changes between groups over time ($p = 0.394$). No significant group × time interactions were observed for body composition (fat mass, $p = 0.127$; fat percentage, $p = 0.322$; fat-free mass, $p = 0.774$) or lower-body strength (knee extension MVC, $p = 0.397$; knee flexion MVC, $p = 0.979$). Similarly, lower-body power (CMJ height, $p = 0.805$; SJ height, $p = 0.101$) showed no significant changes between groups over time.

CONCLUSION: Concurrent strength and endurance training intervention in young cyclists demonstrated significant improvements in relative and maximal power output without concomitant increases in maximal oxygen uptake or other strength measures. Future studies with larger sample sizes and longer intervention durations are needed to verify these findings and further explore the potential benefits of concurrent training in this population.

1.Seipp et al. (2023) 2.Marta et. al (2013),3. Alves et al. (2016)

Oral Presentations

OP-AP06 Talent Identification

**INHERITABLE TRAITS: MUSCLE FIBRE TYPOLOGY OF ELITE FEMALE ATHLETES**

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INTRODUCTION: Elite performance in sports is closely linked to an athlete's muscle fibre composition, with endurance specialists typically exhibiting a predominance of type I (slow-twitch) fibres, while power and sprint athletes tend to have a higher proportion of type II (fast-twitch) fibres. A precise understanding of muscle fibre typology is valuable for guiding athlete development, refining training programs, and optimizing race strategies. However, much of these data are based on studies of male athletes and little is known about the muscle fibre typology of elite female athletes. This gap likely stems from both the historically low representation of elite female athletes in sports performance research [1] and the reliance on invasive muscle biopsies as the primary assessment method.

METHODS: This study utilized proton magnetic resonance spectroscopy ($^1$H-MRS), a non-invasive imaging technique that estimates muscle fibre typology by measuring muscle carnosine levels [2]. More than 110 elite female athletes from diverse sports—such as athletics, swimming, cycling, kayaking, rugby league, and Australian football—underwent assessments. Carnosine concentrations were recorded in the soleus, gastrocnemius, and deltoid muscles and analysed as Z-scores against a reference population. Athletes were categorized as type I or type II dominant if their Z-scores exceeded ±0.5.

RESULTS: Athletes specializing in explosive, power-based disciplines—including sprinting (across multiple sports), weightlifting, jumping, and throwing—had an average Z-score of +0.71, reflecting a strong type II fibre predominance. In contrast, those competing in middle-distance events or team sports exhibited more balanced muscle fibre typology, with an average Z-score of +0.15. Meanwhile, endurance athletes participating in distance events in athletics, cycling, and swimming displayed a Z-score of -0.75, consistent with a higher proportion of type I fibres.

CONCLUSION: Muscle fibre typology varies significantly among elite female athletes, not only across sports but also between event specializations within the same discipline. These findings underscore the usefulness of non-invasive muscle fibre estimation for identifying athletic potential, refining talent development strategies, and tailoring training programs to maximize performance outcomes.

1. Cowley et al. (2021); 2. Baguet et al. (2011)

**FACTORS RELATED TO PULL-UP PERFORMANCE: SMALL RELATIONSHIP BETWEEN BRACHIAL INDEX AND PULL-UP ONE REPETITION MAXIMUM IN CANADIAN RECREATIONAL TO COMPETITIVE CALISTHENICS ATHLETES**

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INTRODUCTION: Pull-ups (PU) are a popular exercise used in resistance training programs. Anthropometrics like total body mass, and fat mass generally affect PU performance.[1,2] However, the relationships of arm lengths or length-ratios on sport and exercise performance varies.[3,4,5,6,7] The brachial index (BI) is defined as the quotient of forearm length (radiale to stylion) and upper arm length (acromiale to radiale). The aim of this study was to investigate the relationship between BI and PU performance and determine differences between high and low performing groups.

METHODS: Thirty male recreational to competitive calisthenics athletes, age 26±5.2 years, body mass 75.5±10.85kg, fat mass 14.2±4.8kg, and height 173±5.38cm, reported to the testing location on a single occasion for anthropometric and performance testing. Participants completed a survey to determine eligibility and provided informed written consent. The protocol was approved by the Sheridan Research Ethics Board prior to commencement. Anthropometric testing included measurement of body mass (BM), height, selected arm lengths, girths, and skinfolds. Performance testing consisted of a one repetition maximum (1RM) PU test which was equal to 1RM load and BM, and mean velocity (MV) at 1RM, 80% 1RM, and BM loads. Pearson's product moment correlation coefficients were used to investigate the relationship between variables, and two-tailed, homoscedastic students t-tests were performed to compare differences between groups.

RESULTS: A small positive relationship was found with BI and all variables of performance. No significant differences were found between high and low BI groups for any variable. However, significant differences ($p<0.05$) were found between groups, with the high strength group (>/=122.4kg 1RM, n=15), having greater body mass, flexed upper arm, chest, and thigh girth, as well as bicep, waist, and thigh corrected girth, lean body mass, body mass index, Brugsch index, and Takai's equation than the low strength group (<122.4kg 1RM, n=15). The high MV at BM load group (>/=0.905m/s, n=15) had non-significant lower chest skinfold (p=0.06), abdominal skinfold (p=0.08), sum of skinfolds (p=0.09), and hip girth (p=0.1), while having a greater BI (p=0.08), flexed upper arm to thigh girth ratio (p=0.051), and significantly greater measures of performance than the low MV at BM load group (<0.905m/s, n=15). Lastly, a positive medium correlation (r=+0.42, n=30) was found with total 1RM load and BM PU MV, which is similar to prior data on first repetition concentric velocity and PU repetitions.[7]

CONCLUSION: BI should not be used for talent selection in the sport of street-lifting. Athletes wishing to maximize 1RM strength and MV in the PU exercise should focus on the accrual of lean mass in the PU prime movers and decreasing excess fat mass.

1.Halet (2009) 2.Sanchez-Moreno et al., (2016) 3.Crossland et al., (2011) 4.Hamano et al., 2015 5.Caruso et al., (2012) 6.Reya et al., (2021) 7.Beckham et al., (2018)

**AEROBIC ENDURANCE, AGILITY, AND STRENGTH: KEY FITNESS PREDICTORS OF SUCCESS IN ELITE JUNIOR TENNIS PLAYERS**

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INTRODUCTION: The relationship between physical fitness and tennis performance in elite junior players remains a significant area of interest. Specifically, understanding how various fitness components influence on-court performance can provide valuable insights for optimizing training regimens. This study aims to investigate how fitness characteristics correlate with the competitive success of elite junior tennis players in China, focusing on differences between players with high and low semi-final list rates across different age groups (U12, U14, U16).

METHODS: A total of 600 fitness test data points were collected throughout 2024 from elite junior tennis players (U12, U14, U16). Players were categorized into high (HSR) and low (LSR) semi-finalist rate groups using K-means clustering, based on the percentage of times they reached the semi-finals relative to the total number of tournaments they participated in during the competitive season. The dataset includes multiple testing instances for each player, as athletes who did not pass a fitness test were required to retake it. The players underwent a comprehensive battery of fitness tests, assessing strength, power, endurance, agility, flexibility, and balance. Performance was quantified using a points system derived from players' tournament rankings. A generalized linear model (GLM) was used to compare the fitness characteristics between the HSR and LSR groups. Additionally, bivariate correlation analyses were conducted to examine the relationship between fitness test results and performance scores.

RESULTS: Significant differences were found in fitness characteristics between HSR and LSR groups across various age and gender categories.

- U12 female: double jump rope (183±63.3vs261±41.5, ES=1.46**), medicine ball throw (7.82±1.26vs8.65±0.947, ES=0.74*), and shuttle run (1251±387vs1576±254, ES=0.99**).
- U12 male: double jump rope (186±69.7vs248±38.9, ES=1.10**) and shuttle run (1405±355vs1810±215, ES=1.38**).
- U14 female: double jump rope (204±61vs250±42.4, ES=0.88**), medicine ball throw (8.84±1.27vs10.5±0.786, ES=1.57***), and shuttle run (1428±328vs1700±233, ES=0.96*).
- U14 male: push-ups (24.7±6.89vs27.4±5.47, ES=0.43*).
- U16 female: double jump rope (223±80vs292±39, ES=1.10*).
- U16 male: no significant differences in any fitness tests.

Bivariate correlation analyses revealed moderate to strong positive correlations between aerobic endurance (r=0.40–0.50), agility (r=0.29–0.50), while strength had moderate correlations (r=0.23–0.41). Balance and muscular endurance showed weaker correlations (r=0.20–0.30).

CONCLUSION: Aerobic endurance, agility, and strength play significant roles in determining competitive success in junior tennis players. The findings suggest that players with a higher semi-final list rate exhibit superior fitness levels in endurance and agility. Coaches and sports scientists should emphasize these key attributes when designing training programs to optimize the performance and success of young tennis athletes.

**DIFFERENCES IN ISOMETRIC STRENGTH AND SPRINTING SPEED OF ACADEMY SOCCER PLAYERS: A SPECIAL FOCUS ON TRANSITION BETWEEN AGE GROUPS**

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INTRODUCTION: Physical and psychosocial development of athletes fluctuates within the various age groups [1]. Despite their minor chronological age, soccer players frequently advance to the superior age groups. However, the neuromuscular development of these athletes must not be neglected, as later maturation and advanced chronological age are potential risk factors for injury in youth soccer [2]. This study compares the isometric strength and sprinting speed of elite academy soccer players. Highlighting differences among age groups may help with the talent identification procedures and injury prevention of players in soccer academies.

METHODS: This cross-sectional study compared a total of 83 academy players from five age groups (U14, U15, U16, U17, and U19) in absolute (N) and relative (N/kg) isometric peak force production in a bilateral 30-degree knee flexion test (ISO 30°), 60-degree abduction and adduction tests (ABD and ADD 60°). Their sprinting speed was compared by a 30-meter sprint test with a 10-meter split time and the 505 change of direction test (COD 180°). Isometric strength was measured by VALD NordBord and ForceFrame (Vald Performance, Newstead, Australia). Sprinting speed was assessed by photocells Witty GATE (Microgate, Bolzano, Italy). A one-way analysis of variance (ANOVA) with Tukey's post hoc test analysed strength and speed differences among age groups. The effect size (ES) was determined by calculating eta-square ($\eta 2$) while pairwise effects were expressed by Cohen's d.

RESULTS: Significant strength differences among the age groups were observed for ISO 30° (p = < 0.001; η2 = 0.40 [U14 < U16, U17, and U19; U15 < U17 and U19]), ABD 60° (p = < 0.001; η2 = 0.41 [U14 < U16, U17, and U19; U15 < U17 and U19]), and ADD 60° (p = < 0.001; η2 = 0.43; U14 < U15 to U19). The relative strength differences occurred only between U15 and U19 groups in ISO 30° (p = 0.043; ES = 1.04). The U14 players were slower in speed tests compared to U16, U17, and U19 (ES = 0.95 - 3.68) while the same pattern occurred for the U15 players (ES = 1.07 - 2.37). The U17 players were faster than U19 players in COD 180° (p = 0.019; ES = 0.22).

CONCLUSION: The major differences in isometric strength are visible between U14 and U16 academy soccer players. The most sensitive period for neuromuscular demands is their transition from the U15 to the U16 age group. We recommend placing a special focus on the analysis of the isometric adduction strength, linear speed, and COD speed in these age groups. There is a plateau in isometric strength and speed performance from U16 to U19 groups. In this period, other methods or factors must be considered when transitioning players to the superior age groups. Lastly, the COD speed should not be considered to analyse age-related differences between U17 and U19 players.

This work was supported by VEGA no. 1/0725/23.

1. Wattie, N. & Baker, J. (2018) 10.1057/978-1-137-48562-5_6

2. Read, P. J. et al. (2018). 10.1111/sms.13013

**INHERITABLE TRAITS: PROFILING ELITE FEMALE SPRINT KAYAKERS**

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INTRODUCTION: Athlete profiling is widely used in elite sport and commonly focuses on physical, physiological and psychological characteristics; however, this method of profiling can be limited due to modifiable factors such as health and training status, stage of maturation and task familiarity [1]. Alternatively, 65% of athlete performance is influenced by inherited traits and therefore profiling these traits may provide a more accurate assessment of performance potential [2]. This study aimed to profile 'inHERitABLE TRAITS' (i.e., muscle fibre typology; MFT, sex hormones and personality attributes) in a group of elite female sprint kayakers.

METHODS: Fourteen female sprint kayakers (KAY; international – world class status) and 64 recreationally active women (CON) were recruited. Proton magnetic resonance spectroscopy was used to estimate MFT in the upper and lower body. The concentration of sex hormones was determined following the collection of a venous blood sample. Personality attributes which have been previously correlated with sex hormones (i.e., competitiveness and willingness to take risks) were determined. Strength and K1 500-m event performances were also recorded to assess the interaction of 'inHERitABLE TRAITS' with performance metrics.

RESULTS: KAY were estimated to have a significantly greater proportion of type II fibres in the lower body (p=0.020) than the CON. Although MFT was not related to strength or K1 500-m performance, the most successful athletes in the 200 and 1000-m events possessed the most extreme MFT. There was no significant difference in hormonal profiles between KAY and the CON, however athletes who displayed an irregular menstrual cycle (>35-d) had significantly lower concentrations of sex hormones (p>0.05). Some sex hormones, most notably free testosterone, were significantly related to strength metrics (p>0.05). KAY reported a significantly higher enjoyment of sport experiences such as competition, risk taking and making progress (p=0.016). In these athletes' willingness to take risks and consistency of interest were significantly related to some sex hormones (p>0.05).

CONCLUSION: Despite there being no single inherent physiological profile for a successful female KAY, inHERitABLE TRAITS may be useful for performance support staff in predicting performance potential in a certain event and individualising training approaches for each athlete.

1.Wattie and Baker. (2018); 2. Lippi et al. (2010)

## Oral Presentations

### OP-AP04 Winter Sports

**PREDICTIVE VALUE OF PRESEASON STRENGTH TEST IMPROVEMENT ON ALPINE SKIING PERFORMANCE**

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INTRODUCTION: Alpine skiing performance needs strength, power, and balance, and high external forces and specific neuromuscular demands influence it. Traditional fitness assessments such as squat jump (SJ) and countermovement jump (CMJ) evaluate explosive power but may poorly address skiing's strength requirements due to high-force outputs occurring at low angular velocities [1]. While anaerobic and aerobic capacities have been explored, their relationship with performance is ambiguous [2]. This study examines whether preseason strength test enhancements correlate with FIS point progression in slalom (SL) and giant slalom (GS), providing insight into strength tests predictive value for skiing.

METHODS: Twenty-one alpine skiers were evaluated. Testing occurred at the preseason beginning (PRE) and conclusion (POST). The assessment battery comprised CMJ, SJ, and loaded squats at different body weight (BW) percentages. Peak force (PF), power, jump height, and velocity were quantified using a force platform [3]. Isometric strength was measured via belt isometric squat at 90°, 110°, and 130° knee angles, focusing on PF, early and late rate of force development (RFD), and maximum RFD. Pre-post differences were analyzed, and deltas between preseason tests were assessed. Competitive performance was quantified by the delta of FIS points between the seasons start and the best result achieved. Data were normalized via Z-score transformation. Statistical tools included Principal Component Analysis (PCA) to identify critical performance variables and multivariate regression to explore the relationships between predictor variables and competitive performance.

RESULTS: The PCA revealed nine components accounting for over 90% of the total variance, with the initial three components explaining 54%. The first principal component was peak power and velocity in loaded squats and CMJ PF. The second one is related to body composition and PF in SJ and isometric squat at 90°. Finally, the third component encompassed power and velocity at the highest squat load alongside various RFD metrics. Multivariate regression revealed that peak power during squat at 150% BW is the primary predictor of performance improvements in SL and GS, with positive coefficients indicating strong explanatory power for the enhancements in both disciplines (R2 = 0.67 and 0.66, respectively).

CONCLUSION: Results underscore the significance of lower-limb power output and high-load strength as pivotal factors in alpine skiing performance. Similar outcomes for SL and GS regression models suggest that enhancing maximum force production at slow movement velocities is more pertinent than augmenting fast, explosive movements. This indicates that conventional jump-based evaluations, which predominantly assess explosive power at elevated velocities, may inadequately capture the crucial strength attributes for skiing.

1 Javet et al. (2022); 2 Schoebersberger et al. (2020); 3 Penitente et al. (2023)

**SELECTION OF THE EXTREMES IN ELITE TEAMS: UNCOVERING THE INTERACTION BETWEEN THE RELATIVE AGE EFFECT AND BIOLOGICAL MATURITY TIMING IN SWEDISH ICE HOCKEY PLAYERS**

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INTRODUCTION: In youth sports, differences in biological maturation and relative age (RA) may lead to selection biases favouring early-born and early-maturing players due to advantages in psychological development and physique, respectively (1). However, no previous study has investigated the interaction of RA and biological maturity timing in ice hockey, considering elite junior and adult success.

METHODS: Between 1998 and 2017, longitudinal anthropometrical data was collected in certified Swedish high school ice hockey programmes. For 2211 players, biological maturity timing was computed as z-scores of % adult height (z%AH) at term 1, compared to a Swedish reference (2). Birth dates for these players were used to calculate numerical relative age. Retrospective data on selection to the Swedish U16 national team (Team 16) and the National Hockey League (NHL) were retrieved from open databases. Next, absolute counts and proportions of players selected for Team 16 and the NHL were tabulated across quartiles of RA and z%AH. Generalized logistic regression models (GLM) including the predictors RA, z%AH, and their interaction, as well as other relevant confounders, were used to analyse selection probabilities.

RESULTS: Distributions in RA and biological maturity timing differed significantly between Team 16 and the NHL. Considering Team 16, the group with the highest proportion of selected players was individuals born late in the year with early biological maturity timing (22%), although absolute counts in this group (n=13) were markedly less than in early-born players at any maturity timing, ranging from 21–28 selected players (10.8%–15.3%). In a GLM, RA and z%AH were independently identified as significant predictors of being selected for Team 16, and a significant interaction between RAE and z%AH was observed ($P < 0.05$). Considering adult success, players with late biological maturation timing (z%AH < -0.03) presented the highest proportion of players reaching the NHL, regardless of RA. Next, z%AH ($P < 0.01$), but not RA ($P = 0.24$), was significantly associated with NHL selection probabilities (favoring players who matured later than average), but there was no significant interaction between RA and z%AH ($P = 0.44$) in the employed GLM.

CONCLUSION: Overall, there were independent and joint associations between RA and biological maturity timing considering the national Team 16 selection. Here, early maturity timing may cancel out disadvantages due to low RA. In contrast, late biological maturity timing was positively associated with NHL selection, but there was no interaction with RA.

References

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2 Albertsson-Wikland, K. et al. Acta Paediatr. 109, 754–763 (2020)

**ISCHEMIC PRECONDITIONING DURING A CONCURRENT TRAINING MICROCYCLE: EFFECTS ON PERFORMANCE IN SHORT-TRACK SPEED SKATING ATHLETES**

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INTRODUCTION: Concurrent training is necessary for short-track speed skating performance.To optimize the benefits of these sessions in a context where athletes might face a diminishing return phenomenon [1], ischemic preconditioning (IPC) may be a promising strategy [2,3].

METHODS: Tier 3 and 4 [4] short track speed skaters (n=21) participated in this randomized crossover study with 2 microcycles including 1 strength session (3 sets of 6 reps and 1 set to failure of trap bar squats at ~85% of 1 RM, with 90 seconds of rest between series) and 1 sprint interval (SIT) session 48 hours later (2 sets of 6 all-out sprints of 15 seconds on a bike, with 2 min of rest between sprints and 4 min between sets). During the strength sessions, mean velocity for each repetition was recorded with a Gym Aware device (Kinetic Performance Technology, Australia). During SIT sessions, power outputs were recorded using a Kickr trainer (Wahoo, Unites States of America). In a random order (AB or BA), athletes performed a microcycle during which strength and SIT sessions were preceded by IPC (week A; 3 x 5 min at 220 mmHg followed by 5 min at 0 mmHg, on each thigh) or a placebo condition (week B; 3 x 5 min at 20mmHg). For strength sessions, the outcome of interest was the number of repetitions completed during the 4th set while for SIT, a percent decrement score (PDecr) was calculated for each set. Furthermore, 24 or 48 hours after SIT, an on ice 4-laps time-trial (TT) was performed. Athletes had 2 or 3 days of receovery between microcycles. During both microcycles, the load of on-ice training was equivalent and the sequence of experimental sessions was the same. Paired-sample T-tests compared performance during IPC and Placebo weeks. Repeated measures ANOVA (Condition*Sex) verified if the effects of IPC varied depending on the sex. Effects sizes were calculated using Hedges' g (rm).

RESULTS: Due to injuries unrelated to the protocol and equipment malfunction, the final sample size was 19 for strength outcomes (9F) and 20 for SIT and TT (10F). IPC improved significantly the mean number of repetitions to failure during the last set (+2.84 reps; $p = 0.015$; $g = 0.21$). No significant differences were observed for mean velocity maintained during this set ($p = 0.126$; $g = 0.07$). During the SIT sessions, for both sets, no significant differences were observed for PDecr (Set 1: $p = 0.556$; $g = 0.17$; Set 2: $p = 0.070$; $g = 0.52$). Similar TT performance has been observed between experimental conditions ($p = 0.294$; $g = -0.05$). No interactions were found between sex and performance outcomes.

CONCLUSION: IPC improves the total volume of repetitions performed to failure in short track speed skaters, which might indicate better resistance to fatigue. Furthermore, contrary to previous reports, adaptations were similar among males and females.

1.Thompson et al. (2024) 2. Rodrigues et al. (2023) 3. Cheng et al. (2021) 4. McKay et al. (2021)

**A PRACTICAL METHOD FOR ANALYSING ON-ICE DRAFTING SKILLS IN LONG-TRACK SPEED SKATERS.**

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INTRODUCTION: Drafting occurs when athletes closely follow behind one or more competitors to reduce aerodynamic resistive forces. Wind tunnel research has shown that with better drafting skills, the reduction in aerodynamic drag increases, resulting in lower energy expenditure (1). Although athletes and coaches are aware of the benefits of drafting, they do not specifically train to improve their drafting skills (2). A hurdle for training is the fact that measuring drafting skills in a practical setting is still a challenge and there is need for a feasible, reliable and valid method. Therefore, this study aims to develop a practical method for quantifying on-ice drafting skills in long-track speed skaters.

METHODS: A protocol has been developed to analyse video footage based on three key components of drafting skills: distance between the skaters, following in a straight line and takeover in de corners. Two independent raters evaluated the drafting skills of experienced skaters (n=29) using Dartfish. Additionally, an expert speed skating coach reviewed the video footage. Relative and absolute intra- and inter-rater reliability was determined by Intraclass Correlation Coefficients (9) and One-Sample T-tests (9). Concurrent validity was assessed using Spearman's rank correlation. Discriminative validity was assessed by categorizing the participants into three groups (good, moderate, poor drafters) based on expert opinion scores, and evaluated using a one-way ANOVA. Statistical significance was set at $p<.05$.

RESULTS: Relative reliability was high with ICCs > .95 ($p<.05$). Absolute reliability was good with 8 out of 9 One-Sample T-tests being non-significant ($p>.05$). Concurrent validity was supported for following in a straight line ($\rho=0.89$, $p<0.001$) and distance between the skaters ($\rho=-0.66$, $p<0.05$). A significant between-group difference was found for following in a straight line ($F(2,11)=8.15$, $p<0.05$) and for distance between the skaters ($F(2,13)=3.38$, $p<0.05$), with better scores for good drafters compared to poor drafters.

CONCLUSION: The method for analysing on-ice drafting skills in long-track speed skaters using video footage is feasible, reliable and valid. This innovative method is a useful and practical tool for analysing drafting skills, and may be used to evaluate and monitor skaters' drafting skills. Establishing a practical method to assess the benefits of drafting skills enables for targeted training and improvement, ultimately enhancing performance in long-track speed skating.

1. Kyle, C. R. (1979).

2. Van den Brandt, F.A.P., et al., in preparation.

**TRACKING EXERCISE INTENSITY: INSIGHTS FROM THREE DIFFERENT ANALYSIS METHODS IN BIATHLON SPRINT RACING**

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INTRODUCTION: Biathlon is an Olympic endurance sport that combines cross-country skiing with precision shooting. Due to the undulating terrain with multiple uphills and downhills and to the shooting series, the skiing part of biathlon is characterized by an intermittent load profile which is reflected in heart rate fluctuations.(1) When monitoring their training biathletes, often use a five-zone intensity scale based on HRmax or a five-zone scale based on laboratory-determined thresholds, while most scientific literature relies on a three-zone model. The aim of this study is to analyze race intensity distribution with the three methods, with the hypothesis that noteworthy differences will be found between them.

METHODS: Four biathlon sprint races were analysed, with 53 (28 females, 25 males) athletes participating, some across multiple events. They were asked to wear a heart rate monitor during the race. Maximum heart rate (HRmax) and lactate thresholds (LT) were determined through a preliminary laboratory test conducted on roller skis. The percentage of race time spent in 5 intensity zones based on HRmax (5STA), LT (5IND), and in 3 based on LT (3Z) were determined. Friedman test with pairwise Durbin-Conover comparisons and Bonferroni correction and the Wilcoxon test were used to compare intensity distribution within the three and when using different methods.

RESULTS: When considering a 5IND intensity distribution model, athletes spent most of the time in Z3 during lap 1 (40%) but progressively shifted to Z5 across the three laps (17% → 37% → 50%; $p < 0,001$), while Z4 remained stable (all $p > 0,05$). 5STA showed a different pattern, with most time spent in Z4 in lap 1 (46%), increasing time in Z5 (28% →59% →70% $p < 0,001$), while Z3 decreased early and remained low (17%, 4% and 3%). In 3Z, time in Z3 increased (42% → 76% → 85%, all $p < 0,001$), while Z2 decreased (40% → 20% → 13% all $p < 0,001$). Compared to 5IND, 5STA had significantly more time in Z5 with Z4 showing smaller differences between methods.

CONCLUSION: These findings highlight how different classification methods influence the interpretation of intensity distribution. We suggest that researchers and coaches should be cautious when using different exercise intensity distribution methods interchangeably. As 3Z categorized most of the effort within Z3, is potentially overlooking fluctuations in higher intensity zones and should therefore be avoided when differentiating those is important. Regarding the five-zone models, smaller differences were found in Z4, with 5IND showing less time spent in Z5 and more time in Z3 compared to 5STA. 5STA, despite being accurate for many athletes, may overestimate exercise intensity, making it unsuitable for the uniqueness of each individual. 1 Laaksonen et al, 2018

## Oral Presentations

### OP-BM03 Sports Injury

**EFFECTS OF COGNITIVE DEMANDS ON BIOMECHANICS DURING CHANGES-OF-DIRECTION IN FEMALE ATHLETES**

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INTRODUCTION: A substantial proportion of anterior cruciate ligament (ACL) injuries occur in football during defensive actions involving change-of-direction (COD). Recent research has highlighted the role of cognitive demands in this movement type [1]. While previous studies have mainly focused on simple decision-making tasks using artificial stimuli (e.g., light signals), the influence of more complex and ecologically valid conditions remain largely unexplored. Thus, this study aimed (i) to determine the effects of increasing cognitive demands on biomechanical parameters during COD tasks in females and (ii) to examine the moderating role of football expertise.

METHODS: Biomechanical data were obtained from 15 female participants with high football expertise (age = 22.9 ± 3.8 yrs, 14.7 ± 3.8 yrs expertise) and 14 female participants with < 1 year football expertise (age = 22.5 ± 1.8 yrs). Participants performed an approach run at 4.0 ± 0.3 m/s, followed by 90° CODs to the left or the right in response to a real opponent, who determined the direction by kicking a ball. Participants performed CODs under four conditions with increasing cognitive demand: (i) anticipated, only one option, (ii) unanticipated, two options, i.e. left or right, (iii) unanticipated, three options including a stop, and (iv) unanticipated, four options including a stop or a feint of the opponent. Knee joint mechanics, trunk and pelvis kinematics were recorded using 3D-motion analysis. A mixed 2x4 ANOVA was performed to analyze the effects of the factors expertise (between-subjects) and cognitive condition (within-subjects) on biomechanical outcomes.

RESULTS: No significant main effects were observed for maximum knee abduction moment and knee abduction angle as well as knee flexion angle at initial contact (IC). However, significant condition effects were observed at IC for trunk rotation ($p<0.001$, $d=0.54$) and pelvis kinematics in frontal ($p=0.004$, $d=0.42$) and transverse planes ($p=0.006$, $d=0.40$). Post-hoc analyses revealed significantly less trunk rotation towards the cutting leg in all cognitive conditions compared to the anticipated condition. The pelvis was significantly more tilted and rotated to the contralateral leg in the anticipated condition compared to condition (iv). No effects of the factor expertise were observed. No significant effects were found for the control variables approach speed and available time to react.

CONCLUSION: This study revealed that increasing cognitive demands significantly influenced trunk and pelvis kinematics but not knee joint mechanics during CODs in both high- and low expertise female football players. Given the established

link between altered trunk and pelvis mechanics and ACL injury risk [2], our findings imply that whole-body kinematics, especially in CODs with increased cognitive demands, should be considered in ACL injury risk evaluations.

REFERENCES:

[1] Gokeler et al., J Athl Train, 2024

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**IN VIVO ANTERIOR TALOFIBULAR LIGAMENT STRAIN IN LATERAL ANKLE INJURY AND HEALTHY-MATCHED CONTROLS ASSESSED VIA STRESS IMAGING ARTHROMETRY**

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INTRODUCTION: A lateral ankle sprain (LAS) typically involves trauma to the anterior talofibular ligament (ATFL). Ex vivo, ATFL has a relatively low yield and ultimate force response (1) so understanding its capacity to tolerate mechanical loading in vivo may be beneficial for injury prevention and rehabilitation. The aim of this study was to assess ATFL strain and changes in its elastic material property to passive ankle inversion rotations in participants with a history of LAS and healthy-matched controls.

METHODS: Bilateral ATFLs were imaged in 34 young adults: 17 with a previous unilateral LAS (12f/5m, 25±6 years) and 17 healthy-matched controls (12f/5m, 25±6 years) using a custom-made arthrometer (2) designed to passively invert the ankle joint from 0° to 5°,10° and 20° and thereby elongating ATFL. ATFL length and strain were assessed via B-mode ultrasonography (15 MHz, 2cm depth) taking the curved path of the ligament into account, and strain referenced to 0° inversion. Shear-wave velocity (SWV; 15MHz, 4cm depth) - as an index of the ligament's elastic material property, was measured via a 25mm region-of-interest within the mid-part of the ligament with the probe stabilised with a mechanical arm over a 2cm gel-pad.

RESULTS: ATFL length, strain and SWV increased with increasing inversion angle ($P<0.001$) independent of the analysed group and limb. ATFL length and strain increased more in the involved limb vs. non-involved limb of injured participants ($P<0.001$), but did not differ between limbs in the control group. As such, the involved and non-involved measurements were compared separately to the average ATFL data from the control group and the involved limb showed a greater length at 0° (21.8±2.5mm vs 19.5±2.5mm, respectively; $P<0.01$) and remained longer through to 20° inversion (25.2±2.7mm vs 20.7±2.6mm, $P<0.001$), reaching a factor of 2.2 compared to the control group strain (15.9±7.0% vs 7.3±2.9%; $P<0.001$). SWV was only different at 5° (2.43±0.26m/s vs 2.33±0.30m/s $P<0.05$) and 10° (2.64±0.24m/s vs 2.56±0.25m/s $P<0.05$) inversion. There were no differences in ATFL properties between the non-involved and control limbs ($P>0.05$).

CONCLUSION: The maximum ATFL strain reported in the involved limb of participants with a history of LAS are above yield threshold (~13%, 1) and close to ultimate strain (~20%, 3) values reported during ex vivo mechanical testing. This suggests maladaptive changes in ligament biomechanical properties following LAS injury. Our non-congruent findings between strain and SWV measurements further suggest that tensile are more affected than transient properties in response to the injury. Thus, interventions that increase tensile stiffness of the ATFL following injury are required.

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**SOUNDING THE FINAL DEATH KNELL INTO THE USE OF ISOKINETIC PEAK TORQUE AS A MEASURE OF RECOVERY AFTER SEMITENDINOSUS TENDON HARVEST**

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INTRODUCTION: The semitendinosus (ST) is important for actions such as sprint performance [1]. Distal ST tendon harvesting for anterior cruciate ligament reconstruction (ACLR) substantially alters ST morphology and induces knee flexion (KF) weakness. As individual muscles within a synergist group specialize in different tasks [2], ST function cannot be compensated for by the other hamstrings [3]. Between-leg differences in isometric strength at 90° of KF strongly relate to ST muscle changes after ACLR [3,4]. Angle-specific strength decrements are also evident during concentric strength testing [5]. Nonetheless, isokinetic peak torque is still used as a clinical measure following ACLR. Here, we compared KF torque metrics from isometric and isokinetic tests in individuals post-ACLR with an ST autograft, hypothesizing that isokinetic peak torque would not relate to angle-specific strength losses.

METHODS: Ten individuals (6 female, 27.2±4.9 y, 1.72±0.10 m, 72.6±13.4 kg, 13.9±3.4 months post-ST autograft ACLR) performed unilateral strength tests (System 4 Pro, Biodex) in the prone position. Maximal voluntary isometric contractions (MVIC) were performed at 15°, 45°, 60°, and 90° of KF [3]. Maximal concentric and eccentric contractions were preloaded at 10-20 Nm (depending on participant MVIC) and performed at 60°/s between 5°-95° of KF. For each contraction type, peak instantaneous torque was obtained from a minimum of three separate efforts. To obtain angle-specific metrics (15°,

45°, 60°, 90°) from isokinetic actions, torque-angle curves were averaged across the two best maximal efforts. Repeated measures ANOVAs and Pearson's correlation coefficients were used to compare torques between legs, angles, and contraction types.

RESULTS: For all contractions, ACLR legs were weaker than contralateral legs at 45°, 60°, and 90° ($p<0.001$), but not at 15° ($p=0.097$). Between-leg differences in torque were larger at 90° than at 15°, 45°, and 60° ($p\leq0.004$). Although peak torques (~20°) were lower (~9%) for both isokinetic modes on the ACLR compared to contralateral leg (main effect: $p=0.018$), magnitudes were substantially less than at 90°, and between-leg differences in isokinetic peak torque did not significantly correlate with differences at 90°, regardless of contraction mode ($r\leq0.539$; $p\geq0.108$). Some individuals who had "recovered" (e.g., <5% difference in isokinetic peak torque) had large between-leg differences in KF torque at 90° (>30%).

CONCLUSION: Between-leg differences in isokinetic KF peak torque are not related to important angle-specific torque metrics. As ST substantially contributes to 90° KF torque [3], we conclude isokinetic peak torque does not provide information on the recovery of ST. Thus, isokinetic peak torque should not be used to inform clinical decisions and treatments, particularly for athletes requiring high-velocity actions such as sprints, where ST is important [1].

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**NO INSTRUCTION, NO PROBLEM: PARKOUR ATHLETES HABITUAL LANDING TECHNIQUE OPTIMIZES LOWER EXTREMITY JOINT CONTRIBUTION TO ENERGY DISSIPATION IN 2-METER DROP LANDINGS**

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INTRODUCTION: Parkour is a highly dynamic sport involving frequent high-impact landings. 67% of injuries in Parkour occur during landings [1]. Previously, rapid, high ground reaction forces, as recorded during landings, have been linked to increased injury risk [2]. Interestingly, in comparison to untrained individuals Parkour athletes tend to execute softer, knee-dominant landings [3], potentially reducing injury risk. Furthermore, while Parkour often involves landings from considerable heights, research has not yet examined impact loads at heights that reflect real-world scenarios in Parkour. This study is the first to assess the effects of different landing instructions on landing biomechanics following drop landings from a 2-meter platform, simulating conditions closer to the environments found in Parkour.

METHODS: Six male Parkour athletes (age: 22.7 ± 1.5y, training: 8.5 ± 2.0y) performed drop landings from a 2-meter platform under three different landing instructions: habitual, soft, and stiff. Soft and stiff landings respectively emphasized and resisted knee flexion upon impact. Sagittal plane video and ground reaction forces, expressed as multiples of bodyweight (BW), were recorded. Inverse dynamics were performed to obtain joint kinetics for the ankle, knee, and hip joints. One-way repeated measures ANOVAs with Bonferroni post-hoc tests were carried-out (alpha = .05).

RESULTS: Peak vertical ground reaction forces were the highest in stiff landings at 10.9 BW (soft: 8.6 BW, habitual: 7.9 BW, $p < .001$). Total eccentric joint work was similar (9.5 J/kg, $p = .201$), however, its distribution varied across landing instructions: The plantarflexors contributed less in habitual (30%) than in soft (39%) or stiff (41%) landings ($p < .001$), while the knee extensors contributed more work in habitual (46%) than in soft (36%) or stiff (37%) landings ($p = .010$). Hip extensor contributions remained constant (22-25%, $p = .446$). Peak joint moments at the ankle (5.1 Nm/kg), knee (5.4 Nm/kg), and hip (9.0 Nm/kg) did not differ across instructions (all $p > .054$). Peak knee eccentric power was found to be greater in habitual landings ($p = .009$), while peak ankle power was lower ($p = .038$).

CONCLUSION: As previously observed, Parkour athletes' habitual landing strategy resulted in knee-dominant energy absorption [3], a pattern maintained even in 2-meter drop landings. Conversely, soft and stiff instructions shifted this energy absorption toward the ankle plantarflexors. The reliance on the larger quadriceps muscles may be crucial for efficiently dissipating the high vertical forces and preventing injury. Importantly, habitual landings did not expose the knee extensors to higher peak loads but rather optimized muscle engagement, displaying better movement control as indicated by the increased eccentric peak power despite similar peak joint moments.

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**PELVIC KINEMATICS IN FEMALE RUNNING - TOWARDS AI-ASSISTED INJURY PREVENTION**

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INTRODUCTION: Running is a common physical activity with significant health benefits but a high injury risk, influenced by strength, anthropometrics, and kinematics (1). Pelvic kinematics are key in running biomechanics, impacting both the lower back (2) and distal limb structures (3). This research is a component of the "AICoachU: Artificial Intelligence in Coaching" project, which utilizes artificial intelligence to forecast kinematic changes in the lower extremities and pelvis that may signify an elevated risk of injury. This study aims to utilize biomechanical data obtained from high-precision kinematic measurements to train neural networks for the analysis of the effects of running speed and incline on pelvic kinematics in female runners, addressing the current limitations in the investigation of pelvic motion.

METHODS: Twenty-five female heel-strike runners participated in a laboratory-based study, undergoing a structured treadmill running protocol. Participants ran at speeds of 10 km/h, 12 km/h, and 14 km/h, as well as at 10 km/h while facing 5% and 10% inclines. Kinematic data were captured using a 12-camera motion capture system, and key parameters of pelvic rotation, tilt, and obliquity were examined. A mixed-effects model was applied to evaluate the effects of speed and incline on pelvic kinematics.

RESULTS: The maximum pelvic rotation exhibited a significant increase with increasing speed ($p < 0.001$). The range of motion for pelvic rotation also demonstrated a significant enhancement with speed ($p < 0.001$). Pelvic tilt at the moment of heel contact was elevated at higher speeds ($p < 0.001$), and maximum pelvic tilt followed a comparable pattern ($p < 0.001$). Incline running was shown to affect pelvic motion, with maximum pelvic rotation increasing at both 5% and 10% inclines ($p < 0.012$). The rotation range of motion was significantly greater at a 10% incline ($p = 0.0016$). Pelvic obliquity increased at a 10% incline, with both maximum obliquity ($p = 0.002$) and obliquity range of motion ($p < 0.001$) exhibiting significant increases.

CONCLUSION: Speed and incline are significant factors affecting pelvic kinematics, which may have important implications for injury prevention. The biomechanical changes observed in this study highlight the need for personalized running strategies and suggest that AI-driven gait analysis has the potential to optimize performance while mitigating injury risks. Future research should focus on developing AI algorithms that adapt to individual biomechanics, potentially guiding runners toward safer training regimens.

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## Oral Presentations

### OP-BM14 Gait

**THE ROLE OF PHYSICAL ACTIVITY IN MITIGATING AGE-RELATED CHANGES IN GAIT NEUROMUSCULAR CONTROL**

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INTRODUCTION: Aging is associated with a reorganization of neuromuscular control, reflected in changes in spinal motor output (1). The Center of Activity (CoA), an EMG-derived measure of spinal activation, represents the temporal distribution of neuromuscular activity throughout the gait cycle (2). Evidence suggests that aging is linked to a posterior shift in lumbar CoA, reflecting delayed neuromuscular activation compared to younger adults (2). This delay in spinal motor output may contribute to an increase in external work and power of the center of mass (Wext & PCOM) during walking in older adults (3). While strength is often considered a determinant of gait mechanics, differences in motor strategies can occur independently of maximal force capacity. Physical activity (PA) may mitigate these effects by preserving neuromuscular coordination. This study examines the impact of PA level on spinal motor output and gait biomechanics in young and older adults.

METHODS: Fifty-nine participants (31 young, 29 older adults) were categorized as more or less active via the Global Physical Activity Questionnaire (GPAQ). Gait analysis was conducted at 1.11 $m \cdot s^{-1}$ on an instrumented treadmill, measuring kinematics, kinetics, and EMG of 12 lower-limb muscles. Wext and PCOM were computed. Isometric maximal voluntary torque (IMVT) of the knee and ankle extensors was assessed, and spinal motor output analyzed using EMG-based spinal maps. A mixed-effects model evaluated age and activity level effects.

RESULTS: Spinal maps showed a lower lumbar CoA ($p < 0.001$) and a reduced lumbar-sacral CoA difference ($p < 0.01$) in less active older adults, suggesting altered neuromuscular coordination. While older adults exhibited reduced IMVT in the knee and ankle extensors ($p < 0.001$), no significant differences were observed in IMVT based on PA level. Despite these neuromuscular differences, Wext was higher ($p < 0.001$) in less active older adults, indicating increased mechanical demand. Additionally, $W_1^+$, the first peak of PCOM corresponding to weight acceptance, was higher in this group ($p < 0.001$).

CONCLUSION: Less active older adults exhibit a posterior lumbar CoA shift, reflecting delayed spinal motor output compared to more active older adults and both young groups. These neuromuscular changes coincide with higher Wext and altered PCOM ($W_1^+$), indicating greater mechanical demand. Interestingly, despite differences in motor strategy, IMVT of the knee and ankle extensors did not differ across PA groups, suggesting that strength alone does not dictate gait adaptations. Physical activity may help preserve neuromuscular efficiency and reduce the mechanical cost of walking in aging.

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**NORMAL GAIT PATTERN IN PATIENTS SUFFERING FROM BRAIN TUMORS IS DISTURBED WHEN APPLYING ADDITIONAL COGNITIVE LOAD DURING WALKING IN A REAL-TIME VIRTUAL ENVIRONMENT– A PILOT STUDY**

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INTRODUCTION: Exercise interventions have the potential to enhance quality of life and to improve physical fitness and balance in brain tumor patients (1-3). Cognitive complaints commonly occur in brain tumor patients (4). However, direct effects of exercise interventions and/or cognitive impairment on gait cycle characteristics have not been reported, yet. This pilot-study is part of a broader investigation to evaluate effects of exercise on balance and gait and examines how additional cognitive load while walking in a real-time virtual environment impacts gait characteristics in brain tumor patients and their caregivers.

METHODS: 7 patients (4f/3m 50±15y, 175±8cm, 72±14kg) and 5 caregivers (4f/1m 44±18y, 169±5cm, 81±16kg) participated performing a walking test on the GRAIL-system. Ground reaction forces were measured separately for both feet as well as kinematics of two markers attached to each foot. Two different conditions were used, a normal gait (NG) with and without an additional cognitive task (CT-Stroop-test with color-denoting words) while walking on a treadmill with constant speed. Step length and width (SL, SW) as well as ground contact time (GCT), swing phase time (SP) were derived for analysis. Statistical analysis for within subject condition (NG vs. CT) was performed using the Wilcoxon tests (alpha=.05). Effect sizes were interpretated using Cliffs's delta (negligible <0.15; 0.15<small<medium<large).

RESULTS: Under Stroop-condition, SL was significantly reduced, and SW was significantly increased compared to normal walking-condition (SL: 1403±143mm vs. 1424±140mm, p<.001; delta =.94 and SW: 126±36mm vs. 117±34mm, p=.003; delta =.72) for all subjects. Group analysis revealed significant SL reduction in patients (1384±158mm vs. 1410±151mm, p=.002; delta =1) but not in caregivers. Similarly, GCT and SP were significantly reduced under Stroop-condition compared to normal walking-condition (603±47ms vs. 612±43ms, p=.02; delta=.74 and 359±24ms vs. 368±24ms, p=.003; delta =.90) for all subjects. This reduction was significant in patients (593±45ms vs. 605±39ms, p=.03; delta =.93 and 356±23ms vs. 368±19ms, p=.016; delta =1.) but not in caregivers. Effect sizes were large for measured parameters (SL, SW, GCT, SP).

CONCLUSION: Additional cognitive load during gait seems to be compensated differently by patients and caregivers. It manifests itself in the gait pattern through a changed step cycle and thus might offer the possibility of a differentiated diagnosis to specifically evaluate effects of training interventions in these patients.

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**ASSOCIATION BETWEEN SELF-SELECTED AND MAXIMUM WALKING SPEED, STRENGTH, BALANCE AND GAIT CHARACTERISTICS AMONG MALES WITH TYPE 2 DIABETES**

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INTRODUCTION: The prevalence of type 2 diabetes (T2D) is increasing, placing a burden on both individuals and healthcare systems. T2D accounts for approximately 90% of all diabetes cases, making it a priority for improved prevention and management. T2D is associated with various pathological complications, including those affecting the neuromuscular system. Previous research suggests that individuals with T2D often exhibit slower walking speeds, altered gait patterns, decreased muscle strength and impaired mobility compared to non-diabetic individuals. The aim of this study was to examine how strength, balance, ankle range of motion and step length are associated with self-selected (SS) and maximum (MS) walking speeds among males with T2D.

METHODS: The study design was cross-sectional, with 18 males (age 62.5 ± 10.6, body height 177.1 ± 5.4 cm, body weight 94.7 ± 16.7 kg), diagnosed with T2D. Participants were recruited from the Department of endocrinology at the University Hospital, Reykjavik, Iceland. Gait speed was assessed for both SS and MS. Maximum voluntary contraction (MVC) of plantar flexors was measured in a seated position using VALD ForceFrame and MVC of knee extensors with VALD Dynamo. Balance was evaluated during a 15 second single leg stance on VALD ForceDecks. Step length and ankle angles at heel

strike and toe-off were determined using video recordings analyzed with the Dartfish software while walking on a treadmill. Jamovi software was used for statistical analysis. Pearsons´s correlation coefficient was used to assess the association between SS and MS with plantar flexor strength, knee extensor strength, single leg balance, step length and ankle angles at heel strike and toe-off. A significance level of $\alpha = 0.05$ was set for all analyses.

RESULTS: Among males with T2D, SS was strongly and significantly correlated with MS ($r = 0.86$, $p < 0.001$). Additionally, SS was significantly correlated with step length at SS ($r = 0.69$, $p = 0.004$) and the strength of plantar flexors ($r = 0.63$, $p = 0.009$). A moderate, but non-significant ($p = 0.060$) correlation was found between knee extensor strength and SS. No significant correlations were found between SS and single leg balance or ankle angles at heel strike and toe-off. For MS, significant positive correlations were found with plantar flexor strength ($r = 0.662$, $p = 0.005$), knee extensor strength ($r = 0.579$, $p = 0.015$), step length at MS ($r = 0.562$, $p = 0.046$) and ankle angle at toe- off ($r = 0.612$, $p = 0.026$). However, MS was not significantly correlated with single leg balance or ankle angle at heel strike.

CONCLUSION: The results of this ongoing study indicate that among males with T2D, greater plantar flexor strength and step length are associated with faster SS and MS. Achieving higher MS may be further influenced by plantar flexion at toe-off and knee extensor strength. These findings suggest a possible beneficial effect of targeted strength training to improve walking speed in this population.

**THE IMMEDIATE EFFECTS OF WEDGE-SHAPED INSOLES ON GAIT AND JOINT LOADING IN PATIENTS WITH THE KNEE OSTEOARTHRITIS:A CASE STUDY**

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INTRODUCTION: Knee osteoarthritis (OA) is a prevalent degenerative joint disease, often leading to pain and functional limitations in older adults. Traditional treatments, such as pharmacological interventions and surgery, have limitations in terms of efficacy and invasiveness. Wedge-shaped insoles have emerged as a non-invasive intervention to redistribute mechanical loads and alleviate symptoms. This study investigates the effects of different wedge angles on knee joint mechanics in a patient with knee OA, aiming to optimize insole design for improved clinical outcomes.

METHODS: A 65-year-old female with knee OA participated in this case study. Seven wedge insoles (0°, 3°, 6°, and 9° in both medial and lateral directions) were tested. Data collection included 3D motion capture (Vicon system), ground reaction forces (AMTI force plate), plantar pressure distribution (Zebris pressure plate), and MRI scans for finite element (FE) modeling. Knee joint angles and meniscal stress distribution were analyzed using FE analysis. Each condition involved five gait trials to ensure data reliability.

RESULTS: Significant changes in knee joint angles were observed across wedge angles. The 6° lateral wedge showed a 12% reduction in peak knee extension compared to the 0° condition ($p < 0.05$). Finite element analysis revealed that the 6° lateral wedge redistributed meniscal stress more evenly, with a 15% decrease in peak medial meniscus stress ($p < 0.01$). Plantar pressure distribution shifted laterally by 8% with the 6° lateral wedge, indicating effective load redistribution. The 3° lateral wedge demonstrated a smaller but significant reduction in knee extension (8%, $p < 0.05$) and a 10% decrease in medial meniscus stress ($p < 0.05$), with a 5% lateral shift in plantar pressure. Conversely, the 9° lateral wedge caused a 20% reduction in knee extension ($p < 0.01$) but also induced a 25% increase in lateral meniscus stress ($p < 0.01$), with a 12% lateral shift in plantar pressure. For the medial wedges, the 3° and 9° conditions increased knee flexion by 6% and 10%, respectively ($p < 0.05$), with corresponding increases in medial meniscus stress of 8% and 12% ($p < 0.05$). These findings suggest that while the 6° lateral wedge provides a balanced mechanical environment for the knee joint, other wedge angles may either under- or over-correct knee mechanics, highlighting the importance of angle optimization.

CONCLUSION: The results highlight the potential of lateral wedge insoles in managing knee OA, particularly the 6° configuration, which demonstrated improved stress distribution and reduced joint loading. However, individual variability in response to different wedge angles warrants further investigation. This study provides valuable insights for optimizing insole design and personalized treatment strategies for knee OA patients. Future research should explore long-term clinical outcomes and patient-specific factors influencing wedge angle efficacy.

**MULTI-MODAL ANALYSIS OF GAIT, BALANCE AND INFRARED THERMOGRAPHY FOR KNEE OSTEOARTHRITIS PREDICTION WITH MACHINE LEARNING**

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INTRODUCTION: Knee osteoarthritis (KOA) is a degenerative joint disease characterized by biomechanical alterations and inflammatory processes that can affect an individual's mobility and balance. Wearable inertial measurement units (IMUs) provide a portable and cost-effective method to capture detailed gait kinematics, revealing alterations such as reduced walking speed or asymmetry that are often present in individuals with KOA. Force platforms offer precise measurements of postural sway, indicating impaired balance in KOA patients. Additionally, infrared thermography (IRT) represents a non-invasive approach to identify thermal anomalies of the body, reflective of underlying inflammatory processes.

METHODS: In this study, we integrated data from IMUs for gait analysis, force platforms for balance assessment, and IRT for detecting knee joint inflammation, followed by advanced machine learning (ML) techniques. A cohort of 16 individuals with clinically diagnosed KOA, along with 16 matched healthy controls, was recruited to undergo comprehensive evaluations across these modalities. The objective was to identify differences in spatiotemporal parameters, balance, and knee

thermal ratios between the osteoarthritic group (OG) and the healthy group (HG). Various statistical methods, including Student's t-tests with Bonferroni-Holm adjustments, were employed to compare the OG and HG. Furthermore, the resulting multi-modal dataset was analyzed using a support vector machine (SVM) classifier with cross-validation to ensure robust model performance.

RESULTS: Our analyses revealed several significant differences between the groups. Notably, compared to the HG, gait symmetry ($p < 0.001$), cadence ($p = 0.019$), left stance ($p < 0.001$), right stance ($p < 0.001$), and swing phase for both legs ($p < 0.001$) were significantly altered in the OG. Additionally, IRT measures indicated pronounced thermal differences around the knee in the medial and lateral patella, medial and lateral knee areas, sovrapatella, and popliteal fossae (all $p < 0.001$), between the OG and HG. Finally, the SVM classifier with a radial basis function kernel was trained using 26 predictors derived from these modalities on 32 samples. Employing 10-fold cross-validation, the optimal model ($C = 0.25$, $\sigma = 0.0263$) achieved an accuracy of 97.5% and a kappa of 0.95.

CONCLUSION: These findings reveal distinct patterns in gait, balance, and knee thermal profiles that not only facilitate early KOA detection but also lay the foundation for timely, personalized intervention strategies tailored to individual biomechanical and inflammatory characteristics.

The work was carried out as part of the PRIN 2022 project entitled "Predictive model of osteoarthritis through the use of inertial knee brace and thermography applied to movement analysis. Get back to move!" announcement D.D. n. 104, 2nd of February 2022, financed by the European Union – NextGenerationEU".

## Oral Presentations

### OP-PN20 Hypoxia and Brain

**THE IMPACT OF SIMULATED FLIGHTS ON EXTERNAL TRAINING LOAD, IMMUNE RESPONSE, AND COGNITIVE PERFORMANCE IN FOOTBALL PLAYERS**

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INTRODUCTION: Mild hypoxia, restricted activity, and disruption of individual routines may affect health and performance following short-haul air travel (SHAT)1. However, the extent to which SHAT affects physiological responses and performance indices of high-level football players remains unknown2. This study aimed to investigate the impact of two simulated SHAT of different duration (4-h and 2-h) on cortisol and immunoglobulin-A (sIgA) responses, external training load, and cognitive performance of high-level football players.

METHODS: Nineteen high-level football players completed, in a randomized order, two SHAT, one week apart, each one lasting 4-h and 2-h, followed by a control condition (CON). Oxygen saturation (SpO2%) and heart rate (HR) were continuously recorded during CON and simulated flights. Salivary cortisol and sIgA, were measured and wearable GPS trackers and the Flanker test were used to evaluate physiological responses, training-related external load metrics, and cognitive performance (i.e., reaction time), respectively, one day before (D-1), the day of the flight (DF), one-day after the travel (D+1).

RESULTS: A notable decline in SpO2% accompanied by a rise in HR was observed during SHAT in comparison to the CON ($p<0.01$). sIgA was decreased at D+1 compared to D-1 only following the 4-h flight ($p<0.05$). No significant differences were observed for cortisol among conditions ($p>0.05$). Total distance covered, very high-speed running distance, and number of accelerations were decreased at D+1 compared to CON after the 2-h SHAT ($p<0.05$). Similarly, high-speed running distance and number of decelerations were decreased at D-1 compared to CON after the 2-h SHAT ($p<0.05$). Reaction time was slower at D+1 compared to CON after the 4-h SHAT ($p=0.04$).

CONCLUSION: This study showed impaired immunological responses and reaction time after the 4-h SHAT. However, the extent to which external load metrics are affected by SHAT warrants further investigation.

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**IMPACT OF HYPOXIA ON CEREBROVASCULAR RESPONSES TO EXERCISE IN YOUNG HEALTHY MALES AND FEMALES**

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INTRODUCTION: Cerebral function is critically dependent upon the adequate and continuous delivery of oxygen to the brain through the active regulation of cerebral blood flow (CBF) (Powers et al., 1985). Hypoxia and exercise result in competing vasoactive stimuli, which in turn influences CBF, therefore the cerebrovascular response to exercise in hypoxia remains unclear (Nobrega et al., 2014). Moreover, males and females had similar CBF responses during incremental exercise in normoxia (Chamoun et al., 2023), but sex-specific differences in cerebrovascular regulation during exercise in hypoxia remain unknown. Aim: This study aimed to i) examine the impact of moderate hypobaric hypoxia on CBF during

incremental cardiopulmonary cycle exercise test (CPET) to volitional exhaustion; ii) examine the effect of sex on cerebrovascular response during exercise in hypoxia and normoxia.

METHODS: In a randomised cross over study, 24 healthy active participants (25±3 years, 12 males and 12 females) completed two separate incremental CPET in normoxia (FiO2=0.21) and moderate hypobaric hypoxia (FiO2=0.14). Middle cerebral artery mean blood velocity (MCAv-mean), an estimate for CBF, was measured continuously throughout exercise using Transcranial Doppler Ultrasound. Breath-by-breath metabolic data, heart rate, oxygen saturation, and blood pressure were measured continuously throughout exercise. Blood lactate (BLa) was measured at the end of each exercise stage.

RESULTS: In comparison to normoxia, hypoxia induced significant increase in MCAv-mean, ventilation (VE), BLa with lower partial pressure of end-tidal carbon dioxide (PetCO2) during submaximal exercise (e.g. at the highest equivalent work rate of 140 watts, MCAv-mean: 68.3±13.5 vs. 59.8±14.6 cm/sec; VE: 69.4±9.8 vs. 59.0±11.8 L/min; BLa: 4.1±1.0 vs. 3.5±0.9 mmol/L; PetCO2: 35.0±3.5 vs. 39.6±5.3 mmHg, $P < 0.01$ for all). Females exhibited higher MCAv-mean and VE, and lower $PetCO_2$ than males during submaximal work rates (80-140 watts) in both normoxia and hypoxia. At 140 watts, MCAv-mean was higher in females than males in both normoxia (64.7±13.0 vs. 54.4±14.8 cm/sec) and hypoxia (69.7±13.2 vs. 60.17±12.6 cm/sec, $P < 0.01$). Hypoxia induced similar relative changes in MCAv-mean across sexes.

CONCLUSION: In hypoxic condition, an increase in MCAv-mean during exercise acts as a compensatory mechanism to preserve cerebral oxygen delivery in response to reduced oxygen saturation levels. Females showed consistently higher CBF compared to males in both normoxia and hypoxia, but hypoxia affected MCAv-mean in both sexes similarly. These findings suggest intrinsic sex differences in cerebrovascular regulation during exercise, independent of oxygen availability.

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**COGNITIVE AND CEREBRAL OXYGENATION RESPONSES TO GRADED NORMOBARIC HYPOXIA IN MIDDLE-AGED ADULTS: A SINGLE-BLIND RANDOMIZED CROSSOVER STUDY**

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INTRODUCTION: Approximately 81.6 million individuals reside permanently at altitudes above 2,500 meters, with many more intermittently exposed to high-altitude environments through travel, work, or recreation. Hypoxia, a reduction in available oxygen, can adversely affect human physiology and cognitive performance. While younger adults often exhibit resilience to moderate hypoxia[1], the extent to which middle-aged adults experience cognitive changes remains less established. Age-related declines in neurovascular coupling and cerebral autoregulation may increase susceptibility to hypoxia-induced impairments, underscoring the importance of focused research in middle-aged adults.

METHODS: Sixteen healthy participants (aged 45–65 years) were recruited to investigate the impact of acute normobaric hypoxia on cognitive performance and cerebral oxygenation. Each participant attended four separate sessions in a hypoxia chamber, simulating altitudes of 0 m (normoxia, FiO2≈20.9%), 1,500 m (low altitude, FiO2≈17.3%), 3,000 m (moderate altitude, FiO2≈14.5%), and 4,500 m (high altitude, FiO2≈12%). At each session, participants completed a cognitive test battery comprising the Stroop test, N-back task, Corsi block-tapping test, and Operation Span Task. Cerebral oxygenation was assessed continuously using near-infrared spectroscopy, measuring tissue saturation index (TSI), total hemoglobin (tHb), deoxyhemoglobin (HHb), and oxyhemoglobin (O2Hb). Changes in these parameters (ΔTSI%, ΔtHb, ΔHHb, and ΔO2Hb) were determined by subtracting normoxic resting values from those obtained during each hypoxia level. Perceived exertion was evaluated after each cognitive task using the DP15 rating scale.

RESULTS: Exposure to graded hypoxia significantly impaired cognitive performance in middle-aged adults, particularly at moderate to high altitudes (3,000–4,500 m). Compared with normoxia, participants exhibited slower reaction times and decreased accuracy on the Stroop test ($p < 0.05$), reduced accuracy on the N-back task ($p < 0.05$), as well as on the Corsi block-tapping test ($p < 0.05$). These deficits were more pronounced under high-altitude conditions (4,500 m). Correlation analyses indicated a strong positive relationship between reduced oxygen availability (SpO2) and heightened perceived exertion ($p < 0.05$), suggesting that lower oxygen levels may directly contribute to cognitive performance decrements.

CONCLUSION: Acute normobaric hypoxia at simulated moderate to high altitudes significantly affects cognitive function in middle-aged adults, underlining a potential vulnerability in this demographic. These findings emphasize the importance of monitoring and mitigating hypoxia-related risks for individuals exposed to lower oxygen environments and warrant further research into interventions that could preserve cognitive performance at altitude.

**THE ACUTE EFFECTS OF MODERATE-INTENSITY CONTINUOUS, RESISTANCE, AND CONCURRENT EXERCISE ON CEREBROVASCULAR REACTIVITY TO HYPOCAPNIA IN HEALTHY YOUNG ADULTS.**

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INTRODUCTION: Exercise promotes cerebrovascular health. However, the impact of different exercise modes on cerebrovascular function in the post-exercise period remains underexplored. In particular, how acute exercise influences cerebrovascular reactivity (CVR) during recovery is not well understood. Therefore, this study explored the acute effect of moderate-intensity continuous (MOD), resistance (RE), and concurrent (CE) exercise on CVR.

METHODS: Twenty-four healthy young adults (12 males, 12 females; mean±SD age: 23.8±2.9 years) volunteered to participate in this study. Each participant completed a total of six visits. During visits one and two, participants performed a ramp incremental exercise test to exhaustion on a cycle ergometer and a 1 repetition maximum (1RM) protocol to assess maximal strength, respectively. The remaining visits involved four 30-minute, time-matched experimental sessions, including a seated control trial (CON), MOD cycling at 90% gas exchange threshold, four sets of 10 repetitions of RE at 70% of 1RM, and CE consisting of 15 minutes of RE followed by 15 minutes of MOD, completed in a randomized order. CVR of the middle cerebral artery to hypocapnia was determined through one minute of voluntary hyperventilation, performed at 25 breaths.min-1. Middle cerebral artery blood velocity (MCAv) was measured using transcranial Doppler ultrasonography, and the partial pressure of end-tidal carbon dioxide (PETCO2) was measured breath-by-breath using a gas analyser. Participants completed the CVR protocol before, and 20 minutes following exercise. CVR was quantified as both the absolute (cm.s-1) and relative (%) change in MCAv from baseline per 1 mmHg change in PETCO2, derived from the final 10 s of hyperventilation. A two-way repeated-measures ANOVA assessed the effects of condition and time on MCAv, $PETCO_2$, and CVR.

RESULTS: Baseline MCAv was unchanged following each condition (P>0.05), while baseline $PETCO_2$ was significantly lower following the RE and CE trials (P<0.05). Following exercise, absolute CVR was lower in the RE trial compared to CON (1.53±0.35 vs 1.70±0.44 cm s-1.mmHg-1, P=0.024) and CE (1.73±0.44 cm s-1.mmHg-1, P=0.012) trials. Additionally, absolute CVR was lower in the MOD trial (1.54±0.47 cm s-1.mmHg-1) than the CE trial (P=0.040). Relative CVR was also reduced post-exercise in the RE trial compared to CON (P<0.001) and CE (P<0.001) trials, and was lower in the MOD trial than the CE trial (P=0.012).

CONCLUSION: These findings demonstrate that CVR is attenuated during recovery following RE, and that MOD results in a greater reduction in CVR compared to CE. This suggests that exercise mode influences post-exercise cerebrovascular function and offers insight into the time course of cerebrovascular recovery.

**CEREBROVASCULAR FUNCTION DURING 24-HOURS OF HYPOXIA, COLD, AND COLD HYPOXIA EXPOSURE IN HUMANS**

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INTRODUCTION: High-altitude environments are commonly frequented by recreational enthusiasts, elite athletes, and inhabitants local to the region. Individuals traveling to, and residing in these regions, can be exposed to a range of environmental stimuli, most notably hypoxia and cold stress. Despite these two environmental conditions often occurring simultaneously, they are rarely studied this way. Impairments in cognition have been described to occur both during hypoxia and cold exposure and may be related to the pattern of cerebral blood flow (CBF) and cerebral oxygen delivery (CDO2) that is observed during these individual and combined environmental stressors. Thus, the aim of this study was to investigate the individual and combined effects of cold and hypoxic exposure on cerebrovascular function over a 24-hour period in humans.

METHODS: Participants (n=11; 4 female) were exposed to three 24-hour environmental conditions inside the TerraXcube chamber (Bolzano, Italy) in a single blinded, non-randomized crossover study. Participants were exposed to 1) room-temperature normobaric hypoxia (23°C and FiO2=13%); 2) cold normoxia (10°C and FiO2=20.93%); and 3) cold normobaric hypoxia (10°C and FiO2=13%) with sessions separated by ~1 week. Participants were dressed in identical base layer clothing and food and water intake was standardized. Measurements of regional and global cerebral blood flow (gCBF) were assessed using duplex ultrasound of the internal carotid and vertebral arteries. Peripheral oxygen saturation, end-tidal gases, and hemoglobin concentration were measured to estimate arterial oxygen content (CaO2) and CDO2. Skin temperature was assessed using multi-site skin thermocouples to calculate total body skin temperature while core temperature was assessed using a rectal thermistor. All measurements were obtained during a room-temperature normoxic baseline (23°C and FiO2=20.93%) and following 6, 12, and 24 hours of environmental exposure.

RESULTS: No differences in gCBF were observed in any condition following 6 and 12-hours of exposure compared to room-temperature normoxic baseline (all P>0.05). Following 24-hours of exposure, gCBF was reduced with cold (P=0.009), but was not different during hypoxia (P=0.760) or cold-hypoxia (P=0.670) compared to baseline. During all three conditions, hemoglobin concentration was similarly increased compared to baseline at 24-hours (all P<0.001). CaO2 was reduced with hypoxia (P=0.009), and increased with cold (P=0.001), but was not different during cold hypoxia (P=0.186) compared to baseline. Under all conditions, at all timepoints, CDO2 was unaltered compared to baseline.

CONCLUSION: Hypoxia prevents the reduction in gCBF which occurs during cold exposure. The changes in CBF in all conditions are commensurate to the changes in CaO2 whereby CDO2 under all conditions is maintained. Previous reports of

cognitive impairment with moderate, prolonged hypoxia and cold stress are likely not related to impairments in bulk cerebral oxygen delivery.

## Oral Presentations

### OP-MH05 Weight Loss II

**NO EFFECT OF AGE AND OBESITY ON PEAK FAT OXIDATION**

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INTRODUCTION: Peak fat oxidation (PFO) is one parameter contributing to metabolic flexibility and may therefore impact metabolic health. However, it remains unclear how obesity affects PFO. In addition, there is a lack of data on the obese elderly population and how the interplay of aging and obesity affect PFO. Here, we hypothesized that peak fat oxidation would be higher in obese compared to lean individuals, independent of age.

METHODS: Healthy males matched for physical activity level were recruited into four groups; Lean young (LY) BMI 23 ± 2 aged 26 ± 5 years VO2max 3988 ± 704 ml/min (n = 12); Lean old (LO) BMI 24 ± 1 aged 65 ± 4 years VO2max 3514 ± 451 ml/min (n = 10); Obese young (OY) BMI 34 ± 3 aged 30 ± 5 years VO2max 4206 ± 675 ml/min (n = 10); Obese old (OO) BMI 33 ± 3 aged 65 ± 5 years VO2max 2998 ± 379 ml/min (n = 8).

Subjects arrived overnight fasted and body composition (Dual-Energy X-Ray Absorptiometry), blood-pressure, blood sampling and hip-waist ratio were measured. After this a submaximal and maximal incremental exercise test to measure PFO and maximal oxygen consumption (VO2max) were performed. Lastly, isometric handgrip strength was tested. Data were tested for normality using Shapiro-Wilk test and Q-Q plots. Data are presented as mean ± SD. Between-group differences were analyzed using two-way ANOVA with BMI (Lean/Obese) and Age (Young/Old) as independent factors, and post-hoc comparisons conducted using Tukey's multiple comparison test where appropriate (GraphPad Prism 10).

RESULTS: BMI influenced fat oxidation at rest (P = 0.003), with higher fat oxidation observed in OY and OO compared to LY. However, fat oxidation at rest did not differ between LY and LO. PFO (LY: 0.44 ± 0.11; OY: 0.58 ± 0.24; LO: 0.57 ± 0.23; OO: 0.49 ± 0.12 g/min) and PFO/Lean body mass (LY: 7.0 ± 1.3; OY: 7.2 ± 3.0; LO: 8.6 ± 4.9; OO: 8.5 ± 2.3 mg/min/kg LBM) were similar in all groups (P > 0.05). FATmax, the percentage of VO2max eliciting PFO, was higher in the old groups compared to the LY group (P < 0.05). VO2max was lower in OO compared to LY and OY (P > 0.05). There were no differences in VO2max between the other groups. Plasma free fatty acids (FFA) were not different between groups (LY: 432 ± 228; OY: 512 ± 222; LO: 542 ± 182; OO: 628 ± 349 µmol/L).

CONCLUSION: In conclusion fat oxidation at rest is higher in obese compared to young lean males regardless of age. However, in contrast to our hypothesis PFO is not affected by aging or obesity when matched for habitual physical activity level, but the intensity eliciting PFO is higher in old compared to lean young males independent of BMI. These findings contribute to our understanding of the interplay between obesity, aging and fat oxidation.

**EFFECTS OF AEROBIC EXERCISE ON RENAL FUNCTION ABNORMALITIES AND MITOPHAGY OF OBESE RATS**

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INTRODUCTION: The rising prevalence of obesity-associated kidney injury is concerning, but the full extent of the injury and its underlying mechanisms are not yet fully elucidated. This study investigates the impact of varying aerobic exercise regimens on renal dysfunction in obese rats and examines the regulatory role of aerobic exercise in mitophagy.

METHODS: Ninety male SD rats were divided into a normal diet group (CON, n=10) and a high-fat diet group (n=80). The high-fat diet group was fed for 8 weeks to induce obesity and renal function abnormality. After modeling, 40 rats were assigned to four groups: a high-fat diet control group (HFD, n=10) and three exercise groups (40%, 60%, and 80% $VO_2$max, n=10 each). Aerobic exercise was performed via treadmill training (60 min/day, 5 days/week) for 8 weeks. Post-intervention, body weight, body length, fat weights, and Lees index were measured. Blood and urine samples were collected to assess lipid profiles, serum creatinine, urinary protein, and microalbumin (mALB). Kidney pathology was examined by HE staining, and ultrastructural changes were observed using transmission electron microscopy. Western blot analysis was conducted to detect key mitophagy proteins (Beclin1 and Parkin) in kidney tissues.

RESULTS: After 8 weeks of intervention, the HFD group exhibited significantly higher body weight and Lees index compared to the CON group (P<0.05), whereas these parameters in all exercise groups were significantly lower than those in the HFD group (P<0.05). The average SCr and mALB levels in the HFD group were significantly higher compared to the CON group (P<0.05). Moreover, the average SCr levels in all exercise groups were significantly lower than those in the HFD group (P<0.05), and the average mALB levels in the 40% $VO_2$max and 60% $VO_2$max groups were also significantly lower than those in the HFD group (P<0.05). The renal tubular epithelial cells in the HFD group showed moderate degeneration. In contrast, the degree of glomerular hypertrophy in each exercise group was reduced compared to the HFD group, and the renal tubules of the 60% $VO_2$max group showed a clearer contour. Moreover, compared with the CON group, the

number of swollen mitochondria in the HFD group was increased, whereas the 60% $VO_2$max group exhibited a significant improvement compared with the HFD group. The protein expression levels of Beclin1 and Parkin were increased in the HFD group compared to those in the CON group ($P<0.05$), and a reduction was observed in the 40% $VO_2$max group compared with the HFD group ($P<0.05$).

CONCLUSION: Moderate to low intensity aerobic exercise can alleviate renal dysfunction in obese rats by reducing mitophagy in renal mitochondria, as evidenced by the downregulation of renal function biochemical indicators and the reduced degree of renal tissue damage.

**COMPARATIVE EFFECTS OF MICT, HIIT, AND RESISTANCE TRAINING ON HEPATIC AND METABOLIC OUTCOMES IN NAFLD: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Given the lack of pharmacological interventions, exercise remains a critical strategy for managing non-alcoholic fatty liver disease (NAFLD), with its efficacy well-established. Different exercise modalities induce distinct physiological stress profiles, potentially exerting differential effects on NAFLD. As NAFLD is considered a hepatic manifestation of systemic metabolic dysregulation, this study comprehensively compared the therapeutic effects of moderate-intensity continuous training (MICT), high-intensity interval training (HIIT), and resistance training (RT) on NAFLD across multiple metabolic dimensions: liver fat, glucose metabolism, lipid metabolism, and central obesity.

METHODS: Thirty-six adults with NAFLD (age: 51±8 years) were randomized to three 8-week supervised exercise regimens: MICT (3 sessions/week, 60 minutes/session at 60-70% HRmax), HIIT (3 sessions/week, 3 sets/session alternating 4-minute intervals at 85% HRmax and 4-minute recovery at 60% HRmax), or RT (3 sessions/week, 8 exercises at 60% 1RM, 3 sets × 12 repetitions). Liver fat content was measured using MRI-PDFF, insulin resistance was assessed using HOMA-IR, insulin sensitivity was assessed using the QUICKI index, and the degree of central obesity was assessed using waist circumference.

RESULTS: After 8 weeks, both MICT (−2.13%; 95% CI, −3.23 to −1.02; $p < 0.01$) and HIIT (−1.74%; 95% CI, −3.00 to −0.48; $p < 0.01$) significantly reduced liver fat, with no difference between the two ($P = 0.64$). MICT also lowered fasting insulin levels (−3.47 μU/mL; 95% CI, −6.22 to −0.72; $p = 0.02$) and improved insulin sensitivity (QUICKI: +0.01; 95% CI, 0.002–0.02; $p = 0.02$). Waist circumference decreased in both MICT (−5.46 cm; 95% CI, −8.18 to −2.74; $p < 0.01$) and RT (−3.25 cm; 95% CI, −6.07 to −0.43; $p = 0.02$), with MICT showing a greater reduction than HIIT ($p = 0.02$). HIIT increased HDL cholesterol (+0.118 mmol/L; 95% CI, 0.02–0.22; $p = 0.03$).

CONCLUSION: MICT was the most effective exercise modality for NAFLD management, achieving simultaneous improvements in hepatic steatosis, insulin resistance, and central obesity. While HIIT reduced liver fat comparably, it exhibited limitations in addressing glucose metabolism and central obesity. RT showed no direct therapeutic effect on NAFLD pathology.

**EFFECTS OF HIGH INTENSITY INTERVAL TRAINING ON LEFT ATRIAL MECHANICS IN YOUNG WOMEN WITH OBESITY**

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INTRODUCTION: High intensity interval training (HIIT) has been shown to improve body composition [1], inflammatory responses [2] and vascular function [3] in individuals with overweight and obesity. However, the effects of HIIT on cardiac parameters, particularly in left atrial (LA) mechanics remain unclear [4]. Therefore, the aim of this study was to investigate the effects of HIIT on LA mechanics in young women with obesity.

METHODS: Twenty-five young women with grade I and II obesity were randomized to receive eight weeks of HIIT (4 x 4 minutes of walking/running at intensity between 85 and 95% of HRmax, alternated by 3 minutes of active recovery at intensity between 65 and 75% of HRmax) or moderate intensity continuous training (MICT) (41 minutes of walking/running at intensity between 65 and 75% of HRmax). Body composition, cardiorespiratory fitness and LA mechanics (LA reservoir, LA conduit and LA contractile) were evaluated.

RESULTS: There were significant improvements in LA mechanics, including LA reservoir (4.2 ± 7.2%, $p=0.03$ and 7.4 ± 4.9%, $p<0.01$), LA conduit (3.0 ± 2.4%, $p=0.02$ and 3.2 ± 2.1%, $p<0.01$) and LA contractile (2.4 ± 3.4%, $p<0.01$ and 3.0 ± 3.0%, $p<0.01$) after HIIT and MICT, respectively. In addition, both protocols reduced body fat, but only HIIT significantly increased cardiorespiratory fitness.

CONCLUSION: Both HIIT and MICT improve LA mechanics in yong women with obesity, suggesting that the effects may be independent of the nature and intensity of aerobic exercise.

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**EFFECTS OF 12 WEEKS POL VS. HIIT TRAINING PROGRAMS IN MALES WITH OBESITY**

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INTRODUCTION: Background: Obesity is primarily caused by a poor diet and low physical activity (1). Compared to normal weight individuals, people with obesity had lower cardiorespiratory fitness (CRF), lower exercise tolerance (4) and impaired lipid oxidation (2) both at rest and during exercise (3). The American College of Sports Medicine (ACSM) recommends a combination of vigorous and moderate exercise to improve body composition and physical performance (4). The aim of this study was to compare the effects of high-intensity interval training (HIIT) and polarized training (POL) on anthropometry, body composition, aerobic capacity, energy cost of transport and substrates used during walking at 5 km/h.

METHODS: Twenty-eight adult males with obesity were recruited and divided into two groups, POL (n: 14) and HIIT (n: 14). Assessments were performed at baseline (T0) and after 3 months of intervention (T3). Anthropometric data, body composition, basal metabolic rate (BMR) and a maximal aerobic capacities (VO2max) were measured. The training programs were structured based on the participants ventilatory thresholds and distributed either interval-based or polarized.

RESULTS: Both groups reduced their weight (-3%) and BMI (-3%) ($p=0.002$). V?O2 (L $min^{-1}$) improved at maximum (+10%, $p=0.004$) and the first (+18.5%, $p<0.001$) and second (+12%, $p=0.001$) ventilatory thresholds in both groups. It also improved both maximal (+10%, $p<0.001$) and threshold (+10%, $p<0.001$) velocity. In addition, total energy expenditure did not change significantly, while carbohydrate utilization (g-$min^{-1}$) decreased (-38%, $p<0.001$) and fat utilization (g-$min^{-1}$) increased (+28%, $p=0.002$).

CONCLUSION: Both training modalities resulted in a reduction in body mass (BM) and body mass index (BMI), while improving VO2 and velocity at maximal and ventilatory thresholds and promoting fat oxidation. These results emphasize the benefits of structured training to improve aerobic fitness, metabolic health and body composition in individuals with obesity, with each method offering different benefits.

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## Oral Presentations

### OP-SH02 Psychology I - Mental Fatigue

**EXPLORING INDIVIDUAL DIFFERENCES IN ATTENTIONAL CONTROL: THE PSYCHOPHYSIOLOGICAL IMPACT OF REWARD AND PUNISHMENT SENSITIVITY**

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Background: Enhanced attentional control is linked to mentally tough behaviours and overall superior sporting performance. One potential explanation for this connection is that attentional control (AC) may help regulate psychophysiological responses to stress, such as gaze behaviour and heart rate, leading to increased focus on task demands and reduced distraction from irrelevant stimuli. Research suggests that individuals sensitive to punishment are more adept at identifying and reacting to threats early. This may help to lower anxiety and free up attentional resources, allowing for superior AC. This study aimed to investigate the impact of punishment (PS) and reward sensitivities (RS) on cognitive performance and psychophysiological responses to stress.

Methods: 83 participants completed three AC tasks targeting shifting, inhibition, and updating. Each task involved coins with varying monetary values under two conditions: gain/no gain (clicking earns money, failure to click results in no gain) and loss/non-loss (failure to click results in a loss, clicking prevents it). Tasks included a practice block, low-stress block (no carryover of earned money), and a high-stress block (where real monetary rewards were based on gains and losses). In the first task (shifting), participants were given £20 credit in the loss condition, providing them with money to lose. Eye tracking and heart rate variability were recorded throughout.

Hypothesis: Individuals with high PS focus on avoiding loss, and their early threat detection may reduce anxiety and improve AC during high-stress tasks. In contrast, those with high RS may be more distracted by gains, leaving fewer resources to manage task demands.

Results: Preliminary data shows a significant increase in self-report anxiety across conditions ($t(43) = -3.69$, $p = .001$). Shifting-task data shows individuals high in PS clicked more coins ($\beta = 2.83$, $p = .01$) than those high in RS ($\beta = 1.70$, $p = .18$), with PS individuals accounting for 24% of the variability in the gain, high-stress condition. Both PS and RS fixated more on the gain condition, though PS individuals demonstrated a greater increase in eye fixation duration on gain coins ($\beta = 1262.45$, $p = .01$), compared to their RS counterparts ($\beta = 978.02$, $p = .07$), with PS predicting 28% of the variability from gain to loss in high stress.

Conclusion: Individuals high in PS excel at task-switching, clicking more coins, fixating longer, and showing less distraction by losses. This may result from stress-induced recruitment of attentional resources, which blunts their stress response to loss and leads them to use strategies (such as utilising the £20 credit in the loss condition to maximize gains and prevent greater overall loss). In contrast, individuals high in RS struggled with task demands, clicking fewer coins and fixating less, for shorter periods. This suggests that the presence of rewards may impair task-switching performance, in RS individuals.

**DETERMINANTS OF MENTAL FATIGUE: THE ROLES OF COGNITIVE CONTROL AND REAL-TIME TASK DIFFICULTY ADJUSTMENTS**

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INTRODUCTION: Mental fatigue impairs performance and safety. This research aims to uncover the underlying causes of mental fatigue by identifying factors that intensify and accelerate its onset. We developed computer-based protocols manipulating (a) cognitive-control demands and (b) real-time task difficulty adjustments designed to promote sustained engagement with the fatiguing activity.

METHODS: In a within-subject single-task study (n = 36) and a between-subject multi-task study (n = 72), we manipulated task parameters from three executive function domains (inhibition, switching, updating) across conditions of (a) lower vs higher cognitive-control demands without difficulty adjustments and (b) high cognitive control with vs without difficulty adjustments, where speed increased following correct responses and decreased otherwise. Subjective, behavioural, and physiological data were analysed for changes in cognitive load, task engagement, and fatigue. Statistical significance was evaluated using ANOVA planned contrasts and reported as percentage changes.

RESULTS: The within-subject study showed that higher (vs lower) cognitive control increased perceived workload by 16.25% while reducing boredom by 23.80% and sleepiness by 6.40%. It also slowed responses by 9.75%, impaired accuracy by 2.65%, and decreased blink rate by 11.50%. Difficulty adjustments (vs none) heightened workload by 34.33% and led to 7.08% less accurate but 32.58% faster responses, with a further 15.89% reduction in blink rate.

The between-subject study extended these findings to mental fatigue. Higher (vs lower) cognitive control did not consistently elevate perceived workload but led to 11.01% lower accuracy and 58.98% slower response times. Difficulty adjustments (vs none) increased workload by 37.22% across all executive function domains and impaired accuracy by 23.85% while speeding up responses by 20.24%. Mental fatigue was 60.87% larger at the end than the beginning of the study on average across all conditions but emerged 28.69% faster under higher cognitive-control demands with (vs without) difficulty speed adjustments. A 15.22% reduction in parasympathetic activity and 78.98% more blink flurries were observed immediately after (vs before) completing the high cognitive-control condition with difficulty adjustments, possibly reflecting compensatory responses to elevated cognitive workload.

CONCLUSION: These findings reveal how prolonged exertion of cognitive control and task difficulty adjustments can intensify cognitive load and fatigue. While the former can create additional cognitive load, the latter promotes task engagement and accelerates fatigue onset. Beyond identifying contributors to mental fatigue, this research introduces an innovative, time-efficient approach that addresses limitations of previous one-size-fits-all fatiguing protocols, promising to reduce opportunity for disengagement and therefore variability in individual responses in mental fatigue.

**BRAIN ENDURANCE TRAINING (BET) IMPROVES UPPER BODY RESISTANCE EXERCISE**

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INTRODUCTION: It is well established that mental fatigue (MF) limits various forms of physical performance. Brain Endurance Training (BET) is a MF countermeasure that combines demanding cognitive tasks that systematically induce elevated levels of MF through engaging higher order executive functions alongside regular physical training. BET has been proven to be effective in improving running, cycling, rhythmic handgrip, and bodyweight calisthenic exercise performance. However, its application to strength and resistance training is less well understood. This study explored the effects of BET on sub-maximal strength training and potential underlying mechanisms that may explain training-related changes in performance.

Method: Forty-two resistance-trained student athletes were randomly assigned to either high cognitive load (high BET group) or low cognitive load (low BET group) conditions and completed 12 training sessions over 4 weeks. In pre- and post-testing, they completed sets to failure at 60% of one repetition maximum for bench press (compound) and preacher curl (isolation) exercise when "fresh" and when mentally and physically "fatigued". Performance (number of exercise repe-

titions to failure), perceived exertion, and mental fatigue were assessed. Linear displacement transducers recorded lifting kinematics (including velocity) while surface electromyography (sEMG) transducers recorded muscle activation patterns.

RESULTS: In pre-testing, exercise performance did not differ between groups. Performance improved in post-testing for both groups as a result of training. In post-testing, the high BET group performed more bench press repetitions than the low BET group both in a 'fresh' and 'fatigued' state. No group differences were observed for preacher curl repetitions. Ratings of perceived exertion (reported after five repetitions) were lower for the high BET group than the low BET group suggesting that increased cognitive demands during training recalibrated the effort-exercise relationship. The high BET group also reported less mental fatigue despite completing more repetitions before failure.

Discussion: The findings show that BET enhances resistance exercise performance and confirm its applicability to strength and conditioning. They also reveal that exercise performance enhancement requires sufficient cognitive load during training to recalibrate the relationship between perceived effort and actual effort. Finally, differences in performance enhancement between the compound and isolated exercises suggest that BET may help improve neuromuscular control.

**MOTOR LEARNING UNDER MENTAL FATIGUE: THE COMPENSATORY ROLE OF REST PERIODS**

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INTRODUCTION: Mental fatigue (MF) is a psychobiological state induced by the realization of prolonged and/or intensive cognitive tasks and characterized by a subjective feeling of tiredness1. It is well established that MF negatively impacts both cognitive and physical performances. Recent research has shown that MF affects motor adaptation2, mainly due to difficulties in engaging explicit strategies. However, its impact on motor learning remains unclear.

METHODS: To address this gap, we used a finger-tapping-task (FTT) and divided 28 participants into one of two groups: an MF group (n=14), which completed a 30-min modified Stroop task, and a Control group (n=14), which watched a documentary of equivalent duration. Following these tasks, both groups trained on the FTT, which required tapping a predetermined sequence as quickly as possible. The training consisted of 48 trials, divided into 12 blocks of 4 trials, with 5-s rest intervals between trials and 30-s rest intervals between blocks. Movement duration and accuracy of each trial were recorded to calculate a composite ratio to characterize motor skill3. We analyzed motor skill improvement between the beginning (T1) and the end (T2) of the training, the learning curve across all trials, and the online and offline processes. The online process represents motor skill evolution within each block, while the micro-offline process reflects changes during the rest periods between blocks. Additionally, to assess the impact of the Stroop task and documentary viewing, MF was evaluated using a visual analog scale (100mm).

RESULTS: MF significantly differed between groups ($p<.001$), with a higher level of MF after the Stroop (61/100) task than after the control task (26/100). Concerning motor skill improvement, the rmANOVA revealed a significant increase in motor skill in both groups between T1 and T2 ($p<.001$) without difference between them ($p=.53$). Similarly, the analysis of the learning curve showed no difference in the learning rate between groups ($p=.82$). However, motor skill deterioration during online process and motor skill improvement during micro-offline process were greater in the MF group (for both, $p=.02$). Interestingly, a strong negative correlation ($r=-0.96$, $p<.001$) was observed between the online and micro-offline processes, meaning that a greater decrease in motor skill during online process is associated with a greater increase during the micro-offline process, and vice versa.

CONCLUSION: While the total motor skill improvement was similar between groups after MF, the dynamic of motor learning differs. The deterioration observed during the online process was compensated by the offline period between blocks with greater motor skill regain in the MF group. These results highlight the potential role of rest periods in optimizing motor learning under MF.

1) Boksem & Tops M, Brain Research Reviews, 2008

2) Apreutesei & Cressman, PloS One, 2024

3) Truong et. Npj Science of Learning, 2023

**MENTAL FATIGUE MONITORING IN ELITE FENCING TRAINING AND COMPETITION**

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INTRODUCTION: Mental fatigue (MF) is increasingly implicated in elite sports. This is strengthened by results from lab studies indicating performance decrements after MF, and by athletes and coaches' self-reported experiences in the field. Fencing, an open-skilled combat sport, demands perceptual-cognitive skills and mental resource allocation for performance optimization and success. The gradual onset of fatigue in simulated fencing competitions is closely linked to increased mental demand. However, to date, MF is not sufficiently addressed in fencing. To optimize performance there is a need to understand the impact of fencing training and competition periods on MF. This would enable coaches and athletes to better manage MF throughout the season.

METHODS: A four-week longitudinal, single-blind monitoring of 31 (7 Epee, 13 Foil, 11 Sabre; 15 Female) elite fencers daily MF was conducted subjectively and behaviorally across phases before, during, and after the national championship (i.e., tapering, competition, recovery training, and normal training week). Subjective MF from a Visual Analogue Scale (MVAS) and reaction time (RT) from the 3-min Psychomotor Vigilance Test (PVT-B) were collected every morning (baseline) and

after the last training session or competition of the day (post). Self-reported individualized training variables (Rating of Perceived Exertion (RPE), duration, contributions of physical, technical, tactical, psychological, and external demands) were also recorded post-training. One-way repeated measure ANOVAs analyzed daily changes (post vs. baseline) in MVAS and RT across phases. Linear mixed-effect models analyzed training days to examine the fixed effects of calculated training load (session-RPE * duration) and specific training demand contributions on daily MVAS changes.

RESULTS: In total, 93 match days and 440 training days were analyzed. MVAS increased after all training and competition compared to baseline, peaking on match days (+19.34 AU, $p<0.001$), which also aligned with an impaired RT (+76.43 ms, $p<0.01$). On training days, general training load ($\beta=0.02$, $p<0.001$), and the contributions of tactical ($\beta=0.26$, $p<0.001$) and physical ($\beta=0.12$, $p<0.001$) demands in training activities, showed significant positive effects on daily MF increase. In contrast, external demand ($\beta=-0.13$, $p=0.022$) substantially mitigated the elevation of MF.

CONCLUSION: Athletes and coaches should recognize the prevalence of MF in fencing and its subsequent impact on reaction performance, particularly on match days. The effects of training variables on daily MF changes suggest the potential of individually tailoring training load and content for active MF management. The focus could be switched between tactical, physical, and external demands in training activities. Finally, field-based MF monitoring should combine daily subjective perceptions with practical, individualized behavioral indicators for an optimal assessment in elite fencing athletes.

## Oral Presentations

### OP-MH42 Sedentary Behaviour

**THE EFFECTS OF REDUCING SEDENTARY BEHAVIOUR ON PERCEIVED WELL-BEING: A SIX-MONTH RANDOMISED CONTROLLED TRIAL**

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INTRODUCTION: High sedentary behaviour (SB) associates with cardiovascular risk factors, which in turn associate with poorer perceived well-being. Therefore, reducing SB could improve well-being in adults with cardiovascular risk factors. However, evidence from interventional studies is scarce. To fill this gap, this randomised controlled trial investigated whether a six-month SB-reducing intervention affects perceived well-being among adults with cardiovascular risk factors.

METHODS: Sixty-four adults with high accelerometer-measured SB (>10 h/day), overweight or obesity, physical inactivity, and metabolic syndrome (58 % women, 58 [SD 7] years old, SB 10 [1] h/day) were randomised to the intervention group (n=33) that aimed at reducing daily SB by 1 h for six months, or to the control group (n=31) that continued their usual activity behaviour. In the intervention group, the reduced SB was replaced by individually discussed non-exercise activities. All participants wore accelerometers connected to a mobile application throughout the study to monitor their daily SB and physical activity in relation to the individually set goals. Perceived well-being was measured using four questionnaires before, at the midpoint, and after the six-month intervention: RAND-36 (quality of life), PSQ (perceived stress), GHQ-12 (depressive symptoms), and workability score.

RESULTS: Compared to the control group, the intervention group reduced SB by 40 min/day. Half of the reduced SB was replaced by light physical activity and standing, and half was replaced by moderate-to-vigorous physical activity. The vitality score in RAND-36 decreased in the control group and increased in the intervention group, and the difference was significant at three months ($p=0.012$) and near-significant at six months ($p=0.079$). PSQ-measured perceived stress increased in both groups (time $p=0.033$) without statistically significant differences between groups ($p=0.143$).

CONCLUSION: A six-month intervention aimed at reducing daily SB by 1 h may improve perceived vitality among adults with metabolic syndrome, high SB, and physical inactivity. Therefore, reducing SB could be considered if fatigue or tiredness is a concern.

**RANDOMIZED CROSS-OVER TRIAL OF MUSCLE ACTIVITY-MATCHED INTERRUPTIONS TO SITTING IN TYPE 2 DIABETES: GLUCOSE AND INSULIN CHANGES**

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INTRODUCTION: Physically active interruptions to prolonged sitting have beneficial effects on glucose and insulin metabolism, potentially through increased muscle activity. However, it remains unclear if specific movement patterns, such as standing up and moving, may be more effective. We examined the effects on glucose and insulin in those with type 2 diabetes (T2D) of prolonged sitting interrupted by standing, seated pedaling, and sit-to-stand transitions—each matched for total muscle activity

METHODS: In a randomized crossover trial, 24 inactive overweight/obese adults with T2D (15 women, 61.3 ± 8.1 y) underwent four 6.5-h conditions on four separate days (with 3–14 days washout). Trial days included a 30-minute seated

steady-state, followed by different one-hour bout conditions repeated six times and ending in 30 minutes of sitting. Conditions were uninterrupted sitting (control; SIT), sitting 30-min and standing 30-min (STAND), sitting plus 6-13-min seated pedaling (PEDAL), and sitting plus 2-7-min sit-to-stand transitions (TRANS). Standardized meals were consumed during each condition. Total areas under the curve (tAUCs) for glucose and insulin were compared between conditions using generalized linear mixed models. Participants' total muscle activity for the active conditions was tailored to match the STAND muscle activity by modifying the duration of seated pedaling versus sitting and sit-to-stand transitions versus sitting within the one-hour bouts.

RESULTS: Compared with SIT, both PEDAL and TRANS significantly attenuated tAUCs for glucose (SIT: tAUC mean 121.8 mmol [95% CI 112.9, 131.4] vs. PEDAL: 117.1 [108.6, 126.4] and TRANS: 116.9 [108.3,126.1]), and for insulin (SIT: tAUC 977.2 pmol [738.9,1292.6] vs. PEDAL: 772.9 [584.5, 1022.0] and TRANS: 773.9 [584.5 to 1024.8]).

CONCLUSION: Interrupting prolonged sitting with brief bouts of seated pedaling or sit-to-stand transitions, but not with standing, can attenuate acute total areas under the curve for glucose and insulin responses in adults with T2D. These findings suggest that within periods of prolonged sitting, dynamic muscle activity, with either seated or upright posture, can be more effective than prolonged standing for reducing glucose and insulin responses.

**THE SPATIAL MISMATCH BETWEEN COMMUNITY PHYSICAL ACTIVITY VULNERABILITY AND URBAN GREEN SPACE ACCESSIBILITY CHARACTERIZES HEALTH PERFORMANCE INEQUALITY**

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INTRODUCTION: Physical activity is influenced by both individual and social environmental factors, and the use of urban green spaces (UGS) is closely related to health. However, urban population growth has led to an imbalance in the supply and demand of UGS, affecting the vulnerability of physical activity and health. This study evaluates the matching of UGS supply and demand and proposes green space compensation strategies to enhance residents health.

METHODS: A physical activity vulnerability index was developed to assess the ability of physical activity and the environment to counteract external pressures at the street level. Taking old communities in Harbin as an example, indicators such as population density and green space quality were selected from three dimensions—exposure, sensitivity, and adaptability—to construct an evaluation system. ArcGIS was used to calculate the indicators. Based on the index, street vulnerability was classified into four categories (low, relatively low, relatively high, and high), and the two-step floating catchment area (2SFCA) method was used to evaluate UGS accessibility.

RESULTS: Firstly, the northwestern part of the selected area has high accessibility to UGS, while residents in old communities in the central and southern parts have relatively high accessibility. Some areas in the northeastern suburbs, however, lack access to any services. Secondly, there are significant differences in accessibility among regions with varying levels of vulnerability ($p < 0.001$), with an overall trend of higher vulnerability in the northeast and lower vulnerability in the northwest. This indicates that regions with relatively high and high vulnerability are at a disadvantage in accessing UGS services. Areas with high vulnerability generally have higher population outflow rates and elderly population proportions compared to low-vulnerability areas. Finally, the community vulnerability index and UGS accessibility show significant spatial autocorrelation ($p < 0.05$, with Moran's I value close to 1).

CONCLUSION: The research findings indicate significant inequalities in the accessibility of UGS and the quality of green spaces in residential areas, leading to potential disparities in the physical activity benefits for residents. Residents of older neighborhoods face greater challenges in accessing well-equipped UGS, which may be a result of urban planning prioritizing short-term gains over the needs of residents. Future planning should prioritize increasing green spaces in areas lacking UGS, with a rational layout and diversified facilities to enhance residents physical activity and health levels. Meanwhile, the internal green space quality in low-vulnerability residential areas is generally lower, posing greater public health risks. It is recommended to prioritize the addition of UGS near these areas to ensure that different vulnerability groups equally benefit from the health-promoting services of UGS, thereby narrowing health disparities.

**EVALUATION OF PHYSICAL FITNESS, BIOCHEMICAL PARAMETERS AND OXIDATIVE STRESS STATUS BEFORE AND AFTER A 24-WEEK WORKPLACE PHYSICAL ACTIVITY INTERVENTION ON ADULT WOMEN OF AN ACADEMIC COMMUNITY.**

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INTRODUCTION: Workplace physical activity interventions (WPAI) are widely recognized for improving employees health, slowing down the ageing process (1) and boosting immunity through an increase in oxidative stress and antioxidant potential (2), but results remain inconsistent. The aim of this study was to evaluate the potential association between physical fitness (PF), biochemical parameters and oxidative stress status before and after a 24-week WPAI on adult women of a university community.

METHODS: Twenty-nine university female employee, aged 50 ± 13.5 years, followed a 24-week WPAI consisting of two circuit training sessions and one mobility session per week. Physical fitness was evaluated as follows: cardiorespiratory fitness (CRF) with 2-min step test (2MST), upper limb strength with Handgrip test, upper body mobility with shoulder-neck test, core endurance with sit-up test, lower limb strength with jump and reach test, balance with one-leg stand test. Total

cholesterol (TC), LDL-cholesterol (LDL-C) and glycemia were assessed before (T0), after 12 weeks (T1) and after 24 weeks (T2). Oxidative stress (d-ROMs test), PF and markers of antioxidant status (BAP test) were assessed at T0 and T2.

RESULTS: 2MST scores increased from 78.8 ± 16.6 (baseline) to 88.3 ± 20.1 (T2). At baseline, women with higher CRF values (>=65 steps in 2MST) showed lower d-ROMs values (378.6 ± 88.9 vs 472.6 ± 118.8 U-CARR) and higher BAP values (2729.3 ± 537.4 vs 2073.0 ± 933.4 µmol/L), compared to those with lower CRF values (<65 steps in 2MST). TC, LDL-C and glycemia values decreased from baseline (199.5 ± 41.1, 120.5 ± 38.7, 90.6 ± 18.0 mg/dl) to T2 (181.2 ± 33.5, 106.6 ± 32.5, 82.2 ± 9.6 mg/dl) with p<0.05, <0.01, < 0.05, respectively. D-ROMs values ranged from 410.4 ± 104.4 at T0 to 464.0 ± 116.4 U-CARR at T2 (p<0.01) while BAP values ranged from 2596.7 ± 632.3 at T0 to 2727.5 ± 569.1 µmol/L (p<0.05) at T2.

CONCLUSION: At baseline a higher CRF was positively associated with lower oxidative stress, suggesting that aerobic fitness may play a protective role. An adapted 24-week WPAI showed improvements in CRF, cholesterol and glycemia in blood samples and an improvement of the oxidative stress status. Specifically, although a significative increase of the ROMs was found, the WPAI may have led to an increase of the antioxidant potential, therefore contributing to boosting protection from absolute oxidative stress.

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2)Meng Q, Su CH. The Impact of Physical Exercise on Oxidative and Nitrosative Stress: Balancing the Benefits and Risks. Antioxidants (Basel). 2024;13(5):573. Published 2024 May 7. doi:10.3390/antiox13050573

**THE CRITERION VALIDITY OF THE ARABIC SEDENTARY BEHAVIOR QUESTIONNAIRE AGAINST ACTIGRAPHY ACCELEROMETERS AND PEDOMETERS IN ADULTS**

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INTRODUCTION: The aim of this study was to test the criterion validity of the Arabic Sedentary Behavior Questionnaire (ASBQ) against accelerometers and pedometers in male and female university students.

METHODS: A total of 151 university students, aged 21.90 ± 1.36 years (55% female), participated in the study. Sedentary behavior (SB) was assessed using the ASBQ in a face-to-face interview. SB and physical activity (PA) were measured in 71 students using an Actigraph for 7 consecutive days. Daily steps of an additional 80 students were objectively measured using pedometers for 7 consecutive days.

RESULTS: On average, students reported 557.58 ± 178.58 minutes/day of SB using the ASBQ. A paired sample t-test revealed a significant difference between the ASBQ and Actigraph, with a mean difference of −332.45 minutes/day (95% CI: −398.44 to −266.45; P < 0.001), indicating that the ASBQ underestimated sitting time compared to the Actigraph. The mean difference for average sitting time was −332.45 minutes/day (95% limits of agreement: −878.92 to 214.03), suggesting a systematic bias between the ASBQ and Actigraph measures of sitting time. No significant correlation was found between the average sitting time estimated by the ASBQ and the average sitting time measured by the Actigraph (r = −0.06, P = 0.59). A small inverse correlation was observed between total sitting time reported by the ASBQ and the index of sedentary lifestyle (<6,000 steps/day) measured by pedometers (r = −0.26, P = 0.05). The ASBQ results also showed gender differences opposite to those observed with the Actigraph. A small inverse correlation was found between total sitting time from the ASBQ and moderate-to-vigorous physical activity (MVPA) (r = −0.26, P = 0.05), though no correlation was observed with light-intensity physical activity (LIPA) (r = −0.03, P = 0.79).

CONCLUSION: The current study revealed a low correlation between the ASBQ and the reference tool (Actigraph). Although the ASBQ tended to underestimate daily sedentary time compared to accelerometry, our findings support its use as a reasonable tool for estimating sedentary time in adults in Arab-speaking countries.

## Oral Presentations

### OP-PN23 Immobilisation and Bed Rest

**SHORT-TERM UNILATERAL LOWER LIMB SUSPENSION: A VIABLE MODEL FOR INVESTIGATING EARLY MUSCLE ATROPHY RESPONSES**

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INTRODUCTION: locomotor muscles such as the knee extensors and the plantar flexors. Prolonged bed rest can lead to a reduction in muscle mass of up to 30%. However, the onset of muscle atrophy is rapid, with measurable changes occurring within a few days of disuse. A 3% reduction in the cross-sectional area of the thigh muscle has been observed after only 5 days of full leg casting 1. Although the full leg cast model is frequently used for studies investigating the initial mechanisms of muscle atrophy, it has some serious drawbacks. The angle of fixation can influence the number of serial sarcomeres. Fixation also makes it difficult to adapt the model outside of clinical investigations, for example in studies investigating atrophy induced by spaceflight, as the joint is fixed in an unnatural position. One option to overcome these

limitations is the unilateral lower limb suspension (ULLS) model, in which the intervention limb is unloaded by lifting the contralateral limb with a plateau shoe. This allows the unloaded limb to assume a straight position and move passively and freely around the hip, which is closer to the situation of an astronaut in weightlessness. To date, there have been no studies investigating whether the ULLS model results in comparable changes in muscle volume to those reported for short periods of bed rest and full leg casting. Therefore, this study aimed to investigate the changes in muscle volume induced by 5 days of ULLS.

METHODS: At the time of abstract submission, a total of 11 subjects have completed the 5-day ULLS protocol, 8 men and 3 women. At the congress we will have data from 20 participants, equally divided between the sexes. The volume of the quadriceps muscle was measured by MRI before and after the five-day unloading. All subjects wore a thermometer patch on the gastrocnemius muscle on both legs, which recorded the skin temperature every minute during the unloading phase.

RESULTS: The intervention resulted in a significant decrease (2.35 ± 1.45%) in m. quadriceps in the unloaded leg (894.7 ± 323.8 cm3 vs 873.7 ± 319.5 cm3, $p < 0.05$). The control leg was unaffected (917.5 ± 323.5 cm3 vs 920.0 ± 327.1 cm3, $p > 0.05$). The magnitude of muscle loss was similar between the sexes (females; -2.35 ± 1.57%, men; -2.36 ± 1.52%). The skin temperature in the unloaded leg was on average 4.2 ± 1.3 °C lower than in the control leg during daily activities.

CONCLUSION: Our preliminary data shows that short-term ULLS produces similar changes in m. quadriceps to those previously reported for bed rest and full leg casting protocols of the same length. This means that the method is suitable for interventions aiming to investigate the early responses of muscle atrophy. We also show that men and women respond similarly, and that continuous temperature monitoring can serve as a tool for protocol compliance.

1 Wall, BT et al. (2014). Acta Physiol. 210, 600–611

**THE EFFECT OF DIETARY BRANCHED CHAIN AMINO ACID RESTRICTION ON FOREARM MUSCLE PROTEIN SYNTHESIS AND AMINO ACID KINETICS DURING DISUSE IN YOUNG, HEALTHY INDIVIDUALS**

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INTRODUCTION: Skeletal muscle loss occurs during short-term muscle disuse, e.g. immobilisation following injury. Muscle disuse is accompanied by a decrease in muscle protein synthesis (MPS) rates and branched-chain amino acid (BCAA) accumulation. However, the relevance of BCAAs in disuse atrophy remains unclear. Thus, we aimed to manipulate muscle BCAA availability via a BCAA restricted diet to assess its impact on MPS and amino acid kinetics during forearm immobilisation.

METHODS: Twenty healthy participants (15/5 M/F; 22±1 yrs, BMI 22.7±0.5 kg·m-2) attended two metabolic test days before (PRE) and after (POST) 48 h forearm immobilisation, during which they were randomly allocated to a control (CON; n=10) or BCAA restricted diet (BCAA-; n=9). During immobilisation, CON consumed a fully controlled diet (50-55 en% carbohydrates, 25-30 en% fat, and 1.5 g·kg-1·day-1 protein [15-20 en%]) containing 20.0±0.7 $g \cdot d^{-1}$ BCAA), whilst BCAA- consumed the same macronutrient matched diet but with 0.9±0.1 $g \cdot d^{-1}$ BCAA. An intravenous infusion of L-[ring-2H5]phenylalanine with repeated arterialised-venous forearm balance samples and m. brachioradialis forearm muscle biopsies in fasted and clamped (hyperinsulinaemic [50 mU·m-2·min-1]-hyperaminoacidaemic [0.11 g·kg-1·h-1]-euglycaemic [5.0 mmol·L-1]) conditions was used to explore the flux of amino acids between 3-pools (arterialised, venous, and intracellular [IC] pools) and mixed muscle fractional synthesis rate (FSR). Data (mean±SEM) were analysed via a 3-way repeated measures ANOVA with clamp, immobilisation and diet as factors.

RESULTS: BCAA- reduced fasted arterialised plasma leucine concentrations (PRE: 125.1±6.5 to POST: 108.6±8.1 µmol·L-1; $P<0.05$), resulting in lower concentrations POST compared to CON (135.6±6.4 µmol·L-1; $P<0.05$). Fasted IC pool phenylalanine and leucine concentrations increased by 26±9% and 24±9% POST in CON, respectively (both $P<0.05$), but remained unchanged in BCAA- ($P>0.05$). Phenylalanine net balance (NB) decreased by 56±6% (fasted) and 67±6% (clamp) from PRE to POST ($P<0.05$), with no effect of diet ($P>0.05$). Three-pool amino acid fluxes increased after clamp ($P<0.05$) but were not affected by immobilisation or diet ($P>0.05$). Forearm FSR increased from PRE to POST ($P<0.05$) but was not affected by diet (PRE: CON 0.052±0.008, BCAA- 0.041±0.007%·h-1; POST: CON 0.103±0.027, BCAA- 0.058±0.015%·h-1; $P>0.05$).

CONCLUSION: Dietary BCAA- decreases plasma leucine concentrations and suppresses intracellular amino acid accumulation but does not affect three-pool amino acid kinetics or MPS during short-term immobilisation. Forearm immobilisation decreases forearm phenylalanine NB, indicating early muscle protein loss, but does not affect 3-pool modelled amino acid fluxes. The rise in MPS after immobilisation may be attributed to intracellular amino acid accumulation, providing leads for future research on the role of extra- and intracellular amino acid availability in muscle disuse atrophy.

**EFFECT OF COMBINED BETA-LACTOGLOBULIN SUPPLEMENTATION PLUS RESISTANCE TRAINING PREHABILITATION ON MUSCLE PROTEIN SYNTHESIS RATES FOLLOWING LIMB IMMOBILISATION IN HEALTHY YOUNG MALES AND FEMALES**

HUGHES, A., FRANCIS, T., MARJORAM, L., ROONEY, J.H., ELLISON-HUGHES, G., POLLOCK, R., CURTIS, M.J., CAPE, A., LARSEN, M., PHILLIPS, B.E., ATHERTON, P.J., SMITH, K., WELSH, B., LAI, Y.C., WITARD, O.C.

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INTRODUCTION: Periods of muscle disuse occur across the lifespan due to illness, injury, and hospitalisation, suppressing muscle protein synthesis (MPS) rates and leading to muscle atrophy and a reduction in physical performance and quality of life. To date, no studies have investigated use of a combined exercise and nutrition prehabilitation regimen to mitigate declines in MPS or muscle mass during a period of disuse. This study aims to investigate the effect of beta-lactoglobulin (BLG), a leucine rich protein, supplementation combined with resistance exercise training before 5-days of unilateral limb immobilisation on muscle mass, strength, and MPS rates.

METHODS: We conducted a randomised, placebo-controlled trial whereby healthy young adults (n=11) ingested a BLG supplement or a dextrose monohydrate placebo (PLA) thrice daily for 1-wk prior to, and during, 5-d of unilateral limb immobilisation. Participants completed four sessions of resistance training during the week prior to immobilisation. Deuterium oxide tracer methodology was used to measure free-living MPS rates in response to prehabilitation and muscle disuse. Measurements of thigh lean mass by dual energy x-ray absorptiometry and muscle strength by isokinetic dynamometry were conducted at baseline, pre-immobilisation (post-exercise training), and post-immobilisation.

RESULTS: Thigh lean mass remained unchanged for BLG (3.1±12.9% pre-immobilisation, 1.7±12.5% post-immobilisation) and PLA (2.2±5.4% pre-immobilisation, 0.4±6.6% post-immobilisation) in response to prehabilitation and muscle disuse. Isometric strength increased in BLG (12.7±16.9%) and PLA (12.6±13.9%) with exercise training, but declined to below baseline in BLG (-3.0±17.4%) and baseline levels in PLA (0.6±16.2%) following immobilisation. Isokinetic strength appeared to decline to a greater extent in BLG than PLA (BLG: -4.7±19.0% pre-immobilisation, -19.5±22.8% post-immobilisation, PLA: 25.7±9.9% pre-immobilisation, -1.5±13.2% post-immobilisation). However, the decline in MPS in response to disuse was attenuated in BLG compared with PLA (change pre- to post-immobilisation, BLG: -23.7±7.4%, PLA: -41.2±12.7%). Protein expression of muscle protein breakdown (MPB) markers indicated a pre-post immobilisation increase in MuRF1 (BLG: 60.7±51.3%, PLA: 57.1±39.5%) and Atrogin-1 (BLG: 55.9±26.6%, PLA: 43.8±31.4%) in both groups.

CONCLUSION: To conclude, BLG supplementation combined with resistance exercise as a prehabilitation strategy may attenuate the decline in MPS following 5-d of immobilisation. However, the improvements in MPS in BLG did not appear to translate to the better preservation of muscle mass and strength compared with PLA, of which the PLA group achieved better outcomes. An increased expression of MPB markers in both groups may be explained by the novel resistance exercise training stimulus, although immobilisation also elicited elevations in MuRF1 and Atrogin-1 levels above baseline.

**SKELETAL MUSCLE MEMORY OF REPEATED DISUSE-INDUCED ATROPHY**

TURNER, D., RAASTAD, T., SEYNNES, O., ULLRICH, M., CHRISTIANSEN, S., HALLÉN, J., SUTHERLAND, H., TREEBAK, J., KELLEZI, E., OWENS, D., HUGHES, D., BODINE, S., JARVIS, J., SHARPLES, A.

*UNIVERSITY OF PAVIA*

INTRODUCTION: Skeletal muscle (SkM) possesses a positive memory of hypertrophic stimuli. However, it is unknown whether SkM has a negative memory of disuse-induced atrophy. The present study therefore investigated the physiological and genome-wide transcriptional response to repeated disuse in young adult human and aged animal SkM.

METHODS: Ten healthy young adult humans (27 ± 4 yrs) underwent 2 wks of lower limb immobilization, 7 wks recovery and 2 wks repeated disuse. Aged rats (F344, 22-24 months, n = 3/condition) underwent 1 wk of tetrodotoxin-induced disuse of the dorsiflexors, 1.5 wks recovery and 1 wk repeated disuse. Before and after each period of disuse, SkM tissue was obtained, and SkM mass, size and strength were assessed. Subsequent transcriptomic analysis (RNA-seq) was performed on human vastus lateralis (VL) and rat tibialis anterior (TA) muscles. A one-way ANOVA with Tukey post-hoc comparisons detected significant physiological changes ($p < 0.05$). Differentially expressed genes (DEGs) were detected via FDR < 0.05 with ≥20% change. Data presented as mean ± SD.

RESULTS: In young humans, leg lean mass, VL muscle cross-sectional area (CSA) and quadriceps strength were significantly reduced after disuse (-4%, -9%, -12-14%, respectively) that were fully restored following recovery. Repeated disuse induced comparable reductions in lean mass, CSA and strength to those seen during earlier atrophy. In aged rats, there was a progressive loss of SkM mass following disuse (-4%), recovery (-18%) and repeated disuse (-30%). Transcriptomic analysis revealed that a larger number of DEGs were downregulated than upregulated after disuse and repeated disuse in adult and aged SkM. In young SkM, disuse evoked 4-fold more DEGs (384) vs. repeated disuse (104), with no DEGs post-recovery. Conversely, a 2-fold greater number of DEGs were identified after repeated disuse (3948) than during earlier disuse (2115) and recovery (2058) in aged SkM. Energy sensing, oxidative metabolism and mitochondrial-related pathways were most enriched after both periods of disuse in both young human and aged rat SkM. Temporal mRNA profiling in young SkM suggested most genes recovered and did not show greater reductions after repeated disuse. In contrast, genes that were altered with disuse in aged SkM were more susceptible to larger, exaggerated changes after repeated disuse. Many genes demonstrated a retained memory profile into recovery following earlier disuse in aged rats or displayed enhanced regulation following repeated disuse relative to young humans.

CONCLUSION: Repeated disuse evokes comparable physiological responses associated with reduced transcriptional perturbations following repeated disuse-induced atrophy in young adult humans. Conversely, SkM wasting is exacerbat-

ed upon repeated disuse in aged rats that is associated with retained or exaggerated transcriptional changes. Further analysis will confirm whether the transcriptional profiles are underpinned by epigenetic mechanisms.

**EFFECTS OF DISUSE ON MITOCHONDRIA AND NEUROMUSCULAR JUNCTIONS IN YOUNG AND OLDER ADULTS**

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*UNIVERSITY OF PADOVA*

INTRODUCTION: Physical activity is essential for muscle health, improving strength, metabolic functions, and cardiovascular health. In contrast, inactivity reduces muscle mass, strength, and overall functionality (Narici & M. D. de Boer, Eur J Appl Physiol, 2010).

Skeletal muscle is a highly innervated tissue and relies on the neuromuscular junction (NMJ) for contraction. Mitochondria are vital for both NMJ and muscle function, supplying energy for neurotransmission and contraction. Evidence indicates that prolonged inactivity disrupts both mitochondrial function and NMJ stability (Sarto et al., J Physiol, 2022; Eggelbusch M et al., Cell Rep Med, 2024). In this study, we hypothesised that inactivity would provoke mitochondrial changes in skeletal muscle, potentially leading to NMJ alterations.

METHODS: To test our hypothesis, we investigated the relationship between mitochondrial function and NMJ morphology following chronic inactivity in both young and older adults. Specifically, we analysed mitochondrial respiratory capacity, ROS production, mitochondrial complexes and supercomplexes abundance, mitochondrial dynamics, and morphology in relation to NMJ integrity.

9 young (18-29 years) and 10 older (65+ years) participants underwent bed rest—10 and 21 days for the younger group and 10 days for the older group—with vastus lateralis muscle biopsies collected before and after bed rest.

RESULTS: In the older group, inactivity decreased the overlap between the motor axon terminal and the post-synaptic specialisations and led to an increase in C-terminal agrin fragment (CAF), a marker of NMJ instability. These changes were also linked with increased ROS production and altered mitochondrial dynamics. Although no visible changes in mitochondrial fission or fusion were observed, there was a reduction in mitochondrial volume density.

In the younger group, after 10 days of bed rest, mitochondrial changes occurred without a corresponding increase in CAF. These changes included shifts in mitochondrial dynamics and reduced volume density. However, after 21 days, both mitochondrial alterations and increased CAF were observed, suggesting that mitochondrial dysfunction may precede NMJ remodelling.

CONCLUSION: In conclusion, our results suggest that inactivity-induced mitochondrial changes in skeletal muscle could be an early driver of NMJ instability. However, the specific role of mitochondria in presynaptic terminal deterioration remains uncertain, requiring further research, especially in the context of ageing and inactivity.

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## Oral Presentations

### OP-SH03 Philosophy and Ethics

**DISCRIMINATION OR PROTECTION? INVESTIGATING THE ETHICS OF LIMITING PARTICIPATION IN SPORTS ON PUBLIC HEALTH AND INDIVIDUAL WELL-BEING GROUNDS**

SESA, G., BORRY, P., LOLAND, S., CAMPORESI, S.

*KU LEUVEN & NORWEGIAN SCHOOL OF SPORT SCIENCES*

Inclusivity is a core value in sports, yet athletes with health conditions are often excluded from participation. Over the past decade, various restrictions have been imposed by governments and sports federations, from limiting sports participation for controlling infectious disease outbreaks to barring athletes with chronic or infectious conditions from participating in sports (Michelini et al., 2021; Magavern et al., 2017). The boundary between unjustly discriminating individuals with a health condition from accessing and participating in sports and justifiably excluding them to safeguard their health or that of others is ambiguous and requires further investigation. This paper seeks to investigate whether and when such exclusions are ethically justified. In doing so, we adopt a collective reflective equilibrium approach, first specifying well-established public health ethical principles and frameworks, next discussing the application of such principles and frameworks to real-world cases, and ultimately developing a framework based on the balancing of the principles and frameworks (Savulescu, 2025). Specifically, we analyze and draw conclusions from four distinct cases: a professional boxer living with HIV, a professional soccer player with a cardiovascular condition, an athlete struggling with an eating disorder, and the exclusion of a 12-year-old from grassroots sports due to mandatory vaccination policies. We conclude that several key factors must be considered when evaluating the ethical justification for sports participation restrictions. Established public health ethics principles—such as beneficence, utility, fairness, respect for human dignity, justice, and transparency —must be operationalized within the sports context. Additionally, novel dimensions—including the nature of the disease, the type of sport, and individual health status—influence how these ethical principles are weighted in deci-

sion-making. We also acknowledge and emphasize the critical role of education and ongoing health monitoring for athletes, to promote safe participation in sports. Together, these considerations provide a foundation for guiding justifiable decisions in sports eligibility and in distinguishing between justifiable and unjustifiable discrimination. Future research should engage a diverse range of stakeholders to gather insights on the practical applicability of the proposed framework.

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Savulescu, J. (2025). Collective reflective equilibrium, algorithmic bioethics, and complex ethics. Cambridge Quarterly of Healthcare Ethics, 34, 1–16.

**SCIENTIFIC THINKING ON SPORTS AND HEALTH ETHICS IN THE ERA OF DIGITAL INTELLIGENCE CIVILIZATION**

JIA, Y., GONG, Z.

*SHANGHAI UNIVERSITY OF SPORT*

Scientific Thinking on sports and Health ethics in the Era of Digital Intelligence Civilization

Jia Yuzhen Gong Zhengwei

Shanghai University of Sport

INTRODUCTION: The rapid development and widespread application of technologies such as big data, artificial intelligence, the Internet of Things, and cloud computing are fundamentally reshaping the practices, decision-making mechanisms, and social structures in the fields of sports and health, leading humanity into the digital intelligence era. In the digital intelligence era, the connotations of sports ethics are undergoing profound changes. This change is not only reflected in the application of traditional ethical principles but also involves ethical considerations brought about by emerging technologies.

METHODS: The research adopts various methodologies such as literature, logical analysis, interdisciplinary research, case analysis, etc.

RESULTS: (1) The core issues of sports and health ethics in the digital era. First, data privacy and security issues. When early wearable devices and health data acquisition systems first emerged, people were concerned about how data helps individuals optimize their health without fully considering the risk of data abuse. Second, algorithm fairness and discrimination. AI is increasingly used in sports training, injury prediction, event referees, etc., but the scientificity, fairness and transparency of its decisions are controversial. Third, the fairness of sports is impaired. the emergence of technologies such as gene editing, AI-assisted training, and brain-computer interfaces has enabled athletes to improve their abilities to break through the boundaries of traditional "natural person" competition and challenge the fairness and ethical bottom line of sports.

(3) The normative construction of sports and health ethics in the digital era. In the construction of normative construction of sports technology ethics, we often face the "Collingridge Dilemma". The Colingridge dilemma needs to be solved by introducing ethical factors in the process of technological development. There are two main paths for ethical intervention: constructive technology evaluation and technical moral design. The ethical design of technology and constructive technology evaluation should form a continuous ethical monitoring mechanism to ensure the ethical compliance of the technology during the application process.

CONCLUSION: The application of digital intelligence technology is not only a technical issue, but also a social issue, involving values, rights distribution and social fairness. The core of the scientific thinking of the digital era for sports and health ethics is how to find a balance between technological innovation and ethical constraints, ensure that technology serves the comprehensive development of mankind, and at the same time maintains basic values such as fairness, privacy and dignity.

References

**COMPARATIVE ANALYSIS OF FOOTBALL COACH EDUCATION: EVOLUTION, STRATEGIES, AND DEVELOPMENT IN ENGLAND AND CHINA**

WU, Y., REN, D.

*BEIJING SPORT UNIVERSITY*

INTRODUCTION: Coaches play an important role in athletes' learning and development, as their coaching philosophy, competencies, and effectiveness are vital to improving their performance. Since 1997, The Football Association (FA) has implemented its "A Charter for Quality," which has significantly influenced how coaches think and deliver, expanded the coaching workforce, and laid a solid foundation for talent identification and development.

METHODS: This study employed documentary and comparative analysis to systematically examine the developmental trajectories of football coach education in England and China. The search was conducted across multiple databases,

yielding 126 relevant articles and books(e.g. Advances in Coach Education and Development(2016) and coach education materials).

RESULTS: The historical trajectory of England's football coach education is categorized into four stages—Enlightenment (1863–1901), Development (1902–1966), Reform (1967–1999), and Takeoff (2000–present). Crucial milestones include sustained government policy support, collaborative societal supervision of qualifications, innovative pedagogical frameworks, and a structured coaching course curriculum.

In contrast, China's formal football coach training originated in 1979 and aligned with the Asian Football Confederation (AFC) certification system between 1994 and 2001.

Discussion: Formal football coach education in England originated in the 19th century during clashes between the ideals of amateurism and professionalism. Regularization began in the early 20th century when the FA introduced standardized coaching courses with professional certification. Mid-20th-century reforms, driven by the National Vocational Qualifications (NVQs) framework and sustained funding, accelerated the expansion of coach education. In the 21st century, a pedagogical paradigm shift embraced social constructivism, prioritizing learner-centered approaches and collaborative knowledge-building.

Policy continuity has underpinned England's coach education system. The 2002 reports by the Department for Culture, Media and Sport (DCMS) pledged nearly £30 million in funding for coaching. Its tiered certification system expands access (Levels 1–2 for grassroots) while maintaining high standards (Levels 3–5 aligning with UEFA B, A, and Pro licenses). The FA also considers the needs of ethnic minority and disabled coaches. Following a shift in pedagogical methodology, this program emphasizes reflection and critical thinking.

For China, the study underscores the need for long-term strategic planning to expand coach education by leveraging centralized resource mobilization. Cross-sector collaboration between sports departments, educational organizations, and social institutions is critical for reforming certification systems, lowering entry barriers, streamlining administration, and delegating power.

**A COMPARATIVE STUDY ON THE DEVELOPING TRENDS OF CIVIC SPORTS IN CHINESE AND EUROPEAN FEUDAL SOCIETIES**

ZHANG, A., YU, C.

*BEIJING SPORT UNIVERSITY*

INTRODUCTION: The rise of civic sports took place in both Chinese and European feudal cities, but they followed different paths. By comparing the two types of civic sports, this study tends to explores their differences and underlying reasons.

METHODS: Utilizing the methods of literature review and historical comparative, this paper sorts out the different developing trends of civic sports in Chinese and European feudal societies.

RESULTS: Although civic sports and their organizations emerged in feudal China and Europe, the developing trajectory of them differed largely.

Firstly, different relationships between civic sports and military led to different degree of confrontation of the bodies of the participators. Because the strong centralization of power in Chinas feudal society opposed the practice of martial arts among the people, Chinese civic sports emphasized the aesthetic effect of physical technology but not the intense of the physical actions. While in Europe, served both of the self-defense of the city and needs of entertainment of the citizens, civic sports pursued the competitiveness of proceed and the fairness of the results.

Secondly, different relationship between civic sports and education led to different historical trends. The civic sports was rejected by Chinese feudal education system which valued morality over physical movement, so that it could only develop along the traditional path with the rise and fall of the feudal economy. In the late medieval Europe, educators modified sports into education to cultivate "the whole people". Civic sports were standardized and scientific and got the foundation of modernization.

Lastly, different relationship between civic sports and royal power led to different social status. The feudal lord class in feudal China regarded civic sports as inferior peoples games and prohibited the nobles to participate. Civic sports in feudal European cities were protected by communes and guilds, even the king, and accepted by the bourgeoisie following the cities' industrialization.

CONCLUSION: The feudal centralized system and the concept of "emphasizing intelligence over body" narrowed the survival space of civic sports in China and making it impossible to get rid of the traditional trajectory. While in feudal Europe, monarchy allied with the city, encouraged the development of civic sport and its economic base, which enabled civic sport to modernize with the citys industrialization.

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**BODY POLITICS AND TRANSFORMATION OF CITIZENSHIP IN THE HANKOW HORSE RACING (1861-1949)**

YU, C., ZHANG, A.
*BEIJING SPORT UNIVERSITY*

INTRODUCTION: Horse racing, as a symbol of colonial modernity, served as a tool for colonists to enforce bodily discipline through discipline, competition, and health. It also became a key field for shaping the body recognition and identity of Hankow's citizens. During urban modernization, Hankow citizens used this activity to reconstruct local modernity, creating a unique path that both echoed and conflicted with European humantistic notions of the body. This study aims to reveal how Horse racing acted as a tool of colonial power and how it was transformed by locals into a practice of identity reconstruction in pursuit of modern citizenship.

METHODS: This study use historical and comparative research methods, analyzing texts on Horse racing management and events from the Hankow Concession Gazette and Customs Reports. A comparison with 15th-century Florences Palio Races reveal the role of sports in shaping civil society across cultures.

RESULTS: The Horse racing in Hankow epitomizes the intersection of colonial modernity and local modernization. As a colonial tool, it reinforces racial and class distinction through bodily discipline; on the other hand, the civic class adapts it as a cultural resource to construct modern identities. This duality highlights the complex interactions of"being disciplined" and"self-enlightenment" in Chinas modernization. Compared to European Renaissance civic sports, Hankow's experience offers a critical perspective on non-Western societies' passive yet creative roles in the transformation of modernity, and provides a case study for the multiple paths of global modernity.

Discussion: 1.Colonial logic of physical discipline:

Horse racing in Hankow imposed Western"civilized body"standards on local citizens through strict schedules, spatial segregation, and behavior codes. The Hankow Club Regulations required Chinese attendees to dress appropriately and behave decorously, or they would be expelled, reflecting the colonial powers intention to divide social hierarchy through bodily control.

2.Reconstructing civic identity:

In the 1920s, Hankow women began attending horse races and even participated in equestrian performances, provoking debate about the"new woman's"body. Women's Magazine recorded ethical criticism of women in Western riding attire, highlighting the conflict between traditional morality and modern body ideals. Local elites transformed horse racing into a symbol of national revitalization by organizing the Chinese Businessmen' s Racing Association.

3.Dialogue with the Renaissance:

Florence' s Renaissance Palio horse racing centered on city-state honor, with citizens displaying courage and loyalty. In contrast, Hankow's horse racing was intertwined with colonial modernity, with civic identity construction constantly navigating the tension between"Westernization"and"localization". Both sports activities shaped public life, but Hankow's case more strongly exemplifies active resistance within passive modernity.

## 11:00 - 12:15

## Invited Symposium

### IS-EX03 ACSM-ECSS exchange symposium: Lactate metabolism

**LACTATE METABOLISM: FROM HYPOXIA TO SHUTTLES**

GLADDEN, G.
*AUBURN UNIVERSITY*

Lactate (La-) stands at the crossroads of glycolytic and oxidative energy metabolism. Studies of exercise and muscle metabolism from the 1700s to the mid-twentieth century asserted that La- is the product of anaerobic glycolysis, with "anaerobic" implying a lack or absence of oxygen (O2) availability for mitochondria. However, it is now appreciated that healthy mitochondria function well, even at low O2 levels such that dysoxia (O2 levels so low that mitochondrial oxidative phosphorylation is inhibited) is rare and low O2 is often a minor factor in the increasing concentrations of La- typically observed with exercise or even many acute critical care situations. Instead the basic mechanisms underlying La- production, removal, and accumulation emphasize stimulation of key glycolytic enzyme activities, limitations to lactate removal, and the distribution of La- among cells throughout the body and even within tumors. From its role in coordinating whole-body metabolism as a fuel to its role as a signaling molecule in tumors, the study of La- metabolism continues to expand and holds potential for multiple clinical applications. Various aspects of the history of La- metabolism, as well as the structures, processes and mechanism of La- appearance, disappearance, and exchange will be examined.

**LACTATE: ITS USE (AND MISUSE) IN SPORT**

JONES, A.
*EXETER UNIVERSITY*

Measurement of blood [La-] during exercise is a mainstay of fitness assessment, performance estimation and training prescription in athletes. However, the application and interpretation of such measurements has been mired in controversy. This presentation will outline several misunderstandings regarding the role of La- in exercise performance, particularly in relation to its role, or otherwise, in fatigue development. Despite these misconceptions, blood La- measurements continue to be valuable if used appropriately. Blood La- dynamics during exercise typically reflect changes in other muscle metabolites that might be more directly involved in fatigue development and help identify exercise intensity domains within which broader physiological responses are manifest - with implications for adaptations to training. While the La- threshold, or its pulmonary gas exchange counterpart, continues to find application in clinical settings, the highest exercise speed that can be sustained in a metabolic (including La-) 'steady state' is of particular importance in endurance sports. New approaches for defining this transition point will be described and the future directions for La- monitoring in athlete evaluation, training intensity assessment and exercise prescription will be considered.

## Invited Symposium

### IS-BM03 Biomechanical and physiological trade-offs in sprint and endurance performance: lessons from the animal kingdom to human athletes

**HOW HUMAN ATHLETES MOVE: TRADE-OffS IN ANATOMICAL AND PHYSIOLOGICAL DESIGN**

BLAZEVICH, A.
*EDITH COWAN UNIVERSITY*

Animals including human athletes move using energy generated (work done) by muscles, which are activated by the nervous system. Optimum movement performance can occur when muscle activation is maximal and coordination optimal (if maximum strength or speed are required) or when the energy cost of activation is minimized (if movement economy is required), so a trade-off between speed/strength and endurance is apparent. Peak muscle force is proportional to the muscle's physiological cross-sectional area (PCSA) while its maximum shortening speed is set by the length of its longest fibers. Yet, inertial masses increase with PCSA and fiber length, reducing limb (and whole body) acceleration and increasing energy cost, thus facilitating "fatigue". So, unless maximal force is primarily required, a balance must be struck between PCSA and fiber length to minimize mass. Thus, no single design allows force, speed, and efficiency (economy) to be optimized, and some balance must be achieved. And this balance must be achieved with consideration of muscle fiber types and fiber pennation angles (the latter influencing fiber rotation, and thus gearing during contraction), which also influence maximal muscle power. In human athletes (and nonathletes), fatigue manifests in the nervous system and muscles, and is affected by muscle coordination (efficiency) and muscle fiber type as well as muscle oxygen delivery (e.g. cardiac output) and utilization (e.g. capillarization). Here too there are trade-offs that affect the physiologic make-up of single individuals (and different animal species) while also governing the types of exercise training done by athletes. Finally, muscles suffer from velocity-related force limitations, impacting high-speed actions and imposing energy-related work limitations (i.e., fatigue). Long tendons can alleviate these problems by momentarily storing the energy of muscles and then releasing it rapidly – the rate of work is increased so power is amplified. Tendon action also reduces (or mitigates) the need for muscles to stretch and shorten, thereby reducing muscle damage (imposed during lengthening) and muscle work and thus energy cost (expensive during shortening), in turn reducing fatigue and improving endurance. Yet, tendon stiffness must vary with the force-time requirements of the task, dictating tendon properties to vary between muscles, between animals (incl. athletes in different disciplines), and over time as physical activity patterns change, imposing a dynamic stiffness-compliance trade-off. Utilizing this framework, the aim of this presentation is to explore trade-offs created by the need for muscle-tendon units to produce forces and power of different magnitudes, at different lengthening-shortening speeds, and over different overall durations. The presentation will investigate the impact of these trade-offs in animal design and on the training of human athletes.

**TRADE-OffS IN ANIMAL MOVEMENT: SPEED AND AGILITY VS ENDURANCE**

MCGUIGAN, P.
*UNIVERSITY OF BATH*

Investigating performance through an animal lens provides examples of where specialization has evolved due to one particular area of performance being key to the survival of an individual; and thus natural selection rather than training has been the driver of adaptations favoring speed and agility or endurance. Exploring these examples at both the organismal and muscle-tendon unit level provides insight into the potential trade offs of this specialization, which are not always as obvious as they might seem. This is because, even in what would be considered the most extreme examples of specialization, there are rarely only two traits that trade-off against each other and it is necessary to consider them within the more complex survival needs of the single animal. This presentation will explore these trade-offs through some examples

of animals using cursorial (running) and saltatorial (hopping) locomotion. The highly specialized digital flexor muscles of the horse enable highly efficient locomotion at slower speeds, but what constraints do their very short muscle fascicles and long tendons place on speed and agility and how would a change in the properties of the those tendons, due to injury or age, impact their function? The fastest land mammals (eg the cheetah) are undoubtedly extreme in terms of their speed and agility, with high peak power output of their hindlimb muscles compared to other large mammals, and about 20% higher than their prey species. But maximum muscle fiber stress (F/CSA) and power alone do not explain the differences between the large predators such as the cheetah and the lion, and in exploring the other factors that determine their remarkable speed and agility we can learn how trade-offs can be optimized to maximize hunting (i.e. survival) success. Finally, by also looking at a more generalist animal, the goat, we will demonstrate how trade-offs in the architecture of different muscles allows plasticity of function to adapt to highly different locomotion conditions (i.e. running, jumping and climbing).

**NEUROMUSCULAR ADAPTATIONS TO RESISTANCE TRAINING IN HUMAN ATHLETES: DO THEY HINDER OR HELP SPRINT AND ENDURANCE PERFORMANCE?**

BAS, VAN H.

*MAASTRICHT UNIVERSITY*

Resistance training results in numerous morphological and physiological adaptations. These adaptations are broadly considered beneficial for athletic performance as well as for reducing the risk of musculoskeletal injury. However, some practitioners believe that resistance training triggers morphological and physiological adaptations that may impair physical performance and increase injury risk. However, the morphological and physiological adaptations by which resistance training might impair physical performance, the likelihood of these being evoked, and the training program specifications that might promote such impairments, remain largely undefined. This presentation will discuss how selected adaptations evoked by resistance training may not only enhance but could also impair sprint and endurance performance, or lead to increased injury risk. The presentation will address specific resistance training program variables under which such beneficial or maladaptive adaptations may be likely to occur. Specifically, it will be demonstrated that high volumes of resistance training can lead to macro- and microscopic adaptations such as increases in internal moment arms, changes in muscle architecture, and alterations in fiber typology, myocellular morphology, and intra- and intermuscular coordination, that may maximize strength at the expense of speed, or maximize speed at the expense of endurance. Finally, the implications for athletic performance and the design of optimized training protocols also will be discussed.

## Oral Presentations

### OP-PN25 Thermoregulation

**HEMATOLOGICAL AND BLOOD RHEOLOGICAL RESPONSES TO TEN DAILY 1-H ACTIVE HEAT ACCLIMATION SESSIONS IN WOMEN: A RANDOMIZED CONTROLLED TRIAL**

NARANG, B., BONCA, E.2, REMEC, K.2, TOMINEC, D.2, RABERIN, A.3, BOUTEN, J.4,5, MCDONNELL, A.C.1, CIUHA, U.1, BROCHERIE, F.4, MEKJAVIC, I.B.1, MILLET, G.P.3, DEBEVEC, T.1,2

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INTRODUCTION: Heat acclimation (HA) has been shown to induce plasma volume expansion, which may stimulate compensatory erythropoiesis and increase hemoglobin mass (Hbmass) [1,2]. However, findings are inconsistent, and most studies have focused exclusively on men, despite possible sex-specific differences in thermoregulatory physiology [3,4]. Additionally, these hematological adaptations may modulate blood viscosity, but this has not been explored with heat acclimation in humans. The aim of this study was to examine the effects of a short-term (10-day) active heat acclimation, compared to equivalent thermoneutral training, on hematological and blood rheological parameters in active women.

METHODS: Twenty-eight healthy, active women were randomized into a 10-day HA (n = 15) or thermoneutral (CON; n = 13) training group. Participants cycled for 1 h per day at 40% maximal aerobic power in either 35°C (HA) or 20°C (CON), with 50% relative humidity. Hbmass, along with blood and plasma volumes, were measured in duplicate at baseline and after the intervention using the carbon monoxide rebreathing method. Venous blood samples were also collected for viscosity analysis at varying shear rates. Data were analyzed using a 2x2 (time*group) mixed-effects ANOVA, with statistical significance set at $p < 0.05$. Data are presented as Mean ± SD.

RESULTS: Blood volume increased similarly in both groups (HA, 4.53 ± 0.67 L vs. 4.91 ± 0.84 L; CON, 4.53 ± 0.81 L vs. 4.66 ± 0.44 L; interaction p = 0.197; time p = 0.012), underpinned by plasma volume expansion (HA, 2.73 ± 0.38 L vs. 2.96 ± 0.59 L; CON, 2.67 ± 0.52 L vs. 2.87 ± 0.24 L; interaction p = 0.853; time p = 0.011). Hbmass remained unchanged in both groups (HA, 9.1 ± 1.1 g/kg vs. 9.3 ± 0.9 g/kg; CON, 9.4 ± 0.7 g/kg vs. 9.4 ± 0.8 g/kg; interaction p = 0.112; time p = 0.147). Native blood viscosity decreased in both groups across increasing shear rates (time p = 0.063, 0.008, 0.002, 0.006, 0.019 for 11.25/s, 22.50/s, 45.00/s, 90.00/s, 225.00/s, respectively). This reduction appeared more pronounced in CON, though a significant time*group interaction was only observed at a shear rate of 90.00/s (p = 0.040).

CONCLUSION: The addition of a heat stimulus (35°C) to ten consecutive daily 1-h moderate-intensity cycling sessions did not elicit additional hematological benefits compared to equivalent thermoneutral (20°C) training. In particular, both groups exhibited plasma volume expansion with no change in Hbmass. Blood viscosity may be marginally preserved by HA at higher shear rates, though notable decreases were observed in both groups. Overall, these data suggest that short-term HA is insufficient to enhance the hematological response to daily exercise training in healthy, active women, compared to an equivalent thermoneutral training intervention.

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**PHYSIOLOGICAL DEMANDS AND MODULATORS OF CORE TEMPERATURE DURING MASS PARTICIPATION DISTANCE RUNNING IN A WARM-HUMID ENVIRONMENT**

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INTRODUCTION: Increased sports participation and global warming are posing a greater heat-related risk to individuals. Sensors assessing physiological parameters (e.g. heart rate (HR) and core temperature (Tc)) offer insights into the cardiovascular and thermal demands of individuals exercising in the heat. However, few studies have characterised both cardiovascular and thermal responses in field-based events, with only one study characterising skin temperature (Tsk) during a mass participation event, albeit in elite populations rather than in recreational populations who may be more poorly informed [1, 2]. Therefore, we utilised a real-time monitoring system to profile HR, Tc and Tsk during mass participation distance running in a warm-humid environment and investigated potential modulators of Tc in a tropical and recreational population.

METHODS: 162 recreational tropical natives participated in a 21km (n=84) or 10km (n=78) run. Real-time continuous monitoring of HR (n=115) and Tc (n=102) was conducted via a multi-user dashboard. Continuous Tsk (n=34) was assessed using iButtons at four sites. Splits and finishing times were extracted from official results. Multiple linear regression (MLR) analyses were performed across various parameters and peak Tc.

RESULTS: Participants achieved peak HR, Tc and Tsk as high as 209bpm, 40.8ºC, and 35.4ºC during 21km and 204bpm, 41.1ºC and 35.3ºC during 10km, respectively. Mean HR (21km: 163±10 (139-188) bpm, 10km: 163±11 (133-180) bpm; p=0.516) and Tsk (21km: 32.9±0.9 (31.6-34.9) ºC, 10km: 33.0±0.8 (30.9-34.6) ºC; p=0.735) were similar between races. Mean Tc was higher in the 21km (38.7±0.5 (37.9-39.8) ºC) than the 10km (38.5±0.4 (37.7-39.9) ºC; $p<0.05$). Tsk exhibited an inverted-U profile in the 21km but plateaued in the 10km. MLR analysis revealed that starting Tc (16%), mean HR (11%), body surface area (11%), and average speed (7%) significantly contributed to peak Tc.

CONCLUSION: This study is the first to integrate Tsk with Tc and HR to provide continuous time-profiles of the cardiovascular and thermal demands of recreational tropical runners, adding to literature that typically focuses on elite populations. The inverted-U Tsk profile in the 21km contradicts the plateau seen in laboratory-based findings and may be explained by air velocity fluctuations and/or differences in pacing in longer distance runs. Real-time monitoring and incorporation of modulators of peak Tc can be used to inform targeted interventions to optimise safety of heat-exposed exercising individuals.

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**THERMOREGULATORY RESPONSES TO A SIMULATED HEAT WAVE ACROSS THE HUMAN LIFESPAN**

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INTRODUCTION: Global population ageing, the rising prevalence of non-communicable diseases (e.g. obesity, type 2 diabetes) and sedentary behaviour suggest that humans are becoming less resilient to hotter climates. Personal cooling strategies, such as electric fans or self-dousing, have been shown to attenuate the adverse effects of environmental heat stress in a range of conditions. However, these acute strategies fail to provide individualised long-term benefits, such as those afforded by regular physical activity and high aerobic fitness (VO2peak). Therefore, this study aimed to determine the relationship between aerobic fitness and thermoregulatory and heart rate responses to a simulated heat wave across the human adult lifespan (18 – 80 y).

METHODS: Sixty-one (27 females) participants (median [IQR]: age 44 y [30, 66], body mass 71.9 kg [63.2, 80.6], VO2peak 42 ml·kg-1·min-1 [31, 49]) completed an incremental treadmill test, dual x-ray absorptiometry scan, and a six-hour heat

wave simulation (43°C, 25% relative humidity). Rectal temperature (Tre) and heart rate (HR) were measured throughout the heat wave simulation. Whole-body sweat rate (WBSR) and physiological strain index (PSI) were calculated at the end of the exposure. Age and either VO2peak or body fat (%) were used as predictor variables in Bayesian regression models. Data are presented as posterior means, [95% credible intervals] and probability of direction (%).

RESULTS: Mean ΔTre during the heat wave simulation was 0.89°C [0.83, 0.95]. An increase in age from 35 to 65 y led to a greater ΔTre of 0.36°C [0.23, 0.49; >99%], whereas a 20 ml·kg-1·min-1 increase in VO2peak had little effect (-0.00°C [-0.14, 0.13; 55%]). Mean WBSR was 142 g·m-2·h-1 [134, 150] and increasing age from 35 to 65 y lowered WBSR by 13 g·m-2·h-1 [-26, 0; 97%], whilst a 20 ml·kg-1·min-1 increase in VO2peak increased WBSR by 21 g·m-2·h-1 [6, 35; >99%]. On average, the percentage of maximum HR (%HRmax) during the last hour of the heat wave simulation was 48% [46, 49]. Increasing age from 35 to 65 y led to a predicted change in %HRmax of -1% [-4, 2; 73%], whereas increasing VO2peak by 20 ml·kg-1·min-1 changed %HRmax by -5% [-8, -2; >99%]. Mean PSI was low (2.2 [2.0, 2.5]). Increasing age from 35 to 65 y increased the PSI by 0.6 [0.2, 1.0; >99%], whilst a 20 ml·kg-1·min-1 increase in VO2peak had no effect (-0.0 [-0.5, 0.4; 59%]). When body fat percentage was included in the models instead of VO2peak, a 15% increase in body fat reduced WBSR (18 g·m-2·h-1 [5, 31; >99%]) and increased %HRmax (5% [2, 7; >99%]) but had no effect on PSI or ΔTre.

CONCLUSION: Ageing increases thermal and physiological strain during a six-hour heat wave simulation in 43°C and 25% relative humidity. A greater VO2peak attenuates cardiovascular strain (i.e. %HRmax), likely facilitated by a greater WBSR, but has little effect on ΔTre or PSI.

**A SIX-SESSION HIGH-INTENSITY, INTERMITTENT HEAT ACCLIMATION PROTOCOL IN FEMALES: PHYSIOLOGICAL AND PERCEPTUAL ADAPTATIONS AND SLEEP RESPONSES.**

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INTRODUCTION: High-intensity, intermittent exercise heat acclimation (HA) is rarely utilised compared to sub-maximal continuous exercise in the heat. However, high-intensity, intermittent exercise HA is likely more specific and perhaps beneficial for team sport athletes when preparing for competition in hot environments [1]. In females, the precise time course for heat adaptation when using a high-intensity, intermittent HA protocol is unknown, including its effect on sleep outcomes as an important marker of recovery. The aim of this study was to investigate, in female participants, the effects of six sessions of high-intensity, intermittent exercise in the heat conducted over seven days on the time course of the thermophysiological (rectal temperature (Tre), skin temperature (Tsk), heart rate (HR), sweat rate), and perceptual adaptations (thermal discomfort, rating of perceived exertion), and the effect on objective sleep measures (sleep duration, wake after sleep onset).

METHODS: Eleven non-heat acclimatised females (mean ± SEM: age 27±2 yr; body mass 69.63±2.64 kg; body surface area 1.78±0.04 m2) of recreationally active to highly trained status [2], completed six, 60-min cycling sessions over seven days in the follicular phase of the menstrual cycle. The intermittent exercise protocol alternated work periods of 30 s at ~90% VO2peak and 30 s active recovery at ~30% VO2peak (mean work rate ~60% VO2peak) in the heat (~40°C, ~40% relative humidity). Tre, Tsk, HR, Tre at onset of sweating, rating of perceived exertion, thermal discomfort, and objective sleep were measured. Linear mixed models were used to compare outcomes measures at the third (HA3), fourth (HA4) and sixth (HA6) compared to the first HA session (HA1). Bonferroni post-hoc procedures were used to locate differences where appropriate. Results were considered statistically significant when $p<0.05$.

RESULTS: In the final HA session (HA6), resting Tre was lower (-0.18°C; p=0.001) compared to the first session (HA1: 37.2 ± 0.1°C). Mean Tre was lower on HA6 than HA1 (-0.21°C; p<0.001), HA3 (-0.16°C; p<0.001), and HA4 (-0.12°C; p=0.001). Mean Tsk was lower on HA6 than HA1 (-0.20°C; p<0.001). Tre at the onset of sweating was lower on HA6 than HA3 (-0.17°C; p=0.035). Mean HR was lowest in HA6 than HA1 (-9 beats.min-1; p<0.001), HA3 (-3 beats.min-1; p<0.001), and HA4 (-5 beats.min-1; p<0.001). TD was lower on HA6 than HA1 (-242 mm; p<0.001), and RPE lower on HA6 than HA1 (-0.9; p=0.003). There were no significant effects on measures of sleep ($p\geq0.208$) during the HA protocol.

CONCLUSION: In females, high-intensity, intermittent exercise presents an effective HA protocol that induces rapid thermophysiological and perceptual adaptations, without inducing disturbances in sleep.

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**PRELIMINARY EVIDENCE OF THE ADDITIVE EFFECT OF ISCHEMIC PRECONDITIONING ON THE TIME-COURSE OF PHYSIOLOGICAL ADAPTATIONS TO HEAT ACCLIMATION**

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INTRODUCTION: Heat acclimation (HA) is a common strategy to prepare military personnel for heat exposure. Combining HA with ischemic preconditioning (IPC) can enhance physical performance and vascular function, which may have an additive effect on thermo-physiological adaptations, yet this has not been investigated. We evaluated the effects of HA or HA+IPC vs. Control (CON) on the time-course of thermo-physiological adaptations among trained participants.

METHODS: Nineteen participants (5 females, 14 males) were randomly assigned to one of three groups: HA+IPC (n = 7; heat acclimation+ischemic pre-conditioning), HA (n = 7; heat acclimation with sham IPC), or CON (n = 5; Control with Sham IPC). Participants received 8 exercise sessions, interspersed by 4 heat stress tests (HST) at baseline (HST1) and after 3 (HST2), 8 (HST3) and 11 days (HST4) of training. Groups exercised for 60 min at a heart rate ~65% maximum, with HA+IPC and HA in 38°C & 40% relative humidity (RH) and CON in 20°C & 40% RH, following 40 min of repeated bi-lateral lower-limb occlusions or sham. HSTs comprised 35 min of cycling at a heat production (Hprod) of 6 W/kg, followed by an incremental test to exhaustion, with thermo-physiological responses recorded.

RESULTS: Linear mixed models, with control for baseline covariance, revealed group by time interaction effects, with post-hoc tests demonstrating HA+IPC and HA groups to have greater ($P < 0.05$) skin blood perfusion compared to CON during fixed Hprod exercise at both HST2 (~33 & ~8%max, respectively) and HST4 (~20 & ~7%max, respectively), with HA+IPC also greater than HA at HST2 and HST4 (~25 and ~13%max, respectively). HA+IPC also had greater ($P < 0.05$: ~18%max) skin blood perfusion compared to CON in the incremental test of HST2. Group by time interaction effects were also found for heart rate during fixed Hprod exercise, with HA+IPC ~7% lower ($P < 0.05$) between HST1 and HST4. Following group by time interaction effects for local sweat rate, HA (~15%) and HA+IPC (~14%) were found to increase ($P < 0.05$) between HST1 and HST4, which was not found for CON (~3%; $P > 0.05$).

CONCLUSION: These preliminary data demonstrate that HA+IPC and HA enhanced two key thermoeffectors (skin blood flow and local sweating) in response to heat exposure more than exercise alone. The addition of IPC accelerated the improvements in skin blood perfusion after only three days of heat exposure and resulted in greater perfusion at higher exercise intensities. Despite reductions in exercising heart rate in HA+IPC, this did not translate to changes in body temperature or exhaustive performance in the heat. These preliminary findings suggest that IPC could be a useful intervention to accelerate the adaptation of the heat-acclimated phenotype, which has potential use in military settings.

## Oral Presentations

### OP-PN04 Female Physiology

**COMPARABLE ABSOLUTE VO2MAX GAINS BETWEEN MIDDLE-AGED FEMALES AND MALES, BUT GREATER PERCENTAGE INCREASES IN FEMALES DURING AND AFTER 11 MONTHS OF AEROBIC EXERCISE TRAINING**

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INTRODUCTION: Exercise training is an effective tool for preventing lifestyle-related diseases [1]. However, individuals exhibit considerable variability in their responses to standardized exercise training programs [2,4]. Sex-based differences may contribute to this variability in adaptive capacity [2,3], but this remains a topic of debate. Studies examining VO2max changes indicate conflicting results regarding sex differences, both in long-duration (39-52 weeks; [2,4]) and short-duration (≤8 weeks; [3]) training interventions. A recent meta-regression study reported that females demonstrated greater percentage changes in VO2max compared to males, while absolute changes (mL/min/kg) were comparable between sexes [5]. However, it is still unclear whether long-term aerobic exercise training leads to similar VO2max changes in females and males. Hence, this study examined whether 11 months of aerobic exercise training induce similar percentage and absolute changes in VO2max in middle-aged females and males.

METHODS: Untrained but healthy middle-aged females (59±6 years; VO2max, 27.3±7.5 mL/min/kg; n=12) and males (52±8 years; VO2max, 38.8±5.3 mL/min/kg; n=15) underwent 48 weeks of aerobic exercise training. The program included 100 cycling sessions (45min each), of which 87 sessions were supervised. Training sessions alternated between high-intensity intervals (4x5min, 5x5min, and 5x8min) and moderate-intensity sessions (6x6min or 45min of continuous exercise). VO2max was determined before the intervention period, and after 8, 22, 32, 40, and 48 weeks of training. Values were normalized to body mass, and both absolute and percentage changes were analyzed longitudinally using a linear mixed-effects model with repeated measures. Time points and sex were treated as fixed effects, with individual participants modeled as random effects. 95% confidence intervals (CIs) were calculated to interpret the results.

RESULTS: Eleven months of aerobic exercise training increased VO2max in both females (4.8±1.4 mL/min/kg; 18.4±6.7%) and males (4.6±3.1 mL/min/kg; 12.8±9.3%). No sex differences were observed in absolute VO2max changes (ml/min/kg) at any time point (95% CIs including zero). However, females demonstrated greater percentage increases in VO2max compared to males after 32, 40, and 48 weeks of training (4.7, 5.2, and 5.6%-points difference, respectively; 95% CIs not including zero).

CONCLUSION: When middle-aged females and males undergo the same 11-month aerobic exercise training program, absolute VO2max increases (scaled to body mass) are comparable between sexes. However, females exhibit greater percentage increases in VO2max compared to males. These findings demonstrate that middle-aged females do not have a reduced capacity to increase VO2max through aerobic exercise training compared to males.

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**"LIVE HIGH-TRAIN LOW" INDUCED CHANGES IN THE ERYTHROPOIETIN-ERYTHROFERRONE-HEPCIDIN AXIS AND HEMOGLOBIN MASS IN FEMALE ENDURANCE ATHLETES**

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INTRODUCTION: Iron availability has been proposed as one of the main factors explaining the high variability in hemoglobin mass (Hbmass) adaptation to hypoxia (1), however, little is known about hypoxia-induced changes in the iron regulatory pathways. In sustained hypoxia, iron availability is supported by the down-regulation of the systemic iron regulator hepcidin via hormones erythroferrone (ERFE) and erythropoietin (EPO). (2) This study investigated the effects of a 21-day live high-train low (LHTL) on iron availability in female endurance athletes by determining the changes in EPO-ERFE-hepcidin axis and routine iron markers serum ferritin and serum transferrin receptor (sTfR) and whether these changes are associated with Hbmass adaptations.

METHODS: 15 participants completed either a 21-day LHTL period in normobaric hypoxia (2500 m, ~18 h·day−1) (INT, n=8) or lived and trained at sea level for the same duration (CON, n=7). All participants conducted PRE and POST tests one to two days before and after the intervention. The tests included Hbmass assessment via the carbon monoxide rebreathing method and resting venous blood samples to test for changes in EPO, ERFE, hepcidin, ferritin, and sTfR. For INT an additional venous blood sample was collected on the 6th morning in hypoxia (MID, 111 ± 5 h in hypoxia) to investigate short-term changes in blood biomarkers.

RESULTS: Normobaric hypoxia increased Hbmass (3.8 ± 2.0 %, $p<0.001$) in INT, while no changes were detected in CON. In INT, serum EPO increased 35.6 % ($p=0.037$) from PRE to MID, followed by a -42.4 % decrease from MID to POST ($p=0.019$). In INT there were no changes in ERFE, hepcidin, or ferritin from PRE to MID or POST but sTfR increased 13.9 % ($p=0.013$) from PRE to POST. In CON there were no changes in any of the iron markers at all time points. Changes in Hbmass were not associated with changes in ERFE or hepcidin in either group. However, a higher Hbmass was associated with a smaller reduction in ferritin during the first 5 days of hypoxia in INT ($r=0.87$, $p=0.005$).

CONCLUSION: The results of the present study suggest that hepcidin and ERFE may not provide additional information regarding changes in iron demand and availability during and within the few days following prolonged hypoxic exposure compared to routine iron markers. The association between Hbmass and serum ferritin, in turn, underlines the necessity of maintaining adequate ferritin levels during hypoxia to support hematological adaptations, thereby supporting the current practical recommendations of dietary and supplementary iron use prior to and during prolonged hypoxia. (1)

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**NO DIFFERENCE IN MYOFIBRILLAR PROTEIN SYNTHESIS RATES OR WHOLE-BODY PROTEIN TURNOVER DURING THE EARLY FOLLICULAR AND MID-LUTEAL PHASES OF THE MENSTRUAL CYCLE**

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INTRODUCTION: Research using ovariectomy models in rats and hormone replacement therapy in postmenopausal females suggest, that the female sex hormones oestrogen (O) and progesterone (P) may influence rates of myofibrillar protein synthesis (MyoPS) and, therefore muscle growth/remodelling. However, limited data are available on how fluctuating low and high endogenous O and P concentrations across phases of the menstrual cycle (MC) impact MyoPS in young females. This study aimed to investigate MyoPS in a postabsorptive state and in response to exercise and nutrition, when O and P concentrations are low and high, during the early follicular (EF) and mid-luteal (ML) phases of the MC, respectively. To provide further insight into the effect of sex hormones on MyoPS, whole-body protein turnover and expression of genes involved in muscle mass regulation were also measured.

METHODS: Fourteen healthy females (age: 25±7 y; BMI: 24±2 kg/m2) were recruited to this randomised cross-over study. Following two months of menstrual cycle tracking, participants completed two experimental trials during EF (4±2 d following menses; O 160±60 pmol/L, P 1.3±0.7 nmol/L) and ML phases (7±1 d following luteinising hormone surge; O 729±332 pmol/L, P 40.5±17.7 nmol/L), using best practice methodologies to confirm MC phases. On each visit, participants received a primed continuous infusion of L-[ring-2H5]phenylalanine and L-[3,3-2H2]-tyrosine for 6.5 h. Following a bout of resistance exercise, participants ingested a drink containing 1.5 g of essential amino acids. Muscle biopsies were collected before and during the 3 h postexercise postprandial period to assess MyoPS and gene expression. Blood samples were collected to assess amino acid concentrations and whole-body protein turnover. Two-way ANOVAs were performed to detect changes across MC phases. Data are expressed as means±SD.

RESULTS: Total plasma amino acid concentrations were lower overall in the ML compared to the EF phase ($P<0.001$). Exercise and drink ingestion increased basal (0.035±0.023 and 0.036±0.013 %·h-1) MyoPS rates between 0-3 h to 0.066±0.028 and 0.060±0.020 %·h-1 ($P<0.001$), for EF and ML, respectively, with no differences between phases at either time point ($P=0.329$). Exercise and drink ingestion decreased whole-body protein synthesis below basal rates by 18±5% ($P<0.0001$), suppressed protein breakdown by 31±6% ($P<0.0001$), which resulted in whole-body net protein balance shift-

ing from negative to positive (P<0.0001), with no differences between EF and ML phases (all P>0.050). Expression of several genes associated with protein synthesis, muscle remodelling and sex hormone signalling were increased in ML vs EF phase, whereas protein breakdown associated genes were decreased.

CONCLUSION: Despite decreased circulating amino acid concentrations and a gene expression profile consistent with muscle growth, MyoPS, whole-body protein turnover and hence muscle growth/remodelling do not appear to be affected by increased O and P during the ML phase of the MC.

**THE IMPACT OF MATERNAL EXERCISE ON PLACENTAL MINERAL TRANSPORT**

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INTRODUCTION: Exercise during pregnancy is associated with improved maternal-fetal outcomes, yet the biological mechanisms linking exercise to placental health remain poorly understood. Emerging evidence suggests that exercise may modulate placental inflammation, oxidative stress, and nutrient transport, potentially influencing levels of minerals. However, the interplay between prenatal exercise, placental mineral homeostasis, and angiogenic protein expression has not been explored. We aimed to investigate the effects of a supervised concurrent exercise program on placental levels of minerals.

METHODS: For the present studys specific aims, 45 placentas were randomly selected from women who participated in the GESTAFIT project into exercise (n=22) and control (n=23) groups. The exercise group followed a concurrent aerobic and strength training program, three 60-minute sessions per week, from the 17th gestational week until birth. Placental levels of toxic minerals (cadmium [Cd], lead [Pb], arsenic [As], cobalt [Co]) and essential elements (copper [Cu], manganese [Mn], zinc [Zn], selenium [Se]) were quantified via inductively coupled plasma mass spectrometry. Statistical analysis was conducted in RStudio v.4.2, with significance set at p<0.05.

RESULTS: After adjusting for confounders such as maternal age and pre-gestational body mass index, the placenta of the mothers who participated in the exercise group presented higher values of Mn [mean difference: 0.18 mg/kg, 95% Confidence Interval (CI)=0.04 to 0.29, p< 0.01] and Pb (mean difference= 0.01 mg/kg, 95% CI=0.00 to 0.02, p= 0.033) compared to the placentas from the control group, while no significant differences were observed in the other minerals explored.

CONCLUSION: This study highlights the significant role of physical exercise during pregnancy in modulating placental nutrient and protein levels. Women in the exercise group exhibited higher placental manganese (Mn), an essential nutrient for fetal neurodevelopment. These findings suggest that maternal exercise may positively influence placental function and fetal development. However, the unexpected rise in placental lead (Pb), a known neurotoxicant, warrants further investigation. Previous studies suggest that increased bone turnover and calcium metabolism during pregnancy may contribute to lead mobilization, although the mechanisms underlying exercise-induced changes in Pb accumulation remain unclear. Future research should explore the interplay between maternal physical activity, environmental exposures, and placental mineral transport to determine whether these findings have clinical implications.

**ANABOLIC AND CATABOLIC HORMONE LEVELS DURING THE MENSTRUATION PHASE IN HIGHLY TRAINED FEMALE ATHLETES**

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INTRODUCTION: Fluctuations in sex hormones during the normal menstrual cycle (NMC) may significantly affect womens performance and well-being, particularly during the menstrual phase when estradiol (E2) concentrations are lowest (Carmichael et al., 2021). However, there is little literature on anabolic and catabolic hormone levels during this phase in a highly trained population.

METHODS: Therefore we tested hormonal levels in fourteen NMC highly trained female athletes, during the early follicular, with low estradiol concentrations (Low E2) vs. the end follicular/peri-ovulatory phase, with high estradiol concentrations (High E2). We examined the concentration of E2, testosterone (T), sex hormone-binding globulin (SHBG), free estrogen and androgen indexes (i.e., FEI= E2/SHBG and FAI=T/SHBG, respectively), dehydroepiandrosterone (DHEA) and cortisol (Cor) basal hormone levels as well as E2/T, DHEA/T, and Cor/T ratios. Body weight and composition were assessed in parallel by impedancemeter.

RESULTS: In Low E2 vs. High E2 phase, there were significantly lower T concentrations (p<0.01) as well as a significant decrease in FEI, FAI and E2/T ratios (p<0.05), without any change in SHBG, DHEA, cortisol concentrations or in body weight and composition. In addition, no significant difference in DHEA/T or Cor/T ratio was found between Low E2 and High E2 phases.

CONCLUSION: As previously described in the literature on healthy active women (Knutsson et al., 2023), there was a significant change in T across the menstrual cycle, with higher values around the ovulation phase vs. the menstruation phase. While both free estrogen and androgen indexes decreased during the early follicular phase, there did not seem to be any significant modification in the endogenous anabolic/catabolic balance during this phase. Further studies are necessary to

determine whether the fluctuation of E2/T ratio across the menstrual cycle, used as an overtraining biomarker in male subjects (Cadegiani & Kater, 2019), may have performance and/or well-being repercussions in female athletes.

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## Oral Presentations

### OP-AP12 Training and Testing II - Maturity, Relative Age and Performance

**BIOLOGICAL MATURITY, PHYSICAL PERFORMANCE, AND FORCE-VELOCITY MEASURES: A MIXED-LONGITUDINAL ANALYSIS**

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INTRODUCTION: Adolescence is marked by significant variability in biological maturation, leading to differences in physical performance among youth athletes despite sharing the same chronological age (CA). These differences influence the timing and magnitude of peak height velocity (PHV), which varies between males (M) and females (F) but also within sexes (1), resulting in different development rates in physical performance qualities (2). Frequent assessment and long-term physical performance monitoring are crucial along the talent pathway. However, there is a lack of normative data on high-level youth athletes, especially considering the varying stages of maturation in both sexes. The study aimed to examine the impact of maturation and gender on physical performance.

METHODS: A mixed-longitudinal study design was used, including 6171 data points from 1478 elite junior tennis players (3633 M: 14.0±2.1yrs; 2538 F: 13.8±1.9yrs) over the last 10 years. Athletes were categorized based on their biological maturity using the maturity offset method into pre-, mid-, and post-PHV. Physical performance was assessed via standardized tests, including anthropometrics, jumping, sprinting, handgrip strength, and endurance. A subsample (n=36) underwent repeated assessments for longitudinal force-velocity (Fv) profile tracking. Correlation and generalized additive model analyses were applied to examine performance differences across maturity stages.

RESULTS: Early matured athletes had superior results relative to their peers at similar CA. Strength and speed-related tasks exhibited the strongest correlations to age, followed by endurance, with M showing higher correlations than F (e.g., CMJ: M: r=0.74; F: r=0.32). Improvements in 20m sprint times nearly doubled from pre- to post-PHV in M (M:11%; F:6%). F demonstrate greater relative changes during pre-PHV, while M exhibit larger relative increases during mid-PHV (e.g., Yo-Yo IR1; F est. 134m, 37%; M est. 228m, 21%). Longitudinal analysis revealed no significant changes in F0 and v0 over three consecutive times, although individual variations were present.

CONCLUSION: The results indicate that performance improves with age and maturity, though the progression differs between sexes in both rate and magnitude. M exhibit a steep performance incline in mid- and partly post-PHV, especially in strength- and speed-based metrics, likely due to testosterone, increasing muscle mass, and neuromuscular efficiency. F enhance performance the most during pre-PHV before estrogen might restrict the minimal but gradual progression. Fv analysis generally aligns with M increasing values post-PHV, and F do not, although lacking significance. Especially F should start maturation-independent individualized training with the onset of PHV, focusing on plyometrics, speed, and endurance to maximize performance in adulthood. Males should prioritize neuromuscular performance post-PHV and its transfer to sports performance, e.g., sprinting.

1 - Cole et al, 2014

2 - Lesinski et al, 2016

**CHRONOLOGICAL AGE VS. MATURITY STATUS : WHAT BETTER INFLUENCES YOUNG FEMALE SOCCER PLAYERS' PERFORMANCE ?**

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*UNIVERSITE COTE DAZUR*

INTRODUCTION: Young female soccer players are typically grouped by chronological age, but this method ignores the substantial differences in biological maturity that can impact critical performance factors like strength, speed, and coordination. Although studies have examined the influence of age and maturity on male youth athletes, research focusing on female players is still limited. As a result, there is insufficient knowledge about how chronological age and biological maturity interact to influence physical performance and development in young female soccer players. This study aims to

address this gap by analyzing the effects of age groups and biological maturity on physical performance, including speed, jumping ability, change-of-direction (COD) ability, and endurance in young female soccer players.

METHODS: Eighty-two young female soccer players from the same club academy squad participated in this study and were classified into four age groups based on their birth years: U11, U13, U15, and U18. Maturity offset (YPHV) was estimated using anthropometric measurements [Mirwald et al. 2002]. Each subject was categorized into one of three maturity group (i.e, PRE (YPHV <-1); MI (-1≤YPHV≤1) and POST (YPHV > 1)).The assessment of physical performance took place over four separate sessions, during which players underwent a series of standardized tests. These included the 30-15 intermittent fitness test, a 40-meter sprint, the COD 505 test, a countermovement jump (CMJ), and a repeated sprint test consisting of six 20-meter sprints.

RESULTS: Players in the U11 age group consistently demonstrated lower performance across all tests compared to their older counterparts. Similarly, the PRE maturity group, predominantly composed of U11 players along with two U13 players, also exhibited reduced performance levels. U13 players performed worse than those in the U18 category, while U15 players achieved lower results in CMJ, sprint, and COD tests compared to the U18 group. Furthermore, the MI maturity group underperformed in all tests relative to the POST maturity group, which included half of the U15 players and all U18 players.

The correlation between chronological age (AGE) and years from peak height velocity (YPHV) with performance was significant, ranging from 0.59 (YPHV) and 0.58 (AGE) for CMJ to 0.78 (YPHV) and 0.75 (AGE) for the 40-meter sprint time. Correlation coefficients for height and body mass were lower compared to those for AGE and YPHV, further highlighting the stronger influence of biological maturity and age on performance outcomes.

CONCLUSION: This study shows that biological maturity (YPHV) influences performance slightly more than chronological age, particularly in speed, jumping, and change of direction. Grouping players solely by age may overlook key developmental differences. Integrating maturity status into training and talent identification could better optimize player development.

**LONGITUDINAL PERFORMANCE TRAJECTORIES FOR YOUTH FEMALE AND MALE SOCCER PLAYERS: 10M-SPRINT PERCENTILE CURVES ADAPTED TO BIOLOGICAL AGE**

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INTRODUCTION: Longitudinal monitoring of performance development could help improve talent identification accuracy in sport, including soccer (1). However, during adolescence, the capability to evaluate performance is confounded by sex-specific inter-individual maturational growth differences which do not necessarily align with chronological age-based evaluation methods. To better consider the influence of maturational growth in performance development data and reduce selection bias, the purpose of the study was to illustrate differences performance percentile curves when evaluated according to maturational age v chronological age. Using this information, a predictive model was generated to develop realistic performance benchmarks and support athlete development.

METHODS: 10m-sprint and anthropometric data were extracted from the Swiss Football Association's online database, ranging from 2014 - 2024. Initially, data from 5115 soccer players (f = 223, m = 4892), aged 9-19 years, with corresponding maturity status (Mirwald) estimates were examined to generate percentile curves, using Lambda-Mu-Sigma (LMS). Then, following screening for longitudinal (3+ measures) only, data on 1881 (f = 63, m = 1818) were examined to identify performance trajectories, generate predictions, and illustrate individualized trajectories, applying Linear Mixed-effects Models (LMMs).

RESULTS: LMS percentile curves based on chronological and biological age were compared and showed significant differences ($t(1013) = 1.21$, $p < 0.001$, $d = 0.39$) in percentile rank improvement for late (v earlier) maturing male players; illustrating differences in performance percentile curves according to maturational age. Similar results were not observed in females, likely due to sample limitations. LMMs identified individualized longitudinal performance trajectories and generated future performance estimates according to chronological and biological age. Finally, a web-based Shiny-App development facilitated evaluation of current performance and predicted future performance relative to others.

CONCLUSION: Percentile ranking improvement of later developing males based on biological v chronological age provides added value in 10m-sprint time assessment. LMMs deployed on longitudinal 10m-sprint data, facilitated the establishment of performance benchmarks and future performance trajectories . Incorporating biological age into modelling allowed individual maturational differences to be better considered, potentially improving predictive accuracy during adolescence. Shiny-App development based on data could provide coaches with maturational considered training objectives, identify likely performance trajectories, and offering a more individualized and maturation-sensitive approach to athlete development and talent identification.

1. Newans et al. (2022)

**BEHIND BEFORE YOUVE STARTED? LONGITUDINAL CHANGING DEVELOPMENT TRAJECTORIES IN EARLY AND LATE MATURING SWIMMERS.**

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INTRODUCTION: The path to athletic success in many sport contexts is predicated on the development of multiple, interacting, factors over time. For instance, anthropometric, physiological, technical skill, psychological, and training structure potentially all contribute toward optimised development. At youth competition stages, maturational growth has substantial influences upon multiple indices, subsequently affecting performance. In swimming, this is somewhat reflected by maturity biases in participation and performance data (Abbott et al., 2021). Thus, examining and understanding the longitudinal influence of maturational growth on performance would be valuable, identifying hypothesised differing early, normative, and late maturational developmental patterns. Such study findings would also justify the benefit of strategies which could account for maturational differences. This study examined longitudinal trajectories in male and female data in 50 and 200-metre (m) Freestyle events.

METHODS: Participants were male (N= 923; N= 364) and female (N= 725; N= 267) youth 50 and 200m Freestyle swimmers respectively, aged 10–18 years (yrs), who completed anthropometric assessment and competed at sanctioned age-group swim events between 2016–2025. To identify longitudinal trajectories, repeated annual best performance times on 4 or more occasions were examined. To test for maturational influences, participants maturity timing (age at Peak Height Velocity; APHV) was calculated from estimates within 1.5 yrs from PHV (M= 0.66 yrs) and included. Following data screening, trajectories were quantified using longitudinal growth curves. Curves were sequentially modelled using a Linear Mixed Models (LMMs) framework with fixed (age and APHV) and random effects (individual repeated measures) added. To assess maturity influences on longitudinal development, interaction terms were added.

RESULTS: In males and females, LMMs identified maturity timing was influential on nonlinear 50 and 200m performance development. Interaction and model-fit statistics indicated earlier maturation was associated with earlier age and more accelerated performance development. Meanwhile, later maturation reflected slower performance at younger ages; but with sustained, steadier, performance trajectories. By 15 yrs (females) and 17 yrs (males), maturational influences upon rates of performance development had diminished and performance differences dissipated or reversed.

CONCLUSION: Consistently differing performance trajectories according to maturity timing were apparent for male and female 50 and 200m Freestyle. Relative to early-maturing trajectories, normative and later-maturing swimmers had correspondingly slower performance times across age ranges. However, post-PHV, trajectories either converged or reversed, illustrating further dynamics for consideration.

Abbott, S., et al. (2021). Maturity-related developmental inequalities in age-group swimming: The testing of 'Mat-CAPs' for their removal. Journal of Science and Medicine in Sport, 24(4), 397-404.

**A SURVIVAL ANALYSIS OF DROPOUT AMONG FRENCH SWIMMERS**

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INTRODUCTION: This study examines the dropout rates among French swimmers based on performance levels, sex, and relative age.

METHODS: Using data from 160,861 swimmers under the age of 21, we analyzed the distribution of birth quarters and dropout rates across performance levels. Chi-squared tests were conducted to confirm the significant effect of birth quarter on performance. Kaplan-Meier Survival (KMS) curves were used to evaluate and interpret the impact of sex and relative age on dropout trends.

RESULTS: The results show that dropout peaks occur at 13.16 years for girls and 17.50 years for boys. Analyzing by age year, at 13 years, the top 10% of female swimmers exhibit a dropout rate of 8.7% (9.9% for males), while the bottom 10% show a much higher rate of 78.1% (69.3% for males). By 17 years, the dropout rate rises to 39.6% (28.6% for males) for the top 10% and 91.7% (83.4% for males) for the bottom 10%. KMS curves, stratified by age, reveal similar dropout trends for both sexes below the age of 13. However, after this age, the dropout rate increases more sharply among females, reaching a maximum difference of 4.8% at 17.9 years. Disparities in dropout rates based on birth quarters are most pronounced at 12.7 years for girls (10%) and at 14.7 years for boys (8.1%).

CONCLUSION: This study underscores the significant influence of sex, relative age, and performance level on dropout rates among French swimmers. Higher performance levels are associated with lower dropout rates, and female swimmers display consistently higher dropout rates than their male counterparts.

Oral Presentations

OP-AP05 Resistance Training

**ATHLETES PHYSICAL FITNESS CHANGES AFTER FLYWHEEL CLUSTER-SET AND FLYWHEEL STRAIGHT-SET RESISTANCE TRAINING PROTOCOLS**

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INTRODUCTION: The aims of this study were to (i) compare the acute physical fitness changes after 6-weeks of flywheel resistance training when using a flywheel cluster-set (FCS) and flywheel straight-set (FSS) protocol and (ii) to monitor the effect of set configuration on flywheel training variable (mean/ peak power outputs and eccentric overload) progression during the intervention period.

METHODS: Twenty-four amateur male field sport athletes (n=24) were randomly allocated into one of two groups (FCS and FSS). Participants underwent pre- and post-intervention testing for 20m linear sprints (Including a 5m sprint interval), countermovement jump (CMJ) performance (height, force and velocity), change of direction (5-10-5) time, and maximal isometric mid-thigh pull (IMTP) strength (peak vertical force (N)). During the intervention, both FCS and FSS groups performed two weekly sessions of quarter-squats and Romanian deadlifts using 0.050 kg.m2 inertial load. The FCS group employed cluster set blocks of three repetitions (3x3x3), with 30-second intra-set rest periods allocated between cluster blocks per session (Ryan et al., 2024b) whereas the FSS group performed four sets of nine repetitions per session. The kmeter apparatus was used to record training variables within sessions and monitor progression of flywheel training performance during the intervention period.

RESULTS: Performance measures were found to be reliable (ICC= 0.876-0.985; CV%= 0.98%-4.82%). A group by time interaction showed a significant (p=0.043) difference for the 5m linear sprint distance in favour of the FCS group. Within group analysis for pre- to post-testing for the FCS group showed improvements for 5m (p=0.016; effect size [ES]=0.82) and 20m sprint time (p=0.016; ES=0.74); COD time (p<0.001; ES=0.34-0.75) and CMJ performance (height; p<0.001, force; p=0.012, velocity; p=0.025; ES=0.25-0.45). Similarly, the FSS group reported improvements in COD time (p≤0.050; ES=0.47-0.49) and CMJ performance (height; p<0.001, force; p=0.030; ES=0.35-0.53). Additionally, both intervention groups observed no significant improvements in IMTP strength (ES=0.045-0.19).

CONCLUSION: The findings support the usability of both flywheel training protocols to enhance field sport athletic performance. However, the FCS group experienced greater improvements in performance, providing an alternative option for flywheel training through the use of cluster sets.

**TIME TO PEAK VELOCITY AS AN INDIRECT MEASURE OF DYNAMIC RATE OF TORQUE DEVELOPMENT**

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INTRODUCTION: The measurement of velocity through accelerometers or linear encoders has become a common practice in resistance training. As peak velocity is dependent to the total impulse expressed during a contraction, practitioners have recently focused on time to peak velocity as a complementary measure, which is thought to better reflect dynamic rate of torque development (RTD). Consequently, the aim of this work is to understand the behavior of this metric at different velocity conditions and its relationship with dynamic RTD and muscle activation.

METHODS: Sixty-four young adults performed two isometric maximal voluntary contractions (MVC) and an incremental load test on a single-leg isoinertial leg extension to obtain their individual torque-velocity relationship and to measure peak torque, peak velocity, time to peak velocity and RTD for each load. The root mean square (RMS) of high-density surface electromyography (HDsEMG) recorded from the vastus lateralis and medialis was quantified in the first 50 ms of each contraction. Torque and EMG signals of dynamic contractions were normalised by the corresponding values obtained during MVC.

Linear hierarchical regression analysis was used to assess the relationship between time to peak velocity (dependent variable), peak velocity and peak RTD as fixed factors. A second model was performed using peak velocity and RMS as fixed factors. Each analysis was performed accounting for repetition's peak torque and considering the intercept and slope of peak velocity of each subject as a random effect.

RESULTS: As expected, time to peak velocity was principally affected by peak velocity ($F = 461.6$, $\beta = -7.4 \times 10^{-1}$, $\eta2 = 0.80$, $p < 0.001$) but also influenced by peak RTD ($F = 141.3$, $\beta = -1.3 \times 10^{-3}$, $\eta2 = 0.18$, $p < 0.001$). In the second model, peak velocity retained its primary role in determining time to peak velocity ($F = 475.2$, $\beta = -7.5 \times 10^{-1}$, $\eta2 = 0.77$, $p < 0.001$) with a significant effect of RMS ($F = 91.9$, $\beta = -9.7 \times 10^{-3}$, $\eta2 = 0.13$, $p < 0.001$). In each analysis, the independent influence of peak torque was minimal ($\eta2 \leq 0.01$).

CONCLUSION: We support the theoretical basis for using time to peak velocity as an indirect indicator of the rate of torque development during dynamic resistance training contractions. This is further reinforced by the correlation between early muscle excitation (first 50 ms), which is widely recognized as a key factor influencing explosive contractions, and time to peak velocity.

**EFFECT OF DETRAINING ON MUSCLE STRENGTH AND MASS OF LOWER EXTREMITIES AFTER SYSTEMATIC RESISTANCE TRAINING WITH MULTI-JOINT OR SINGLE-JOINT EXERCISES**

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INTRODUCTION: The use of multi-joint or single-joint resistance exercises is an effective method to increase muscle strength and mass. Yet, it remains unclear if the use of a multi-joint or a single-joint exercise, might result in different loss rates of these adaptations during a detraining period. The purpose of this study was to investigate the effect of 8 weeks detraining on muscle strength and mass of lower extremities after 8 weeks systematic resistance training with either multi-joint or single-joint exercises.

METHODS: Fourteen young moderately trained women (height 173±6cm, mass 62±10kg), with no experience in systematic resistance training, followed 8 weeks of unilateral lower extremities' strength training, in which one leg trained with multi-joint exercise (leg press; LP) and the other with single joint exercise (knee extension; KE). The training protocol involved 2 sessions per week, 4 sets X 6 repetitions at, 80% of maximal strength for both training interventions. After 8 weeks of training, participants completely abstained from training for another 8 weeks. Unilateral maximum strength (1-RM) in LP and KE, quadriceps' muscle cross sectional area (CSA) at 2 different sites of the thigh length (40%, 60%) and vastus lateralis (VL) thickness (via ultrasonography) were evaluated before training (T1), at the end of systematic training (T2) and at the end of detraining (T3).

RESULTS: Unilateral 1-RM strength increased significantly (LP: 36.5±11.5% and KE: 28.3±14.8%, respectively, $p<0.05$) after training, with no difference between interventions ($p>0.05$). Quadriceps muscle CSA increased at 40% (LP: 10.2±3.6% and KE: 8.2±3.4%, $p<0.05$) and at 60% of thigh length (LP: 11.2±4.5% and KE: 7.1±3.2%, $p<0.05$) with significant differences between interventions, $p<0.05$). VL thickness increased significantly (LP: 8.4±4.5% and KE: 5.6±5.4%, $p<0.05$) with significant differences between interventions, $p<0.05$) after systematic training. Unilateral 1RM strength decreased between T2-T3 (LP: -11.2±6.3% and KE: -16.8±6.5%, $p<0.05$) with significant difference between interventions, $p<0.05$). Quadriceps' muscle CSA at 40% of thigh length (LP: -5.9±2.1% and KE: -6.3±3.4%, $p<0.05$) and at 60% of thigh length (LP: -7.0±2.8% and KE: -4.8±2.1%, $p<0.05$), as well as VL thickness (LP: -4.9±3.0% and KE: -3.2±3.6%, $p<0.05$) decreased significantly between T2-T3, but with no difference between interventions.

CONCLUSION: These findings indicate that leg press and knee extension resulted in similar increases in 1-RM. On the contrary, the LP led to larger increases in quadriceps muscle mass in comparison to the KE. However, after 8 weeks of detraining, a comparable reduction in muscle mass is anticipated regardless of the type of exercise that was previously implemented. Therefore, the use of a mutli-joint resistance exercise is a more effective way to increase muscle mass, yet detraining has a similar effect in muscle mass reduction regardless of the type of exercise used.

**THE EFFECT OF POST-ACTIVATION POTENTIATION ENHANCEMENT (PAPE) INDUCED BY ISOMETRIC CONTRACTIONS ON VERTICAL JUMP PERFORMANCE: A SYSTEMATIC REVIEW, THREE-LEVEL META-ANALYSIS AND META-REGRESSION**

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INTRODUCTION: There is increasing interest in the post-activation potentiation enhancement (PAPE) effect of isometric contractions, which differ from dynamic isotonic contractions in the factors that influence PAPE and may offer unique advantages for practical applications. However, the complexity and inconsistencies in existing studies present challenges for effectively applying PAPE in training and pre-competition settings. This study aimed to assess the impact of isometric contractions on subsequent vertical jump performance and explore the moderating variables that influence the PAPE effect of isometric contractions.

METHODS: Literature up to December 10, 2024 was searched in five electronic databases. Studies were assessed for eligibility using the PICOS protocol. Risk of bias and study quality were evaluated using a modified Cochrane Collaboration tool and the PEDro scale. A three-level meta-analysis and moderator analysis were conducted using R software and the metafor package. Meta-regression examined the relationship between PAPE effects and factors such as total contraction duration, volume, and measurement timing. Dose-response relationships for different intensity groups were analyzed. Sensitivity analysis and publication bias assessment were performed.

RESULTS: A total of 18 studies were included. For comparison within the isometric group, the three-level model indicated a significant effect favoring post-test (ES = 0.180, p = 0.001), with all moderators showing significance (significant levels including male individuals, strength training experience≥2years, moderate volume, moderate duration, short and moderate interval, multi reps, knee angle of 90-140°). Compared with control group, the effect size significantly favored the isometric group (ES = 0.349, p = 0.003), with all moderators except volume showing significance. A similar effect was found when compared with dynamic isotonic resistance training (ES = –0.061, p = 0.642). For comparison within the isometric group, a significant risk of bias at level 2 was found, but no significant risk at level 3. No significant publication bias was detected in the isometric vs control group comparison. Meta-regression analyses revealed inverted U-shaped relationships between vertical jump improvement and time of measurement, total contraction duration, and volume (with optimal improvement at 7.7 min, 7.3 sec, and 7.4 units, respectively). Dose-response relationships showed greater improvements at later time points (>8 minutes) for maximal intensity and earlier improvements (<4 minutes) for submaximal intensity. Submaximal intensity favored longer contraction durations (≥12 seconds), while maximal intensity benefited from shorter to moderate durations (< 12 seconds). Similar trends were observed for volume.

CONCLUSION: isometric contractions can serve as an effective tool for inducing the PAPE effect on vertical jump, which might be most pronounced with a moderate recovery interval (4-8min), moderate total contraction duration (8-12sec), and moderate volume (6-10 unit). However, the optimal recovery time, total contraction duration may vary when using different intensities. Individuals of male, or with at least two years of strength training may benefit greater from it. When prescribing isometric contractions for PAPE effect, multiple repetitions, holding isometric muscle actions, and maintaining joint angles of 90°~140° are also recommended for better application.

**THE EFFECTS OF TRADITIONAL AND AUTOREGULATION METHODS ON RESISTANCE TRAINING PERFORMANCE AND RECOVERY OUTCOMES IN RUGBY PLAYERS: A RANDOMIZED CROSS-OVER TRIAL**

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INTRODUCTION: Resistance training (RT) is fundamental for performance enhancement in various sport disciplines. In team sports, effective RT programming is essential to balance the conditioning stimulus and the concurrent fatigue responses within a microcycle. This is critical during the in-season period when competitions are frequent. The current study investigated the effects of traditional (TRA) and two autoregulation resistance training methods—Objective Autoregulation Rest-Redistribution Training (O-ARRT) and Subjective Autoregulation Rest-Redistribution Training (S-ARRT)—on recovery outcomes in highly trained rugby players during competitive microcycles.

METHODS: Twelve athletes completed a randomized, crossover trial involving three sessions using the barbell back squat exercise, matched for volume (24 repetitions), load (80% of 1RM), and total rest time (540 seconds), but differing in training structure: TRA: 4 sets of 6 repetitions with 180 s of between-set rest; O-ARRT and S-ARRT: personalized structures of clusters, repetitions, and rest intervals regulated according to a velocity loss threshold or perception of the number of repetition in reserve from failure, respectively. Recovery kinetics was investigated at two timepoints, immediately after the experimental sessions and on the day of competition that followed, approximately 48 and 8 hours prior to the official match, respectively. Recovery was assessed through neuromuscular performance (session barbell velocity, countermovement jump height, net propulsive and braking impulse) and perceptual responses (rate of fatigue, perceived recovery status). The effects of the different RT methods were examined using linear mixed-effects models.

RESULTS: The O-ARRT method resulted in significantly higher mean session barbell velocity outputs compared to both TRA ($p < 0.001$, $b = 0.032$ [95% CI: 0.015, 0.049]) and S-ARRT ($p < 0.001$, $b = 0.031$ [95% CI: 0.017, 0.045]). Additionally, O-ARRT resulted in greater recovery of neuromuscular performance and perceived fatigue on match day, with the latter returning to baseline and reduced by 1 unit compared to TRA ($P = 0.033$, $b = -0.98$ [95% CI: -1.88, -0.08]), while braking impulse showed a recovery improvement of 12 N·s ($P = 0.039$, $b = 12.2$ [95% CI: 0.7, 23.7]) compared to TRA.

CONCLUSION: The O-ARRT method demonstrated greater mean velocity outputs, enhanced recovery of kinetic measures, and reduced perceived fatigue compared to the TRA and S-ARRT methods, while yielding similar perceived recovery status outcomes. These results suggest that the O-ARRT method may be a more suitable choice for strength sessions scheduled close to competition. These findings also have affective implications, as autoregulation-based RT offers a personalized approach that may enhance athletes sense of control and motivation to achieve their performance goals.

## Oral Presentations

### OP-AP11 Team Sports III - Basketball

**PERIPHERAL NEUROMUSCULAR FATIGUE INDUCED BY A SIMULATED BASKETBALL MATCH-PLAY**

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INTRODUCTION: Basketball is a high-intensity intermittent team sport that places significant demands on neuromuscular factors to execute quick accelerations, decelerations, jumps, and direction changes [1]. While match-play has been reported to negatively impact physical performance [2], less is known on muscle contractile function and the associated recovery process. Therefore, this study investigated the amount and recovery of knee extensor peripheral neuromuscular fatigue induced by a simulated basketball match-play.

METHODS: Thirteen highly-trained adult male basketball players (age: 25±4 years, stature: 185±9 cm, body mass: 86±14 kg) voluntarily participated in this study. Each player performed a simulated match-play consisting of standardized specific basketball activities. The simulated match-play lasted a total of 63 min with 32 min of activity (i.e., representing real active play time) being performed across quarters. Each quarter involved two 4-min activity bouts and standardized passive seated rest reflecting the likely occurrence of in-game stoppages. Before (PRE), immediately after (POST), 24 h (POST24) and 48 h (POST48) after the simulated match-play, neuromuscular evaluations were performed on the knee extensor muscles to determine the amount and recovery of peripheral fatigue. Electrical stimuli (single pulses and 10-Hz and 100-Hz paired pulses) were delivered in resting conditions to evoke a peak twitch (PT) response, from which maximal rate of torque development (MRTD) and relaxation (MRTR) were also determined. Furthermore, the ratio between 10-Hz and 100-Hz PT (10:100 Hz ratio) was calculated.

RESULTS: Significant time-related changes (one-way repeated measures ANOVA) were observed for single and paired pulses PT (main effect: $P < 0.001$, strong), MRTD ($P < 0.05$, moderate-to-strong), MRTR ($P < 0.05$, minimum-to-strong) and 10:100 Hz ratio ($P < 0.001$, strong). Overall, post hoc analyses revealed that all variables were significantly reduced at POST compared to PRE, but completely restored at POST24.

CONCLUSION: A simulated basketball match-play induced peripheral fatigue in the knee extensor muscles of highly-trained basketball players, that was marked immediately after the match but fully restored 24 h later. The observed decline in the 10:100 Hz ratio is indicative of low-frequency fatigue that however did not last more than 24 h.

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**COMPARING TRADITIONAL AND SMALL-SIDED GAME WARM-UPS: IMPACT ON WORKLOAD, PERFORMANCE, AND ENJOYMENT IN YOUTH BASKETBALL**

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INTRODUCTION: Traditional warm-up routines (TRAD) in basketball typically involve individual dribbling and shooting drills, or pair-executed give-and-go drills. However, different warm-up typologies can be implemented during basketball training sessions, including small-sided games (SSGs), such as 1v1, 2v2, and 3v3. Although SSG warm-ups might represent a more specific and enjoyable alternative in preparing players for upcoming activities, limited research is available comparing its effects on workload, physical performance, and enjoyment (ENJ) levels with TRAD warm-up routines. Therefore, this study aimed to compare the differences in workload between TRAD and SSG warm-up routines and their effects on physical performance and ENJ in youth basketball players.

METHODS: In a counterbalanced, crossover design, 24 male young basketball players (age: 16.0 ± 0.1 years; stature: 1.82 ± 0.07 m; body mass: 73.8 ± 9.1 kg; training experience: 8.6 ± 3.1 years) completed time-matched (~12-min) SSG and TRAD warm-ups performed in groups of six players on a half-court. Before each warm-up typology, players were required to report their fatigue levels via a rating of fatigue (ROF) scale and to complete an 8-min standardized pre-warm-up performed without a ball. For each warm-up typology, players internal [i.e., rating of perceived exertion (RPE), mean heart rate (HRmean), and peak heart rate (HRpeak)] and external [i.e., movement load (ML) measured via inertial movement units] loads were monitored. Prior to and after each warm-up typology, players physical performance was measured via a 20m sprint (including a 10m split time) and a countermovement jump (CMJ) test, while the 505 test was performed only at the post-warm-up time point. After completing each warm-up, players were also required to report their enjoyment levels (ENJ) using a previously used scale.

RESULTS: No between-group differences were evident for ROF ($p=0.053$), RPE ($p=0.259$), and HRmean ($p=0.053$), while a higher HRpeak was found in SSG compared to TRAD warm-up ($p=0.001$). Conversely, ML was lower in SSG compared to TRAD ($p<0.001$). No interaction, effect of time, or warm-up typology was found in any of the physical performance tests evaluated, except for higher CMJ performance documented for TRAD compared to SSG warm-up routine ($p=0.047$). Finally, no difference was found for ENJ between TRAD and SSG ($p=0.066$).

CONCLUSION: The higher external load in TRAD compared to SSG might be explained by the more static basketball activities (e.g., screening, boxing out) performed in SSG compared to TRAD, which yet elicited a higher internal load (i.e., HRpeak). Basketball coaches should use SSG warm-ups when preparing players for specific activities encompassing basketball-specific static conditions typical of basketball match performance. Moreover, the overall lack of differences in physical performance (except for CMJ) suggests that coaches can use both modalities interchangeably to prepare players for the upcoming training session drills.

**THE EFFECTS OF DIFFERENT RE-WARMING STRATEGIES ON LOWER LIMB PERFORMANCE IN COLLEGIATE BASKETBALL PLAYERS**

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INTRODUCTION: Re-warming strategies have been widely investigated as a means to mitigate performance decline following a prolonged passive recovery after warm-up[1,2]. This study hopes to compare the effects of three re-warming strategies—passive rest (PR), plyometric-based potentiation re-warming (PPR), and inertial resistance re-warming (IRR) on lower limb performance in collegiate basketball players.

METHODS: This study recruited nine collegiate basketball players, each of whom performed a 10-minute comprehensive warm-up[3] followed by one of three randomly assigned re-warming strategies: (1) PR: a 10-minute complete rest after the warm-up (control group); (2) PPR: a 3-minute rest, a 4-minute plyometric re-warm including countermovement jumps, short sprints, and lateral shifts, and another 3-minute rest (experimental group 2); and (3) IRR: a 3-minute rest, followed by a 4-minute inertial-resistance re-warm using the Exxentric kPulley Go for squats, short sprints, and lateral shifts, followed by an additional 3-minute rest. Lower limb performance was measured before and after each re-warming strategy, using the My Jump Lab mobile application, Kinvent Physios Kpull tool, and the Lane Agility Drill test to assess agility. The tests including CMJ height (cm), CMJ relative force (N/kg), maximal knee flexion/extension strength (kg), and Lane Agility Drill

Test time (seconds). A two-way repeated measures ANOVA was used to analyze performance differences across conditions and time. The post-hoc test was used for more detailed analysis of significant main effect differences and the partial eta squared values (ηp2) was calculated to determine the significance of the findings of two-way repeated measures analysis.

RESULTS: This study found a statistically significant difference in CMJ height and agility over time ($p = 0.02$, $\eta^2 = 0.472$ and $p < 0.01$, $\eta^2 = 0.714$). Additionally, both plyometric-based potentiation re-warming (PPR) and inertial resistance rewarm-up (IRR) showed a significant effect on the knee extension strength of the non-dominant leg compared to the passive rest (PR) group ($p = 0.01$, $\eta^2 = 0.735$). This effect may be attributed to the superior ability of these rewarm-up methods to activate the muscles of the non-dominant leg more effectively than complete rest.

CONCLUSION: The results suggest that an appropriate rewarm-up can enhance lower limb performance and optimize bilateral muscle activation.

**IS PRE-GAME NEUROMUSCULAR STATUS ASSOCIATED WITH KEY GAME-RELATED STATISTICS IN MALE BASKETBALL PLAYERS DURING OFFICIAL GAMES?**

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INTRODUCTION: One of the primary goals of the sport performance staff is to ensure athletes arrive at the day of competition in the best conditions possible to perform. This study evaluated if pre-game neuromuscular status is associated with in-game technical-tactical performance of male basketball players during the competitive season.

METHODS: 11 male semiprofessional basketball players (age: 20.1±4.1 years) underwent bilateral countermovement jump testing (no arm-swing) 45 minutes before the start of official games, with jumps recorded and analysed using a valid and reliable smartphone application (MyJump Lab) to calculate the modified Reactive Strength Index (RSImod) (Bishop et al., 2022). Z-scores of RSImod were computed for each player to evaluate variations in individual players' neuromuscular status (Gallo et al., 2015). In-game performance was evaluated by monitoring the following, well-established key basketball technical-tactical indicators (Leicht et al., 2017; Gasperi et al., 2023): points; free-throw-accuracy (FT%); 2-point-shots-accuracy (2P%); 3-point-shots-accuracy (3P%); total rebounds (TREB); assists (AST); turnovers (TO); and Performance Index Rating (PIR), with all variables normalized per minute of playing time. Separate linear-mixed models were performed (using Jamovi statistical software) to evaluate the effect of pre-game RSImod on players' technical-tactical performances.

RESULTS: No effect of RSImod was found on any of the technical-tactical indicators monitored (all $p > 0.05$).

CONCLUSION: Pre-game neuromuscular status is not associated with key technical-tactical performance indicators in male semi-professional basketball, which is likely due to the different performance domains assessed. Future studies should assess more pertinent aspects, such as neuromuscular status with external load metrics, and cognitive and psychological measures with technical-tactical indicators.

**SALIVARY PH AS A BIOMARKER FOR INJURY RISK AND TIME-LOSS IN YOUNG BASKETBALL PLAYERS**

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INTRODUCTION: Studies in young basketball players indicate a high incidence of injuries, therefore accurate identification of players at risk for injury is crucial to implement prevention strategies. Salivary-based diagnostic techniques have been studied as a potential diagnostic tool due to its abundance of biomarkers, non-invasiveness, cost-effectiveness and suitability for field use.

Among all salivary biomarkers, pH levels seem to play an important role in oxygen availability through the Bohr effect, a physiological mechanism that describes in which a lower pH reduces hemoglobins affinity for oxygen facilitating greater oxygen delivery to tissues with increased demands [1]. Given the high physiological demands of basketball players and the importance of efficient oxygen transportation in the sport context, pH levels could be associated with players' injury risk and time-loss.

The aims of the present study were to (1) compare pH levels between injured and non-injured players and (2) investigate differences in total number of injuries suffered and time-loss between pH groups.

METHODS: A total of 124 elite young basketball players (68 male and 64 female) from 12 to 18 years old participated in the study. Preseason salivary pH levels were assessed using test strips. Participants were grouped into tertiles based on their salivary pH values: Acidic, Neutral and Basic. Injury-related variables were registered throughout the season following the protocol detailed in the International Olympic Committee consensus and the OSICS classification system [2].

The data collected were analyzed using IBM SPSS Statistics version 29.0. A Pearson chi-square test was used to compare the distribution of injured players according to pH levels. Non-parametric test of Kruskal Wallis was used to compare the injury-related variables between pH groups.

RESULTS: Significant differences in salivary pH level were observed between injured and non-injured players ($p = 0.042$). Differences in the total number of sport injuries ($p = 0.014$) and time-loss ($p = 0.029$) between pH groups were found. Specifically, players with the highest pH levels (Basic) sustained more sport injuries and greater time-loss due to injury

compared to those players with lower pH (Acidic and Neutral). Same trend was found in non-contact sport ligament injuries (p = 0.024).

CONCLUSION: In conclusion, the findings of the study point to a potential relationship between salivary pH levels and sport-related injuries and time-loss. Although further research is needed, the results suggest that salivary pH could serve as a screening tool to detect players with an increased risk of injury.

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# Oral Presentations

## OP-MH03 Sports Medicine and Orthopedics I

### IMPROVING RISK PREDICTION FOR HEAT STROKE AND RACE DROPOUTS IN ATHLETICS: BEYOND THE WBGT

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INTRODUCTION: Exercising under strenuous environmental conditions can lead to fatal exertional heat stroke (EHS) if not managed promptly and adequately. Also, the number of athletes who do not finish a race (DNF) is believed to be influenced by environmental stress during competition. To measure heat stress, international federations rely on thermal indices, such as the Wet Bulb Globe Temperature (WBGT) in Athletics. However, the relationship between thermal indices, EHS incidence, and DNF rates in elite endurance athletes remains unclear. The aim of this study was therefore to i) quantify the incidence of EHS and DNF events in World Athletics competitions, ii) examine their association with thermal indices, and iii) develop predictive models to estimate EHS and DNF risk before a race.

METHODS: Eighty Athletics endurance races held between 2019 and 2024 were included in the analysis, encompassing the World Championships and the Olympic Games. Environmental parameters (e.g., temperature, humidity) and WBGT were measured on-site and linked to race-specific details (e.g., distance, race time), and the number of DNF and EHS (called dependent variables) were counted. Additionally, several thermal indices (e.g., PET, mPET, UTCI) and energy expenditure were estimated for each race. To analyse the relationship between predictors and the dependent variables, a linear regression analysis was conducted, with a significance level at 0.05. Additionally, Generalized Additive Models (GAM) with k-fold cross validation were used to assess the prediction power of models on unknown races.

RESULTS: A total of 41 EHS cases were diagnosed among 4938 athletes (8/1000 athlete exposures) with 56 races (70%) reporting no EHS and 24 races (30%) recording between 1 and 5 cases. In average, each race led 6 ± 9 DNF, ranging from 0 to 60. The strongest EHS linear regression was observed for UTCI ($R^2$=0.10, p=0.003), while WBGT showed a lower association ($R^2$=0.06, p=0.025). For DNF, race distance was the strongest linear regression ($R^2$=0.40, p<0.001) while WBGT association was not significant ($R^2$=0.01, p=0.58). The best GAM for predicting EHS included temperature, WBGT, mean radiant temperature, and the days elapsed since the last spring onset, with an $R^2$ of 0.20 ± 0.15. For DNF, the best GAM included WBGT, race time, and mean velocity, achieving an $R^2$ of 0.80 ± 0.03.

CONCLUSION: Our analysis showed that WBGT alone has only a weak linear relationship with EHS and DNF in Athletics and that more recent thermal indices (e.g., UTCI), while improved, still do not demonstrate a sufficiently strong association. Likewise, non-linear prediction models incorporating environmental parameters and race-specific details do not provide a robust estimation of EHS. This suggests that key factors contributing to EHS were not accounted for in our analysis. However, the prediction models for DNF proved to be robust, allowing for an accurate estimation of the number of athletes who will not finish the race, before the start of the competition.

### INVESTIGATING THE ASSOCIATION OF GENETIC MARKERS, PREVIOUSLY IDENTIFIED BY GENOME-WIDE ASSOCIATION STUDIES, WITH ACL RUPTURE IN MULTIPLE COHORTS

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INTRODUCTION: Genetic variance is an important risk factor for many musculoskeletal soft-tissue injuries, including ACL rupture. Several direct-to-consumer genetic tests have emerged that claim to be able to test for susceptibility to such injuries[1]. Only a single company uses injury-specific genetic markers based on the findings of genome-wide association studies (GWAS), an arguably more robust and scientifically reliable approach than the traditional candidate gene studies. The genetic markers identified by GWAS used to determine ACL rupture risk include rs188099931 (A/G), rs186727643 (C/T) and rs144051132 (T/A)[2]. However, their viability as reliable markers of injury risk has yet to be critically and scientifically evaluated in independent cohorts. Thus, this study aimed to determine whether rs188099931, rs186727643 and rs144051132 are associated with ACL rupture across multiple population groups.

METHODS: A genetic association study, comprising cases clinically diagnosed with ACL rupture (ACL), a subset of cases who had sustained an ACL rupture via a non-contact mechanism (NON) and a control group (CON), was conducted whereby participants from four cohorts of European ancestry; South African (CON=229, ACL=242, NON=161), Australian (CON=82, ACL=330, NON=149), Polish (CON=147, ACL=142, NON=56) and Swedish (CON=116, ACL=95, NON=79), as well

as a South African mixed ancestry (MA) cohort (CON=106, ACL=99, NON=51), were genotyped for the three variants using TaqMan™ Genotyping assays. Genotype distributions were compared between ACL and CON groups, as well as NON and CON groups.

RESULTS: No significant associations between the three variants and ACL rupture were reported. Furthermore, several genotypes were either absent or rare. Specifically, the rs188099931 GG, rs186727643 TT and rs144051132 AA genotypes were not detected. Six rs188099931 AG [CON(0.2%, n=1) vs ACL(0.6%, n=5), p=0.410; CON vs NON(0.7%, n=3), p=0.448)], one rs186727643 CT [ACL(0.1%, n=1), p=1.000; NON(0.2%, n=1), p=0.589) and 12 rs144051132 TA [CON(0.7%, n=4) vs ACL(1.0%, n=8), p=0.770; CON vs NON(0.9%, n=4), p= 0.819] genotypes were identified across the European cohorts. In the MA cohort, one rs188099931 AG [CON(0.9%, n=1), p=1.000], eight rs186727643 CT [CON(2.8%, n=3) vs ACL(5.1%, n=5), p=0.486; NON(2.0%, n=1), p=0.092] and three rs144051132 TA [CON(0.9%, n=1) vs ACL(2.0%, n=2), p=0.611; NON(2.0%, n=1), p=0.489] genotypes were identified. All three heterozygote genotypes were absent from the Swedish cohort, while rs188099931 AG and rs186727643 CT were absent from the Polish cohort. The rs186727643 CT genotype was also absent from the South African cohort.

CONCLUSION: The scientific evidence is too weak to support an association between ACL rupture and rs188099931, rs186727643 or rs144051132. The observed rarity of the effect alleles suggests that the use of these variants as reliable markers of ACL rupture risk is not viable, and we do not support their inclusion as markers of ACL rupture risk in a genetic test.

**SPORTS-RELATED HEAD IMPACTS AND CORTICAL AND SUB-CORTICAL BRAIN FUNCTION: DIFFERENCES BETWEEN CONTACT AND NON-CONTACT SPORT ATHLETES**

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INTRODUCTION: Repetitive head impacts in contact sports may have significant effects on neural function even in the absence of a diagnosed concussion. While much attention has been given to the cognitive and motor consequences of concussive injuries, less is known about the impact of sub-concussive head impacts on auditory processing. This is an essential function for communication in dynamic sporting environments but also acts as a physiological marker for brain health. This study investigates how contact sports influence auditory neural responses by comparing cortical and sub-cortical electrophysiological markers between contact and non-contact athletes.

METHODS: We tested n=54 tier 2 athletes age (mean ± SD) (20.24 ± 1.99 years), height (1.76 ± 0.09m) and body mass (77.2 ± 12.7kg) divided into two groups of n=28 contact sport and n=26 non-contact sport athletes. Groups were matched for age (contact: 20.25 ± 1.92 years; non-contact: 20.23 ± 2.1 years, $t(52) = -0.035$, $p > 0.05$) and body mass index (BMI) (contact: 25.38 ± 3.35; non-contact: 24.08 ± 2.44, $t(52) = -1.76$, $p > 0.05$). There was no significant difference in sex distribution (contact: 10 female, 18 male; non-contact: 17 female, 9 male, $\chi^2(1) = 3.63$, $p > 0.05$). Cortical (N100) and sub-cortical (auditory brainstem responses) responses were recorded using 32-channel electroencephalography (EEG) to measure auditory neural processing under two conditions: (i) low neurophysiological stress (no background noise) and (ii) high neurophysiological stress (background noise).

RESULTS: Results from a mixed-model two-way ANOVA revealed a significant main effect of group ($F(1,52) = 4.476$, $p < 0.05$) for the auditory cortical responses, where contact athletes showed a reduced neural response to sound (N100 amplitudes, -2.07 ± 1.7μV) compared to non-contact athletes (-2.81 ± 1.54μV). There was no significant main effect of stress condition ($F(1,52) = 2.060$, $p > 0.05$) and no significant group x stress condition interaction ($F(1,52) = 1.822$, $p > 0.05$). Sub-cortical neural responses (F0 amplitudes) showed no significant group ($F(1,52) = 1.246$, $p > 0.05$), stress condition ($F(1,52) = 2.088$, $p > 0.05$) or interaction effect ($F(1,52) = 2.181$, $p > 0.05$).

CONCLUSION: These findings show that cortical auditory processing may be more vulnerable to repetitive sub-concussive head impacts than sub-cortical responses. This suggests that cortical brain areas are more susceptible to impact-induced dysfunction than sub-cortical brain areas, indicating that sub-concussive injury is potentially damaging to cortical neural generators of the auditory N100 response.

**PHYSICAL CHARACTERISTICS AND INCIDENCE OF INJURIES IN ELITE PAIR SKATERS:A RETROSPECTIVE SURVEY**

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INTRODUCTION: Figure skating is a sport that combines art and athletic competition. Technical movements mainly include jumps and spins. Pair skating builds on this with some pair movements like lifts, throws, twist lifts, death spirals and so on. Firstly, due to the technical characteristics of pair skating, there are many overhead movements and also in order to be competitive the athletes have to constantly increase the difficulty, speed and power of their performance, which leads to an increased risk of sports injuries.

METHODS: As a retrospective survey, 20 elite pair skaters (10 male and 10 female) of Team China voluntarily completed a study questionnaire about general demographic information, exercise habits, and injury history from January 1, 2024 to December 31, 2024. A total of 20 questionnaires were distributed and 20 valid questionnaires were recovered, with a valid recovery rate of 100 percent. Survey data on injuries in pairs skaters as well as observational data were summarized and analyzed using SPSS 26.0 and Excel.

RESULTS: In this survey, age of male skaters is 18.1±2.13 years, and training duration is 9.6±2.22 years. Age of female skaters is 13.8±2.15 years, and training duration is 6.6±1.90 years. The age difference between male skaters and female skaters is large. The time of injury was mainly in October(35%), September(20%), November(20%), December(20%). Ranking of injury rate was ice training(100%), physical training(20%), specialized training on land(20%), warm-up exercise on land(5%). And the most common injury parts were knee(50%), ankle(45%), groin(40%), low back(35%). If it was categorized according to different genders, in male skaters, the most common injury parts were knee(50%), shoulder(40%), ankle(30%), groin(30%), low back(30%), and in female skaters, the most common injury parts were ankle(60%), knee(50%), groin(50%), low back(40%). The type of injury was mainly acute(55%).

CONCLUSION: Due to the specificity of pairs skating movement technology, the injury of male athletes and female athletes is different, but the lower limbs are the same parts with more injuries. For their different sports injuries, it is important to develop injury prevention methods to minimize injury.

**CORRELATION ANALYSIS OF PATIENT-ORIENTED AND CLINICALLY-ORIENTED FUNCTIONAL ASSESSMENT IN PATIENTS WITH CHRONIC ANKLE INSTABILITY**

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INTRODUCTION: Chronic ankle instability (CAI) affects up to 40% of individuals following initial ankle sprain. While traditional assessment primarily focuses on clinically-oriented objective measures such as muscle strength and range of motion, the International Ankle Consortium emphasizes incorporating patient-oriented subjective measures through patient-reported outcome measures (PROMs). We hypothesized that correlations exist between patient-oriented and clinically-oriented measures in CAI patients, with distinct patterns between genders. This study investigates these potential correlations and their gender-specific characteristics.

METHODS: Forty-six CAI patients (23 males, 23 females) were evaluated using patient-oriented (Cumberland Ankle Instability Tool [CAIT] ) and clinically-oriented measures (Y-Balance Test [YBT] and handheld dynamometer testing for ankle and hip strength). Spearman correlation analysis examined relationships between between subjective and objective measures.

RESULTS: Overall analysis: CAIT scores correlated with YBT anterior ($\rho$=0.297), posteromedial ($\rho$=0.325), posterolateral ($\rho$=0.355), composite ($\rho$=0.359), ankle dorsiflexion ($\rho$=0.319), eversion ($\rho$=0.302), and hip external rotation strength ($\rho$=0.316, all $P<0.05$). Gender differences: Males showed correlations between CAIT and ankle dorsiflexion ($\rho$=0.445, $P<0.05$) and YBT anterior ($\rho$=0.435, $P<0.05$), posteromedial ($\rho$=0.491, $P<0.05$), posterolateral ($\rho$=0.494, $P<0.05$), composite ($\rho$=0.473, $P<0.05$); In females, no significant correlations were found between CAIT scores and any clinically-oriented objective measures (all $P>0.05$).

CONCLUSION: The CAIT scores showed significant correlations with YBT performance, ankle dorsiflexion strength, eversion strength, and hip external rotation strength, indicating that the perceived instability in CAI patients is closely related to muscle strength deficits and impairments in dynamic stability. In male patients, CAIT scores were correlated with YBT performance, suggesting that the subjective feeling of instability in males is associated with deficits in dynamic stability. In contrast, no correlations were found between CAIT scores and objective measures in female patients, indicating that the source of their perceived instability requires further investigation.

## Oral Presentations

### OP-BM15 Corticospinal Responses

**EMOTIONAL MEMORY RECALL WITH HIGH AROUSAL FACILITATES CORTICOSPINAL EXCITABILITY IN LOWER LIMB MUSCLES**

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INTRODUCTION: Emotional memory refers to the recollection of emotionally significant experiences, which tend to persist longer than neutral experiences and influence behavior by modulating motor control. Previous research has shown that recalling negative emotional memories enhances corticospinal excitability (CSE), a key mechanism underlying motor control [1]. However, given the variety of daily emotions, the impact of discrete emotions (e.g., sadness, anger) on CSE is unclear and requires further investigation. Furthermore, while the effects of emotional memories on CSE have been studied in upper limb muscles, their impact on lower limb muscles remains unexplored. Thus, this study aimed to investigate the effects of discrete emotional memory recall on CSE in lower limb muscles.

METHODS: Twenty-one healthy males (18–29 years old) participated in this study. CSE was assessed using motor-evoked potential (MEP) amplitudes elicited by transcranial magnetic stimulation applied to the primary motor cortex. MEPs were recorded from the soleus, tibialis anterior, medial and lateral gastrocnemius, and rectus femoris muscles. While recalling episodes of happiness, sadness, fear, anger, and neutral (morning routine), 12 MEPs were recorded per condition. Participants rated arousal (high–low) and valence (pleasant–unpleasant) levels of their recalled episodes using the Self-

Assessment Manikin. Statistical analyses included a two-way ANOVA with an aligned rank transform to examine the effects of five muscles and five emotions on MEP amplitudes, followed by a post-hoc contrast test using the ART-C procedure. Additionally, a repeated measures correlation (rmcorr) was conducted to explore relationships between MEP amplitudes and valence/arousal levels. The level of statistical significance was set at $p < 0.05$.

RESULTS: The two-way ANOVA showed a significant main effect of emotions ($p < 0.01$) but not of muscles ($p = 0.99$) or their interaction ($p = 0.82$). Post-hoc contrast tests revealed that recalling emotional memories—whether happiness, sadness, fear, or anger—significantly increased MEP amplitudes compared to neutral (all $p < 0.05$). Given the lack of a significant main effect of muscles, the rmcorr was conducted using mean MEP amplitudes across all muscles and revealed a significant positive correlation between MEP amplitudes and arousal levels ($r = 0.34$, $p < 0.01$).

CONCLUSION: The results indicate that recalling emotional memories enhances CSE in lower limb muscles. Although no significant differences were observed among discrete emotions, MEP amplitudes were positively correlated with arousal levels. These findings suggest that subjective arousal levels rather than emotion types modulate CSE in lower limb muscles. This study advances our understanding of the interplay between emotional memories and motor control, with potential implications for sports performance and rehabilitation strategies.

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**AFFERENT-LIKE MODULATIONS OF RESPONSES EVOKED BY TRANSCUTANEOUS SPINAL CORD STIMULATION**

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*INSERM U1093 CAPS*

INTRODUCTION: Transcutaneous spinal cord stimulation (tSCS) is an emerging stimulation technique which has known a great interest in the neuromuscular field. It presents the advantage of evoking concomitant responses in multiple muscles of the lower limb, known as posterior root muscle (PRM) reflexes (Minassian et al., 2007). Although the nature of these last is complex, stemming from sensory and/or motor solicitation, they present some similarities with the H-reflex that is evoked by peripheral nerve stimulation (PNS). Conversely to PRM reflex, the H-reflex results mainly from Ia afferents depolarization and its amplitude is modulated by external interventions, known to activate Ia afferents, such as neuromuscular electrical stimulation (NMES) (Vitry et al., 2019), local vibration (LV, Abbruzzese et al., 2001) as well as muscle lengthening (Budini & Tilp, 2016). The aim of this study was to determine whether the modulations observed for the H-reflex are also present for the PRM reflex.

METHODS: Fourteen volunteers participated in two experimental sessions. For both sessions, tSCS electrodes were placed at the L1-L2 level of the spinal cord and under the umbilicus to evoke soleus PRM reflex, while PNS was applied to the posterior tibial nerve, to evoke soleus H-reflex. Amplitudes of H- and PRM reflexes were matched at 85%Hmax. For the first experiment, H- and PRM reflexes were delivered before, during and after 3min of Achilles tendon vibration and 1min of plantar-flexor muscles stretching (amplitude: 20°, speed: 30°/s). For the second experiment, both reflexes were delivered before and following 20-s of NMES applied at a frequency of 20 and 100Hz. The evolution of the amplitude of H- and PRM reflexes was explored before, during (for the first experiment only) and after each intervention.

RESULTS: Results showed similar modulations of the responses evoked by PNS and tSCS for the four interventions that were tested. Indeed, both H- and PRM reflexes were decreased during LV and stretching ($P < 0.001$) with a return to baseline values following the interventions. For the NMES trains, a decrease was observed following the 20-Hz train ($P < 0.02$) while no modulation was revealed for either reflex for the 100-Hz condition ($P = 0.51$).

CONCLUSION: Present results show that H- and PRM reflex are modulated in the same way by different external interventions known to solicitate Ia afferents. This suggests that similar mechanisms, most probably presynaptic inhibitory mechanisms, are responsible for both H- and PRM reflexes modulations during these different interventions. This study provides new proof of the similarities between the two types of reflexes and a better understanding of the nature of PRM reflexes.

**SPINAL AND SUPRASPINAL EXCITABILITY DURING NORDIC SKIING USING V2 SKATING TECHNIQUE**

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INTRODUCTION: Motor control has been divided into spinal and supraspinal control, which can be measured using H-reflex and V-wave methods, respectively (Aagaard et al. 2002, Nevanperä et al. 2023). Utilizing these methods in dynamic conditions are challenging since responses are sensitive with variation on neural behavior, constance of performance (skiing) techniques and distance between stimulating electrode and the nerve. The purpose of the study was to analyze repeatability of H-reflex and V-wave methods during cross-country skiing (XCS). In addition, the role of spinal and supraspinal control was evaluated especially in the gliding phase (balance control).

METHODS: Seven experienced skiers (27-49 yrs) performed 10-15 trials (3- minutes each) using V2 skate on roller skies (treadmill; 2° incline) with a velocity corresponding 85% of their maximal skiing velocity. Soleus muscle V-wave (normalized to Mmax) was measured utilizing supramaximal stimulation intensity (150% Mmax) at 1, 255 and 455 ms after the ground contact of the roller ski to measure the effect of supraspinal output during early contact phase, early gliding phase and the late gliding phase, respectively. H-reflex responses (conditioned with 15% Mmax) were measured with identical delays to evaluate spinal level output.

RESULTS: Between day repeatability (ICC) was moderate to good for the V-wave and H-reflex 0,556-0,748 and 0,663-0,895, respectively. In both responses, there was significant main effect between the phases (V-wave F=4,529, p<0.05; H-reflex F=9,969, p<0.001) without significant interactions. V-wave responses increased significantly from contact phase to early gliding phase (p<0.01) with no changes between early and late gliding phases. Similarly, H-reflex increased significantly from contact to early gliding phase (p<0.001) with again no changes between early and late gliding phases.

CONCLUSION: Stimulation techniques may be a potential tool to investigate motor control during XCS. Spinal output was higher during the gliding phase, likely due to increased supraspinal output, although the possibility of increased reflex loop output cannot be ruled out. Possible limitations of the methods are variation of the muscle length and of the pressure of the stimulation electrodes during skiing, which may be subject dependent behavior. Weaker skiers in pilot trials also showed a tendency to lower repeatability. This is to be further investigated evaluating the method applied to XCS.

**FATIGUE- AND RECOVERY-RELATED ALTERATIONS IN CORTICAL AND MOTONEURONAL EXCITABILITY WHEN ASSESSED DURING THE PERFORMANCE OF FAST MAXIMAL-EFFORT ISOKINETIC ELBOW EXTENSIONS IN FEMALES AND MALES**

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INTRODUCTION: Despite the task-dependent nature of fatigue, performance fatigability and subsequent neuronal adaptations have primarily been gleaned from isometric tasks. In the context of dynamic contractions, neural excitability is typically assessed using an isometric model prior to and following termination of the repetitive task. Because performance fatigability is also task-dependent, it is most relevant to assess cortical and motoneuronal excitability during a dynamic contraction. At present, it is unclear how neural excitability is affected by repeated, fast muscle-shortening actions. Further, reports on the influence of sex on fatigue-induced power loss after rapid concentric contractions are equivocal. Thus, the purpose of this study was to assess cortical, motoneuronal, and peripheral excitability during and after repetitive, rapid, concentric isokinetic elbow extensions in females and males.

METHODS: Twenty healthy participants (12 females: 26+/-5y; 8 males: 28+/-5y) performed 120 maximal-effort elbow extensions at an isokinetic velocity of 240 deg/s. Peak power was used to characterize performance fatigability. Neural excitability was assessed during separate elbow extensions during the first 11 (START) and last 11 (END) contractions of the fatigue task, as well as at 10-min post task termination (POSTTEN). Motor evoked potentials (MEPs) from transcranial magnetic stimulation (TMS), cervicomedullary motor evoked potentials (CMEPs) from transmastoid electrical stimulation, and maximal compound muscle action potentials (Mmax) from brachial plexus electrical stimulation were evoked during a TMS-induced silent period while performing concentric elbow extensions. All evoked potentials were induced in the triceps brachii at 90 degrees of elbow flexion. Peripheral excitability was evaluated using Mmax area. To isolate cortical and motoneuronal excitability, the CMEP and MEP area were normalized to the Mmax and CMEP area, respectively.

RESULTS: Peak power (START: 115.73+/-37.60W) decreased by 36.2+/-12.2% (p<0.01) with no sex-related differences (p=0.90). Compared to START (Mmax area: 0.17+/-0.04mV·s, CMEP/Mmax area: 0.16+/-0.07, MEP/CMEP area: 1.26+/-0.54), Mmax area (p=0.19) was unaltered by the END, but CMEP/Mmax (p<0.01) and MEP/CMEP (p<0.01) areas decreased by 31.7+/-25.3 and 38.3+/-53.1%, respectively, for both sexes (p≥0.16). At POSTTEN, regardless of sex (p≥0.32), Mmax area was 9.6+/-16.7% less than START (p=0.02), whereas MEP/CMEP area recovered (p=0.94). Interestingly, CMEP/Mmax area was less in females compared to males (p=0.01) at POSTTEN, such that female CMEP/Mmax area remained blunted (37.5+/-22.9%; p<0.01), but males recovered (p=0.96) compared to START.

CONCLUSION: Taken together, fatigue-induced peak power loss was likely, in part, owing to decreased cortical and motoneuronal excitability for both sexes. Despite cortical excitability recovering fully within 10 min of task termination, motoneuronal excitability remained blunted for females, but not males.

**EXPLORING THE NEURAL CORRELATES OF EFFORT PERCEPTION AND PAIN DURING A VISUO-MOTOR TASK PERFORMANCE.**

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INTRODUCTION: The perception of effort (PE) arises from voluntary actions and reflects their costs, influencing decisions to initiate, sustain, or terminate a task. However, the neural network underlying PE remains poorly understood compared with that of pain. Research suggests that pain and PE share common neural substrates, including regions such as insula, supplementary motor area (SMA) and middle cingulate cortex (MCC). This overlap suggests the possibility of an interaction between these two perceptions.

This study aims to: i) replicate the behavioral effect of pain on the PE, ii) investigate the brain mechanism underlying the interaction between pain and effort. We hypothesize that: i) executing a visuo-motor task in the presence of painful stimulations, compared to non-painful stimulations, increases the associated PE, ii) the activity in the MCC and SMA increases during a visuo-motor task in the presence of pain.

METHODS: Forty healthy participants (50% female, aged 18-40) visited the laboratory twice. During the first visit, each participant completed a thermal calibration to identify the temperatures eliciting a perception of warm and intense pain. During the second visit, participants performed a visuo-motor task in an MRI scanner in the presence of painful or warm (control) thermal stimulations. The task consisted of handgrip contractions at 5% or 30% of the participant's maximal force,

with the instruction to match as precisely as possible a line presented on the screen. After each contraction, participants rated their perceived effort and pain/warm intensity on visual analogue scales.

RESULTS: To maintain performance, PE was higher in the presence of pain, compared to the warm stimulation (p<.001). fMRI analyses confirm a) robust activations in several cortical regions in response to painful stimuli, including SMA/pre-SMA, MCC, and insula; b) significant activations associated with the visuo-motor task in motor cortices, including the SMA and MCC, as well as the parieto-occipital cortex. Contrary to our hypothesis, fMRI analysis revealed a decreased activation in the SMA and MCC during the visuo-motor task when performed in the presence of pain (fdr-corrected q=.05).

CONCLUSION: Our behavioral results confirm that maintaining performance in the presence of pain is effortful. Contrary to our hypothesis, the activity of SMA and ACC decreased. Our finding still suggests a role of these areas in effort and pain integration, offering new insights into the neural mechanisms underlying effort in painful contexts. The decreased activation in SMA and ACC may be linked to the integration of pain processing and action execution; or to the hypoalgesic effect of action execution on pain elaboration. Future studies should investigate the complex interplay between visuo-motor tasks, pain, and PE, to better understand how SMA and ACC activity is related to pain and performance regulation.

## Oral Presentations

### OP-SH11 Mental Health

**EXPLORING FACIAL ACTIONS AS INDICATORS OF AFFECTIVE RESPONSES DURING RESISTANCE EXERCISE: A NOVEL APPROACH TO UNDERSTANDING EXERCISE-RELATED PLEASURE AND DISPLEASURE**

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Feelings of pleasure and displeasure (affective valence) during exercise are considered predictors of future exercise behavior (1). Affective valence is typically measured using self-report scales such as the Feeling Scale (FS) (2). However, these measures are susceptible to biases (e.g., social desirability). Consequently, identifying alternative methods that mitigate biases could offer new insights into affective responses during exercise. Facial actions have emerged as promising objective measures, providing real-time, non-verbal indicators of affective states (3). This study examines relationships between facial actions and pleasure–displeasure during resistance exercise.

We hypothesized that FS scores would decrease over repetitions and that specific facial actions (e.g., mouth open, jaw drop) would negatively correlate with FS scores, indicating reduced pleasure.

Using a within-subjects repeated measures design, participants completed 4 sets of 10 repetitions of a seated row exercise with a 3-minute recovery period between sets. Exercise intensity was standardized using each participants 10-repetition maximum. FS responses were collected after repetitions 1, 4, 7, and 10 of each set. Facial actions were continuously recorded and analyzed at 30 frames per second using iMotions (version 8.1).

Preliminary analyses of 40 participants (19 females, 21 males; mean age = 42.8, SD = 12.1) using repeated-measures ANOVA found no significant inter-set FS differences ($p > .05$). However, a repeated-measures ANOVA with Greenhouse-Geisser correction revealed a significant intra-set effect, $F(1.35, 52.71) = 13.98$, $p < .001$, eta^2 = .264, indicating a moderate-to-large effect size.

Post hoc pairwise comparisons (Bonferroni corrected) demonstrated that FS scores significantly decreased between repetitions 4 and 10 ($p < .001$), 4 and 7 ($p = .003$), and 1 and 10 ($p = .006$). No significant differences were observed between repetitions 1 and 4, and 1 and 7 ($p > .05$). The associated mean FS scores rose from repetition 1 to 4 before declining thereafter with values of $M = 2.13$ (SD = 1.28), $M = 2.24$ (SD = 1.21), $M = 1.84$ (SD = 1.41), and $M = 1.47$ (SD = 1.52) at repetitions, 1, 4, 7 and 10, respectively. Pearson correlations revealed significant negative associations between eye widen, cheek raise, and FS scores, indicating these facial actions may reflect affective responses during exercise.

These findings offer support for the use of facial actions as indicators of affective responses during resistance exercise, offering a complementary approach to self-report measures. Future studies may employ these novel methods in different protocols, such as cardiorespiratory exercise, to further validate their utility. Such research could inform the development of exercise protocols that maximize pleasure, ultimately promoting long-term engagement in physical activity.

(1) Rhodes & Kates, 2015

(2) Hardy & Rejeski, 1989

(3) Cohn et al., 2007

**EFFECTS OF MODERATE-TO-HIGH COMPARED TO LOW INTENSITY SHAM RESISTANCE EXERCISE ON DEPRESSED MOOD STATE AMONG YOUNG ADULT WOMEN WITH ANALOGUE GENERALIZED ANXIETY DISORDER: A RANDOMIZED CONTROLLED TRIAL**

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Young adult women are at risk for Generalized Anxiety Disorder (GAD) and Major Depressive Disorder (MDD), which are highly comorbid. The antidepressant effects of regularly-performed resistance exercise training (RET) are well-established, and have high potential for impact among women. However, little is known about the effects of a single resistance exercise (RE) session on transient feelings of depressed mood, or depressed mood state.

PURPOSE: To examine the acute effects of a single moderate-to-high intensity compared to low intensity sham RE session on depressed mood state among young adult women with subclinical, or analogue GAD (AGAD), with or without comorbid subclinical, or analogue MDD (AMDD).

METHODS: Sixty-six young adult women (22.0±2.8y) with AGAD were randomized to eight weeks of moderate-to-high intensity, guidelines-based RET, or a low intensity sham RET attention control. An acute randomized controlled trial at week one investigated the effects of a single RE session on mood states. Moderate-to-high intensity participants performed two sets of 8-12 repetitions of eight exercises with loads of approximately 70-80% of their estimated one-repetition maximum (1RM). Low intensity sham RE participants completed the same RE session with lighter loads (~20% 1RM). The Depression subscale of the Profile of Mood States-Brief Form (POMS-B) measured depressed mood state pre- and 10 minutes post-RE. A two group (RE/sham) X two timepoint (pre/post) repeated measures ANOVA examined differences between moderate-to-high and low intensity RE. Sub-analyses were conducted among young adults with comorbid depressive symptoms, AMDD, and pre-exercise POMS-B $\geq$1 and $\geq$4.

RESULTS: No significant group X time interaction was found for depressed mood state ($F(1,64)=2.40$, $p=0.127$). Significant main effects for time were found among the total sample ($F(1,64)=30.55$, $p<0.001$, $d=0.56$-$0.59$), and sub-samples with comorbid depressive symptoms ($F(1,56)=29.70$, $p<0.001$, $d=0.55$-$0.64$), AMDD ($F(1,24)=20.38$, $p<0.001$, $d=0.73$-$0.90$), and pre-exercise POMS-B $\geq$1 ($F(1,36)=46.23$, $p<0.001$, $d=0.76$-$1.16$) and $\geq$4 ($F(1,16)=34.07$, $p<0.001$, $d=1.10$-$1.37$), such that depressed mood state reduced following both moderate-to-high and low intensity RE.

CONCLUSION: Moderate-to-high and low intensity RE elicited similar, within-condition, moderate-to-large magnitude reductions in depressed mood state. Consequently, anxious young women may achieve similar benefits for depressed mood state by performing light intensity RE, requiring less physical effort, as they would from higher intensity, more physically-demanding RE.

**BREATHING TECHNIQUES FOR STRESS REDUCTION AND COGNITIVE FUNCTION IMPROVEMENT IN 14 – 17-YEAR-OLD ADOLESCENT ATHLETES POPULATION**

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INTRODUCTION: Adolescent athletes face an enormous amount of stress due to high demands in their career, and it can impact their physical performance and mental well-being. Since ancient times people have used breathing techniques to help them improve their focus and prepare for the challenges ahead. A number of these techniques have been proven to work for adults, but there is a lack of knowledge of what kind of techniques can be applied to adolescents. The aim of the study was to identify and summarize breathing techniques for stress reduction and cognitive function improvement in 14 – 17-year-old adolescent athletes.

METHODS: Following the Joanna Briggs Institute Manual for Evidence Synthesis searches covered databases: Science Direct; Scopus; Cochrane; ProQuest; PsycINFO; Google Scholar; The Web of Science; EBSCOhost Complete. A scoping review for English-language research covered the period from January 2000 to December 2023, to determine the scope of the use of breathing techniques in an adolescent sports environment.

RESULTS: The results yielded five articles that encompassed such breathing techniques as heart rate variability biofeedback, slow-paced breathing, yogic breathing techniques and relaxation breathing. Stress was a much more prevalent outcome variable as compared to cognitive function.

Discussion: The benefits of breathing techniques have been long documented for various conditions both related and unrelated to sports. The present scoping review affirmed that breathing techniques for adolescent athletes can reduce stress and enhance cognitive capacity. In sports context this can be used as a tool to gauge the nervous system and maximize the benefit of either peak activity moments or the recuperation phase thereafter. As for the adolescent population, more demand and techniques seem to be available for the calming effect.

Conclusions

Breathing techniques can reduce stress and improve cognitive function in adolescent athletes, but more research is needed to determine the most effective techniques.

**SOCIAL PHYSICAL ACTIVITY, HUMOR EXPRESSION, AND LONELINESS: A CROSS-SECTIONAL STUDY OF THEIR RELATIONSHIPS**

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INTRODUCTION: Social isolation is a growing concern among older adults. Previous studies have demonstrated that physical activity can enhance social cognitive functioning through multiple neurobiological pathways (Ludyga et al., 2022). This study used a Bayesian sparse regression model with a large-sample dataset to examine the associations among physical activity, humor expression, and loneliness.

METHODS: Older Japanese adults participated in an online survey (n=5213, 50% women, age range: 65–84 years). We used a Bayesian sparse regression model with horseshoe priors to select relevant variables related to loneliness from physical activity patterns (e.g., team/individual sports experience and physical activity), sedentary behavior, and humor outcomes (humor and humor coping styles). A Bayesian structural equation model (SEM) was used to examine how variables with a high inclusion probability (IP) affected loneliness.

RESULTS: The Bayesian sparse regression model identified the following variables with high IP: past exercise experiences with friends (IP = 0.758), present exercise experiences with friends (0.736), affiliative humor (0.899), self-deprecating humor (0.809), self-enhancing humor coping (0.829), and aggressive humor coping (0.755). Past and present exercise experiences with friends, affiliative humor, and self-enhancing humor coping were associated with reduced loneliness. In contrast, self-deprecating and aggressive humor coping was associated with increased loneliness. The Bayesian SEM revealed that both past and present exercise experiences with friends were associated with reduced loneliness through affiliative humor (past: posterior mean = -1.171 [95% Credible Interval = -1.406, -0.936]; present: -1.591 [-1.906, -1.277]) and self-enhancing humor coping (past: -0.547 [-0.700, -0.394]; present: -0.659 [-0.863, -0.455]). Additionally, an indirect pathway associated with greater loneliness was found for past exercise experiences with friends through self-deprecating humor (0.114 [0.013, 0.214]).

CONCLUSION: These findings highlight relationships between exercise experiences with friends and reduced loneliness, which were associated with utilizing affiliative humor and self-enhancing humor coping. In contrast, self-deprecating humor mediates the association between past exercise experiences with friends and increased loneliness. These results provide valuable insights into the development of interventions aimed at reducing loneliness among older adults. Specifically, promoting exercise experiences with friends may encourage positive humor expression and indirectly alleviate loneliness, with the present exercise status playing a more critical role than past exercise experiences.

REFERENCES:

Ludyga et al., Exerc Sport Sci Rev, 2022

**EFFECTIVENESS OF PHYSICAL EXERCISE INTERVENTIONS ON MENTAL HEALTH AND WELL-BEING IN UNIVERSITY STUDENTS - A SYSTEMATIC REVIEW**

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INTRODUCTION: University and college students might be at higher risk of developing mental health issues due to high stress levels, and depression and anxiety disorders peaking during these years. Physical Exercise Interventions (PEIs) effectively improve mental health and well-being outcomes in various populations [1]. However, existing reviews in university students solely focus on self-reported questionnaires [2]. Therefore, this review aims to investigate the effectiveness of PEIs in university students not only using validated questionnaires, but also psychophysiological measures (e.g., EEG, HRV) to decrease depressive and anxiety symptoms, and to increase well-being.

METHODS: The review followed the PRISMA guidelines. The search was conducted on Web of Science and SPORTDiscus with the following eligibility criteria: university or college students, physical activity intervention, outcomes of depression, anxiety, or well-being, psychophysiological measures, and English language. Reviews and meta-analyses were excluded. The methodological quality of included studies is assessed using the PEDro scale. A meta-analysis will be performed if feasible.

RESULTS: After removing duplicates, the search revealed 2,140 records. The screening process, methodological quality assessment, data extraction, and synthesis are ongoing. We expect that PEIs are efficient strategies to decrease depression and anxiety symptoms and improve well-being in university students [2]. We also expect to find increased HRV after PEIs and modulations of theta and alpha brain rhythms. If meta-analysis is feasible, a small-to-moderate effect size favoring the PEIs is expected [1].

CONCLUSIONS

This review will provide a comprehensive overview of the effectiveness of different PEIs (e.g., aerobic exercise, yoga), comparing the findings to existing literature. It is expected that there will be limited information about the effectiveness of PEIs combined with standard treatment (e.g., psychotherapy) in students. However, research suggests the additional benefits of combining these interventions over standard treatment alone in clinical populations [3]. The findings of this review will help to inform future intervention studies aimed at improving mental health and well-being in university students.

1. Rebar et al. (2015) https://doi.org/10.1080/17437199.2015.1022901

2. Donnelly et al. (2024) https://doi.org/10.1093/heapro/daae027
3. Lee et al. (2021) https://doi.org/10.1016/j.jad.2021.09.043

## Oral Presentations

### OP-MH18 Health and Fitness - Children

**CHANGES OF OCULAR BIOLOGICAL PARAMETERS AND PHYSICAL HEALTH STATUS IN SCHOOL-AGE CHILDREN: A 2-YEAR COHORT STUDY**

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INTRODUCTION: Myopia has become a growing global health concern, with a particularly high prevalence among school-age children1. Research has established that various ocular biometric parameters, such as axial length (AL), spherical equivalent refraction (SER), anterior chamber depth (ACD), and axial length-to-corneal radius ratio (AL/CR), are intricately linked to the onset and progression of myopia. Studies highlight a direct correlation between AL elongation and myopia severity2. Physical health indicators—such as BMI, height, and cardiorespiratory fitness—also play a crucial role, influencing ocular growth and visual health outcomes. Despite the extensive body of research, there remains a significant gap in long-term longitudinal studies that examine the simultaneous relationship between multiple ocular biological parameters and physical health in school-aged children.

METHODS: This two-year longitudinal study involved a cohort of 313 children (172 boys, 141 girls) aged 8–12, drawn from two urban primary schools in Hefei, China. Annual assessments conducted from 2019 to 2021 measured various ocular biometric parameters and physical health indicators. Myopia was categorized as persistent (diagnosed in both 2019 and 2021), incident (new diagnosis in 2021), or absent (no myopia at both time points). Exclusion criteria included ocular diseases, surgeries, or significant refractive disparities. Physical health evaluations were performed in accordance with national standards, assessing height, weight, BMI, cardiorespiratory fitness, agility, and strength through tests such as the 50-meter run, sit-and-reach, rope skipping, and sit-ups. Statistical analyses, including Pearson correlations, ANOVA, and multivariate linear regression, were performed to identify relationships between ocular and physical variables over time.

RESULTS: The rate of myopia was 25.56% in 2019. By 2020, it soared to 63.90%, and reached 72.20% in 2021, by the end of the study, 226 children (127 boys, 99 girls) were classified as myopic. Consistent trends were observed across all groups, including increased AL, ACD, BMI, height, and strength-related metrics (rope skipping and sit-ups), coupled with decreased SER and flexibility scores($p<0.05$). The persistent myopia group exhibited the most pronounced axial elongation and myopia progression($p<0.001$). In this group, changes in SER correlated positively with sit-up performance($r=0.085, p<0.05$), while axial length changes correlated negatively with height and positively with vital capacity($r=-0.201, p<0.05$; $r=0.223, p<0.05$). The increased myopia group showed a significant correlation between ACD changes and sit-up performance($r=0.138, p<0.05$). In none myopia group, slower 50-meter run times corresponded to more stable refractive errors($r=0.216, p<0.05$). Regression analyses revealed that higher BMI changes predicted greater SER shifts in increased myopia group, and improved sit-up performance was linked to higher AL/CR changes($p<0.05$).

CONCLUSION: This study demonstrates a significant association between physical fitness indicators—such as BMI, cardiorespiratory endurance, and strength—and ocular biometric parameters. These findings suggest a complex interaction between physical and visual development in school-age children, emphasizing the importance of integrated strategies for myopia prevention. Public health initiatives should consider the combined influence of lifestyle, physical fitness, and visual health, aiming to mitigate myopia progression through holistic interventions.

**SCHOOL-BASED PHYSICAL ACTIVITY, ACADEMIC ACHIEVEMENT IN SCIENCE AND HEALTH-RELATED FITNESS: A COMPARISON OF SCHOOL-AGE CHILDREN WITH AND WITHOUT OBESITY.**

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INTRODUCTION: Physical inactivity among children is a significant public health concern that is becoming increasingly prevalent1,2. This study compared school-based physical activity levels (PA), health-related fitness, and academic achievement (AA) in science-related courses between normal-weight and obese school-age children in Qatar.

METHODS: Fifty healthy schoolchildren were recruited (age: 11.2 ± 0.41 years; body mass: 44.36 ± 8.17 kg; height: 1.56 ± 7.79 m; body mass index (BMI): 21 ± 3.8 kg/m2). Based on age-specific BMI percentiles, the schoolchildren were classified as normal weight (n=25) and obese (n=25). Measurements included anthropometric data and health-related fitness test (T-half test for change-of-direction (CoD), 10 m sprint, medicine ball throw (MBT) and Stork test of static balance (SB)). AA was assessed through school records of grades point average (GPA) in Mathematics, and Science courses. The International Physical Activity Questionnaire Short Form (IPAQ—SF) was used to estimate the total amount of time engaged in PA per week in children classified into three intensity levels: moderate (4 METs), vigorous (8 METs), and walking. Additionally, the time spent sitting (TS) was calculated to quantify sedentary behaviors.

RESULTS: Comparative analysis showed that obese students exhibited significantly lower AA scores in Mathematics (80.80 ± 9.32% vs 89.60 ± 3.80%, $p < 0.001$, $d = 1.24$) and Science (81.20 ± 9.92% vs 89.20 ± 3.73%, $p < 0.001$, $d = 1.07$) compared to their normal-weight peers. While health-related fitness performance metrics showed no significant differences between groups. However, obese participants demonstrated significantly higher weekly TS (4.12 ± 2.13 vs 2.92 ± 1.44 hours, $p = 0.02$, $d = 0.66$) and lower engagement in moderate-intensity PA (448.00 ± 291.43 vs 611.20 ± 277.01 MET-minutes/week, $p = 0.05$, $d = 0.57$).

CONCLUSION: This study determined health-related fitness and AA in BMI-stratified obese and non-obese schoolchildren. Surprisingly, the predictor's body weight did not influence the health-related fitness of the students. Descriptive analysis revealed that obese children had lower levels of PA compared to their normal-weight peers. Conversely normal-weight students demonstrated the highest AA. Future studies are required to incorporate additional variables, such as biological maturation status, to validate our observations and enhance accuracy. Schools should consider strategies to increase PA and health-related fitness as part of their overall strategy for improving AA of science-related courses.

1Martin et al., Cochrane Database Syst Rev. 2018 Jan 29;1(1):CD009728.

2Cerda-Vega et al., Sports (Basel). 2024 Jun 26;12(7):180.

**THE ROLE OF ACTIVE BREAKS IN ENHANCING COMPLEX PROCESSING SPEED, MATH PERFORMANCE, AND PHYSICAL ACTIVITY**

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INTRODUCTION: The World Health Organization (WHO) recommends that children and adolescents aged 5 to 17 engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) daily. Adherence to these guidelines is low across European countries, with a notable increase in physical inactivity among children [1]. To address this concern, Active Breaks (ABs) have gained increasing attention in educational settings. ABs are short periods of physical activity integrated into the school day, aiming to enhance both academic and physical outcomes. Research indicates that ABs can improve attention levels and mathematical performance in primary school children [2]. The present study aimed to evaluate the effects of a 12-week ABs program on academic and physical outcomes in primary school children.

METHODS: This study was designed as a randomized controlled trial (RCT) to assess the effects of a 12-week ABs program, consisting of two daily sessions of 10 to 15 minutes each. A total of eighty third-grade children (aged 7.84±0.37 years) were recruited from Primary School in Italy. Following baseline assessments, classes were randomly assigned to one of four conditions based on the type of AB protocol performed: Creativity-based ABs (CREAT; n = 20), Fitness-based ABs (FIT; n = 20), Combined ABs (COMB; n = 20), and a Control group (CON; n = 20). At both baseline and post-intervention, all participants underwent the MOTORFIT test, Reynolds Interference Task (RIT), and the AC-MT 6-11 Math Test.

RESULTS: RM-ANOVA showed significant improvement in mathematical performance, in particular written calculations and problem-solving, where the experimental groups showed significant improvement from pre- to post-assessment ($p<0.001$) and a significant difference between groups, where the combined group showed better performance than the control group ($p<0.030$). Significant improvements were found in complex processing speed, where the experimental groups showed significant improvement from pre- to post-assessment ($p<0.001$) and a significant difference between groups, where the combined group showed better performance than the control group ($p=0.032$). Finally, significant differences were found in the MOTORFIT test, in particular in single-leg hops, alternating single-leg hops, and hitting a ball with a tennis racket, where the experimental groups achieved better performance than the control group ($p<0.05$). Significant improvements were found from pre- to post-assessment in the shuttle run test, in the fitness and creative groups ($p<0.001$).

CONCLUSION: The study demonstrated that the incorporation of active breaks over 12 weeks within the school system led to improvements not only in physical skills but also in math performance and complex processing speed. These enhancements positively impacted two key academic parameters: problem-solving skills and written calculation. Therefore, physical activity promotes motor abilities and better executive functions performance.

1. Colella D. (2020), 2. Fiorilli G. (2017)

**PARAMETERIZED NEURAL ACTIVITY FOLLOWING AN ACUTE BOUT OF EXERCISE**

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INTRODUCTION: Physical exercise has been found to benefit cognitive and brain health. Reported changes in brain function using electroencephalography (EEG) following exercise have traditionally been measured via canonical frequency bands. However, previous studies have yet to investigate changes in brain function while accounting for the aperiodic component of the neural signal. The aperiodic component is a scale free metric of EEG imbedded within the neural signal and has been associated with age, cognitive function, and brain injury. Therefore, we aimed to use resting-state EEG (rs-EEG) to examine within-subject differences in parameterized frontoparietal brain function following an acute bout of high-intensity interval exercise (HIIE) in a cohort of healthy preadolescent children. We hypothesized pre-intervention cardiorespiratory fitness (CRF) would influence any observed changes in brain function following HIIE.

METHODS: Preadolescent children (N=89; 36 female; 9.51 ± .52; 9 – 11 years) completed one study visit, which consisted of a two-minute collection of pre-intervention eyes open (EO) rs-EEG data. Next, they performed an intervention consisting of 20 minutes of HIIE (squats, high knees, jumping, etc.), followed by a two-minute collection of post-intervention EO rs-EEG (same protocol as the pre-intervention). The FOOOF algorithm was used to parameterize the collected neural signal to account for rs-EEG metrics of the aperiodic component. Power within the canonical frequency bands (e.g., alpha, beta) were also processed and analyzed. Analyses were conducted using a linear mixed effects model, with a time*CRF interaction, accounting for sex, age, body mass index, and baseline maximal heart rate.

RESULTS: A significant main effect of time was observed, which revealed a significant increase of the aperiodic exponent (b = 3.05, p = 0.039) following HIIE. A significant main effect of time also revealed a significant decrease in beta2 relative power (b = 0.022, p = 0.048) following HIIE. No significant effects of time*CRF were observed for either brain metric. However, CRF was associated with beta2 relative power post-exercise (p = 0.03) but not pre-exercise (p = 0.17).

CONCLUSION: Preliminary findings reveal significant differences in the aperiodic exponent and beta2 relative power following HIIE. This suggests that an acute bout of exercise may influence parameterized brain function in healthy preadolescent children. Furthermore, CRF did not influence changes in brain function immediately following exercise. As such, increases in the aperiodic exponent (slope of the power spectrum) coupled with decreases in canonical beta2 activity, within the frontoparietal network, may be a plausible mechanism for the immediate effects of HIIE on brain function in healthy preadolescent children. Future research should continue to explore this potential mechanism relative to its effects on cognition.

**OUTDOOR PHYSICAL ACTIVITY IS MORE BENEFICIAL THAN INDOOR PHYSICAL ACTIVITY AT IMPROVING COGNITIVE FUNCTION IN YOUNG PEOPLE**

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INTRODUCTION: Substantial evidence demonstrates the beneficial acute effect of physical activity on cognitive function in young people. Being outdoors is also reported to improve cognition. Given that being outdoors and physical activity can independently enhance cognitive function, there is a potential synergistic effect between the two i.e. outdoor physical activity may have a larger impact on cognitive function than indoor physical activity.

METHODS: Forty-five children (aged 11-13 years) took part in an identical physical activity session (30-min basketball session) outdoors and indoors. Participants completed cognitive tests (Stroop test, Sternberg paradigm, and Flanker task) before, immediately post-, and 45-minutes post-physical activity. Outcome variables were accuracy (percentage of correct responses) and the response time of correct responses. Data were analysed using mixed effect models, using two-way (condition [indoor, outdoor] * time [pre-, immediately post-, 45-minutes post-physical activity]) repeated measures approach.

RESULTS: Outdoor physical activity improved response time more than indoor physical activity immediately post-physical activity on the 3-item level of the Sternberg Paradigm (-34 vs +14ms; P = 0.001) and 45-minutes post-physical activity on the complex level of the Stroop test (-94 vs -20ms; P = 0.002), the 1-item (-9 vs +71ms; P = 0.026) and 3-item (-37 vs +69ms; P < 0.001) levels of the Sternberg paradigm, and the congruent level of the Flanker test (-44 vs -14ms; P = 0.001). Outdoor physical activity improved accuracy more than indoor physical activity immediately post- (+2.0 vs +0.4%; P = 0.036) and 45-minutes post- (+2.0 vs +0.1%; P = 0.043) physical activity on the complex level of the Stroop test and 45-minutes post-physical activity on the incongruent level of the Flanker test (0 vs -3%; P = 0.008).

CONCLUSION: This is the first study to demonstrate superior cognitive benefits of outdoor vs indoor physical activity. Attention restoration theory may explain these findings; it suggests that exposure to nature captures attention in a non-taxing way, allowing cognitive processes to be restored. Young people spend a lot of time in activities requiring prolonged and focused attention (during school) and thus are more likely to experience mental fatigue and a diminished capacity for complex cognitive tasks. Exposure to nature offers an organic, practical, and cost-effective avenue to nurture and support healthy cognitive development during these critical formative years. Therefore, utilising the outdoors/ nature should be a key consideration in the design of future physical activity interventions. The findings of this investigation give support to initiatives that increase time spent outdoors during the school day, e.g., schools to incorporating outdoor physically active learning into their day, increasing the proportion of PE lessons done outdoors, and using initiatives such as the Daily Mile to ensure children get some outdoor physical activity every day.

Oral Presentations

OP-PN14 Molecular Biology and Biochemistry I - Omics and Training

**DIFFERENT PROTEIN PROFILES DISPLAY UNEQUAL CHANGES AFTER RESISTANCE TRAINING, DETRAINING AND RETRAINING**

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INTRODUCTION: Proteins can be fractionated in skeletal muscle into e.g. "myofibrillar" and "sarcoplasmic" fractions, but these are not pure and distinct profiles (1). Alternatively, high-end proteomics has been used to examine responses of individual proteins and pathways to exercise. It can also be used to study protein profiles based on cellular location where their molecular function is known to take place (i.e. myofibrillar, ribosomal, nuclear, enzyme etc. proteins). A study design including resistance training (RT), detraining (DT), and retraining (reRT) (2) enables investigating short- and long-term effects of RT and a potential "proteomic memory" of RT. Therefore, the present study aims to investigate the effects of RT, DT, and reRT on different protein profiles based on their cellular location.

METHODS: Thirty untrained participants were divided into training-detraining-retraining (TDR, n = 17) and control (n = 13) groups. TDR underwent 10 weeks of RT, 10 weeks of DT, and 10 weeks of reRT, while the control group remained non-trained for 10 weeks. Biopsies were collected from vastus lateralis in weeks 0, 10, 20 and 30. High-end diaPASEF on the mass spectrometry of the timsTOF Pro 2 platform was used for proteomics analysis. In total, > 3000 unique proteins were quantified. Of these, 50 unique proteins were classified based on the literature as myofibrillar proteins (37 sarcomeric and 13 sarcomere-associated proteins). Other quantified protein profiles were classified using Panther and Gene Ontology Cellular Component databases: mitochondrial (714 proteins), ribosomal (120), and nuclear (992) proteins. Statistics were conducted using ANOVA and Tukey´s post hoc test. Statistical significance was set at $p<0.05$.

RESULTS: The relative abundance of sarcomeric and sarcomere-associated proteins displayed no significant changes between the timepoints, suggesting these protein profiles change at the same rate as muscle proteins on average during RT, DT, and ReRT. Instead, the relative abundance of ribosomal, mitochondrial, and enzyme protein profiles increased during 10 weeks of RT ($p<0.05$) and compared to controls, and there was a trend for increases in nuclear proteins ($p=0.06$). Enzymes and mitochondrial proteins returned to baseline after DT, whereas nuclear and ribosomal proteins remained elevated after DT ($p<0.05$).

CONCLUSION: Herein we show different temporal changes in protein profiles after resistance training depending on their classified cellular location. Our results suggest relative and persisting expansion of nuclear and ribosomal protein profiles after resistance training and detraining. This may indicate proteomic memory of resistance training-induced hypertrophy.

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**NEW INSIGHTS INTO HUMAN CIRCULATING MIRNA PATH IN EXERCISE: ARTERIOVENOUS CIRCULATING MIRNA BALANCE IN RESPONSE TO MAXIMAL ACUTE EXERCISE**

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INTRODUCTION: Physical exercise can modify circulating microRNA (c-miRNA) profiles in vein and skeletal muscle in a stimulus-specific manner [1]. Along with the posttranscriptional regulation of miRNAs, this makes them potential functional biomarkers in sports [2]. However, the specific secretory and target tissues during exercise remain unclear. Therefore, the aim of this study was to assess the c-miRNA profile in femoral artery and vein influenced by exercise and its potential physiological and performance implications. This approach enables to isolate the specific influence of the muscle environment on the c-miRNA profile in vivo.

METHODS: Nine healthy trained men performed a maximal aerobic test where VO2max and Wpeak were measured. Blood samples were obtained from femoral artery and vein immediately before and after the test. Plasma obtention was followed by miRNA extraction and massive sequencing. Only those c-miRNAs with at least 30 RPM in 3 or more subjects and in one of the two time points or vessels were considered. Principal Component Analysis followed by Principal Component Regression was used to relate c-miRNAs with performance parameters. Functional analysis was performed by a multiscale in silico analysis of the most enriched protein-protein interaction networks.

RESULTS: In basal state, 56% (23 miRNAs) of the c-miRNAs were present in both vessels. Of them, 83% showed a trend to a lower expression level in vein. Consistently, a higher number of c-miRNAs were unique in artery vs vein (16 vs 2), highlighting a possible role of the muscle environment as a target. After the test, 69% (25 miRNAs) of the c-miRNAs were shared between vessels, with a tendency to higher levels in vein (63%). In this line, exclusive vein c-miRNAs were predominant vs artery (1 vs 10), showing a shift of the muscle environment towards increased secretion after exercise. A significant

increase in miR-26b-5p (p-value=0.018, FC=9.07) and miR-21-5p (p-value=0.044, FC=4.04) was found in vein before and after the test, supporting the secretion role. Arterial miR-22-3p, miR-20a-5p, miR-107, miR-106b-5p, miR-103a-3p and let-7g-5p were found to be predictors of VO2max, while post-test arterial levels of miR-486-5p, miR-451a, miR-93-5p, miR-20a-5p, miR-144-3p and miR-15a-5p were related to VO2max. Higher uptake of miR-106b-5p by the muscle environment was correlated with VO2max (p-value=0.021, r=-0.767), highlighting a potential implication of c-miRNA regulation on performance. In silico analysis showed that c-miRNAs correlated with VO2max have a high association at the protein level involved in phosphorylation-mediated processes.

CONCLUSION: The specific c-miRNA profiles described in vein and artery suggest a role of secretion and uptake from the muscle environment, influenced by exercise. The association with performance parameters and phosphorylation functions highlights the importance of c-miRNAs in regulating the response to exercise.

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2. Fernandez-Sanjurjo et al, ESSR, 2018

**NON-INVASIVE MONITORING OF ATHLETES BLOOD BIOCHEMICAL INDICATORS USING URINARY METABOLOMICS: A MULTIVARIATE REGRESSION APPROACH**

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INTRODUCTION: Precision training management requires continuous monitoring of athletes physiological states to optimize performance and prevent overtraining. Traditional blood tests are limited by their invasiveness and complexity. Urinary metabolomics has emerged as a non-invasive and information-rich alternative, offering significant potential in sports physiology. This study uses UHPLC-HRMS-based urinary metabolomics to develop multivariate regression models for predicting key biochemical markers, including hemoglobin (Hb), testosterone (T), cortisol (C), creatine kinase (CK), and blood urea nitrogen (BUN). These models provide a novel tool for non-invasive monitoring and personalized training strategies.

METHODS: Urine samples from 90 National Level athletes were analyzed using high-throughput targeted metabolomics, detecting 416 metabolites per sample. Stepwise Multiple Linear Regression (SMLR) was employed to construct predictive models for the five biochemical markers. The models were evaluated using Adjusted $R^2$, Mean Absolute Error (MAE), and Mean Relative Error (MRE). Predictive performance was validated through cross-validation and independent validation set testing. Comparative analyses with machine learning methods, including Random Forest (RF) and Neural Networks (NN), confirmed the superior stability, accuracy, and interpretability of SMLR.

RESULTS: The models demonstrated high predictive accuracy, with Adjusted $R^2$ values of 0.855 (Hb), 0.974 (T), 0.915 (C), 0.896 (CK), and 0.970 (BUN). Cross-validation results showed mean relative errors (MRE) of 14.25% (Hb), 21.16% (T), 6.12% (C), 20.8% (CK), and 27.27% (BUN), indicating robust performance across diverse markers. For example, the hemoglobin prediction model is represented as:

$\hat{Y}Hb=122.71 - 0.008 \times$ Indole-3-methyl acetate $- 0.003 \times$ Glycolithocholic acid 3-Sulfate $+ 0.034 \times$ Dethiobiotin$+0.003 \times$ Nicotinamide $- 0.002 \times$ Riboflavin 5-monophosphate $+ 0.001 \times$ Arginine $- 0.004 \times$ Octanoylcarnitine $+ 0.001 \times$ X4 Pyridoxic acid $- 0.052 \times$ N-Acetylphenylalanine $- 0.001 \times$ Stachyose $- 0.006 \times$ Methylcysteine $+ 0.000054 \times$ Cystine $- 0.006 \times$ Adenosine monophosphate AMP $- 0.001 \times$ Phthalic-acid $- 0.005 \times$ Sepiapterin $+ 0\text{-}259 \times$ Glycoursodeoxycholic acid GUDCA $+ 0.00008 \times$ Uracil $- 0.033 \times$ Acetylcholine

The models effectively captured metabolic patterns associated with athletes physiological states, offering a non-invasive approach to optimize training and recovery.

CONCLUSION: This study is the first to establish urinary metabolomics-based predictive models for multiple biochemical markers, providing a non-invasive and efficient tool for athlete monitoring. Despite a higher MRE for BUN, the model offers valuable insights for optimizing recovery strategies. Future research will expand the sample size and explore advanced machine learning techniques to enhance predictive accuracy and applicability.

**LONGITUDINAL CHANGES IN METABOLIC PHENOTYPE RESPONSE TO A 7 X 200 M HIGH-INTENSITY SWIMMING SESSION IN HIGH-PERFORMANCE MALE AND FEMALE SWIMMERS**

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INTRODUCTION: Swimming training combines high-volume, low-intensity work with high-intensity intervals, eliciting diverse physiological responses. Most (70-85%) swimming training occurs below the second lactate threshold, with <15% above it (Hellard et al., 2019). However, excessive low-intensity work near high-intensity thresholds may hinder metabolic adaptations. While lap times, heart rate, and blood lactate monitor performance, they provide limited physiological insight. Metabolic profiling offers a deeper view of long-term adaptations, yet longitudinal studies in swimming are rare due to sampling challenges and limited access to elite athletes. Here we examined metabolic phenotype changes in high-performance swimmers undergoing an 8-week high-intensity training program.

METHODS: Fourteen elite swimmers (8 males, 6 females; mean age 20.6 ± 1.6 years) ranked in Australia's top 200 completed a biweekly, standardised 7 × 200 m high-intensity swimming trial for 8 weeks. They adhered to a dietitian-prescribed diet and tracked daily wellness. Capillary finger prick blood samples, collected pre- and post-trial, were ana-

lysed using 1H NMR and targeted LC-MS to assess metabolic phenotypes. Temporal changes were investigated using multivariate (ANOVA simultaneous components analysis) and univariate (linear mixed model) analyses.

RESULTS: Preliminary findings revealed distinct metabolic profiles over time, with sex-specific and individual variations. Key metabolites differentiating males and females were linked to oxidative stress (phosphocholines) and lipid metabolism (lipoproteins, sphingomyelins, ceramides). Further analysis will explore metabolite variability temporal shifts in metabolic phenotype.

CONCLUSION: This study enhances the understanding of molecular responses to training, supporting individualised training, recovery, and nutrition strategies. Findings may inform sport-specific metabolite monitoring panels, aiding coaches and sport scientists to prescribe training that optimise swimmers' performance.

**ASSOCIATION BETWEEN ACTN-3 C.1729C>T POLYMORPHISM AND SHORT LINEAR SPRINT PERFORMANCE IN YOUTH FEMALE VOLLEYBALL PLAYERS.**

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INTRODUCTION: Quick accelerations and vertical jumping are key components of volleyball game [1;2]. Due to its short dimensions, volleyballs court involves relatively short-distance sprints as well as quick movements [3]. Consequently, the volleyball performance is directly affected by the capacity of producing power in sprinting actions [4, 5]. The ACTN-3 c.1729C>T polymorphism is one of the genetic marker most studied in the field of sport sciences and it has been associated with sprint performance [6]. It codes for the a-actinin-3 protein, which is a decisive factor in the ability to produce high-power, high-velocity muscular contractions required for sprinting performance [7]. This study examined the influence of a common genetic variant in the alpha actinin-3 gene (ACTN-3, c.1729C>T (rs1815739) on short linear sprint performance in youth female volleyball players. We hypothesized that volleyball players harbouring the C allele would have a best sprint performance than those players with the TT genotype.

METHODS: This was a cross-sectional study, conducted in a single visit. A total of 57 female youth sub-elite volleyball players (15.1 ± 1.1 years) participated in the study. Anthropometric variables such as weight and stature were measured and 5 meters linear sprint was assessed using 2 pairs of timing gates (Witty Gate, Microgate USA). Genomic DNA was extracted using a buccal swab, and the ACTN-3 genotyping was performed using a RFLP PCR method.

RESULTS: No significant differences have been found in age, training volume, BMI and in the distribution of positional roles across ACTN-3 genotypes ($p>0.05$). The main finding was that CC players performed significantly better linear running speed than TT players (CC=1.23±0.09 sec vs TT=1.37±0.08 sec, $p=0.004$). Moreover, the players harbouring a copy of the C allele (CC+CT genotypes) showed a better sprint time than players carriers of the TT genotype (CC+CT= 1.26±0.09 sec vs TT=1.37±0.08 sec, $p=0.009$). The shorter running time (1.08 sec) was registered for a player carrier of CC genotype, while the higher sprint time (1.49 sec) was obtained by a player carrier of TT genotype. Differences were also found in the sprint test among positions on the field, with liberos that were significantly fastest than setters ($p = 0.021$) and middle blockers ($p = 0.010$). None of libero was carrier of the TT genotype.

CONCLUSION: We found, for the first time, an association between the ACTN-3 polymorphism and liner running speed in youth female volleyball players. If our finding will be replicated in larger research, it could be used in future to adapt the training protocols to enhances volleyball performance.

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## Oral Presentations

### OP-MH35 Ankle Injuries

**CORTICAL CHANGES DURING SINGLE-LEG LATERAL LANDING IN INDIVIDUALS WITH CHRONIC ANKLE INSTABILITY**

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INTRODUCTION: Chronic ankle instability (CAI) is not only a peripheral musculoskeletal injury but also involves neurophysiological dysfunction. After an initial ankle sprain, 40% of individuals develop CAI, while others (referred to as "Copers") do not, potentially due to central nervous system alterations. Investigating cortical electrophysiological parameters to under-

stand functional changes in brain activity post-injury holds clinical significance, as it may influence rehabilitation strategies. This study aims to assess sensorimotor cortex activation characteristics during single-leg lateral landing in individuals who developed CAI versus Copers.

METHODS: Participants included 46 individuals with CAI (male=23, female=23) and 41 Copers (male=18, female=23). A 64-channel EEG system was used to record cortical activity during a single-leg lateral landing task from a 16 cm-high platform onto a force plate. The α-band power spectral differences in the sensorimotor cortex and time to stabilization (TTS) during landing were analyzed. Statistical analyses included repeated-measures ANOVA (for α-power comparisons within and between groups) and independent t-tests (for TTS).

RESULTS: Individuals with CAI exhibited significantly higher α-power at the C3 electrode (sensorimotor cortex) compared to Copers (CAI: 0.53 ± 0.22 vs. Coper: 0.19 ± 0.28, $P < 0.001$), while showing significantly lower α-power at the C4 electrode compared to Copers (CAI: 0.42 ± 0.23 vs. Coper: 0.57 ± 0.29, $P < 0.001$). Within-group comparisons revealed hemispheric asymmetry, with CAI showing higher α-power at C3 compared to C4 ($P < 0.001$), whereas Copers demonstrated the opposite pattern (C4 > C3, $P < 0.001$). Additionally, the time to stabilization (TTS) was significantly shorter in the CAI group compared to the Coper group (CAI: 1.10 ± 0.43s vs. Coper: 1.98 ± 0.62s, $P < 0.001$).

CONCLUSION: During single-leg lateral landing, individuals with CAI demonstrated asymmetric sensorimotor cortex activation, which may enhance postural control efficiency. These findings provide neurophysiological evidence for altered neural mechanisms underlying postural adjustments in CAI, highlighting the role of central adaptations in functional recovery.

**ACUTE EFFECTS OF TRANSCRANIAL STATIC MAGNETIC STIMULATION OVER THE VISUAL CORTEX ON SENSORY REWEIGHTING IN RECURRENT LATERAL ANKLE SPRAINERS WITH RELYING ON VISUAL INFORMATION**

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INTRODUCTION: Sensorimotor maladaptation may contribute to diminished static postural control in individuals with recurrent ankle sprains (RAS). Individuals with RAS heavily rely on visual cues for maintaining posture [1]. Visual reliance is linked to poor postural control, potentially associated with increased activation in the visual processing cortices. Transcranial static magnetic stimulation (tSMS) is a non-invasive brain stimulation that reduce neural activity at a specific area, including the visual cortex [2]. tSMS over the visual cortex may decrease visual reliance via tSMS-induced reduction of the visual cortex in individuals with RAS. However, no study has explored effectiveness of tSMS in restoring optimal sensory reweighting in those with visual reliance. Therefore, this study aimed to investigate the acute effects of tSMS on sensory reweighting in individuals with RAS relying on visual cues.

METHODS: This randomized, double-blinded placebo-controlled study enrolled 45 participants with RAS from a convenience sample. Participants performed a single-leg assessment of the Clinical Test for Sensory Integration in Balance (CTSIB). Participants relying visual cues were identified by a preference ratio greater than 100 % from the CTSIB. Twenty participants with visual reliance were included (M=11, F=9; Age=21.5±1.5years; Height=167.1±9.2cm; Mass=60.6±8.0kg) and ramdomly assigned to a tSMS (n=10) or sham group (n=10). During intervention, participants sat in an armchair while either a neodymium magnet (tSMS group) or an identical non-magnetic stainless-steel cylinder (sham group) was placed on the scalp over their visual cortex for 30 minutes. Followinng the intervention, participants completed the CTSIB. The CTSIB variables included scores of somatosensory, visual, vestibular, and preference ratios. Independent t-tests were used to compare absolute change scores for each outcome measure between groups. Cohen's d effect sizes, along with 95% confidence intervals (CI), were calculated for each comparison. Significance was set a priori at $P<0.05$.

RESULTS: The absolute change scores of the preference ratio showed a trend toward a between-group difference with a large effect size (P=0.087, d=-0.81, 95% CIs:-1.71, 0.12). No significant findings were observed in other outcome measures ($P>0.05$).

CONCLUSION: tSMS over the visual cortex demonstrated a trend toward a acute reduction in preference ratio scores. These findings indicate that tSMS might acutely decrease visual reliance during static postural control via tSMS-induced reduction of cortical activity at the visual cortex. Further studies should explore effects of tSMS with somatosensory-targeted interventions for increasing somatosensory use in populations with RAS who exhibit visual dependence.

References:

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**THE ASSOCIATION BETWEEN FUNCTIONAL ABILITIES AND ANKLE SPRAINS IN NEWLY RECRUITED INFANTRY COMBAT SOLDIERS**

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INTRODUCTION: Ankle sprain is a common injury in soldiers and comprises approximately 10% of all musculoskeletal injuries in the military. An ankle sprain is a risk factor for recurrent sprains and may impair the soldier's functional abilities. The aim of the study was to examine the associations between ankle sprains and functional abilities such as balance, agility, strength and proprioception in newly recruited soldiers during infantry training.

METHODS: One hundred and seventy-nine soldiers, all males between the ages of 18-21, were assessed throughout their infantry training at baseline (Pre), after 12 weeks (Post), and after additional 10 weeks (Follow up). The assessments included dynamic balance (Y-Balance test YBT), agility (Hexagon hop test), muscle strength (heel raise test) proprioception (Active Movement Extent Discrimination Assessment AMEDA), and 3,000m run. In addition, the participants filled out the Cumberland Ankle Instability Tool (CAIT) for perceived ankle instability. Injury data were collected once every two weeks on personal encounters of the physiotherapist with the soldiers throughout the first 12 weeks of the training. A repeated measures 2-way ANOVA [time (Pre, Post, Follow up) and injury (yes/no sprain)] was performed.

RESULTS: Fifty-two soldiers (29%) were diagnosed with ankle sprains in the first 12 weeks of training.

Time effect was found for hexagon, heel raise and YBT ($p=0.005$, $p<0.001$, $p<0.001$ respectively), the uninjured soldiers improved their performance throughout the training and the injured did not. In the AMEDA the injured improved and the uninjured did not ($p<0.001$), and in 3,000m run both groups improved ($p<0.001$). In the CAIT, both groups worsened ($p<0.001$).

Injury effect was found for YBT, Hexagon, Heel raise ($p<0.001$, $p<0.001$, $p<0.001$ respectively) where the uninjured performed better that the injured; and for the CAIT, where the uninjured reported more ankle stability than the injured ($p<0.001$).

Time*injury interactions were found for Hexagon ($F1,143=15.999$, $p<0.001$) and YBT ($F1,144=10.324$, $p=0.<0.001$), in both measurements the uninjured improved from Pre to Follow up, and the injured did not improve; for AMEDA ($F1,137=3.409$, $p=0.034$) in which the injured improved from Pre to Follow up and the uninjured did not improve; and for the CAIT ($F1,154=13.547$, $p<0.01$) where both groups worsened from Pre to Follow up.

CONCLUSION: Soldiers who sprained their ankles during basic infantry training performed worse than their uninjured peers at Post and Follow up assessments. An ankle sprain affects the soldiers' balance, strength, agility and aerobic fitness. Surprisingly, the injured soldiers' proprioception ability improved throughout the training. The injured soldiers may have been more attentive to the ankle from fear of recurrent sprains and attrition. An intervention program for the prevention of ankle sprains in infantry training is recommended.

**JAPANESE BASKETBALL COACHES PERCEPTIONS AND IMPLEMENTATION OF ANKLE SPRAIN PREVENTION**

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*JUNTENDO UNIVERSITY*

INTRODUCTION: Basketball requires jumping, landing, and rapid changes of direction, all of which place stress on the lower extremities. Ankle sprains have the highest incidence among basketball players, and it has been reported that ankle sprains in adolescence can lead to subsequent chronic ankle instability. Therefore, the prevention of ankle sprains is important, especially with proper coaching on prevention measures. However, coaches' perceptions and implementation of injury prevention are not clear. This study aims to investigate the perceptions and implementation of ankle sprains prevention measures among basketball coaches.

METHODS: A web-based survey was administered to 104 basketball coaches in Japan holding an E-level or higher coaching license, certified by the Japan Basketball Association. "Perception" was assessed through coaches' views on the importance of ankle sprain prevention; "Implementation" was analyzed according to the presence of ankle sprain prevention measures; and "Knowledge" was evaluated based on their awareness that ankle sprains are the most common injuries among basketball players.

RESULTS: After screening, 45 coaches with coaching experience (Age: 38.36±12.14 years, Male: 40 [88.89%], Female: 5 [11.11%]) were analyzed. All respondents (n=45) perceived the importance of ankle sprain prevention. On the other hand, the actual implementation of ankle sprain prevention measures was 57.78%. Most coaches (86.67%) understood that ankle sprains are the most common injury in basketball players. However, 13 of 19 coaches (68.42%) who did not implement preventive measures cited a lack of resources for ankle sprain prevention as one of the main causes for non-implementation.

CONCLUSION: Coaches perceived the importance of ankle sprain prevention, but implementation was lacking. A lack of awareness of ankle sprain prevention was one of the reasons for poor implementation.

**EFFECTS OF TISSUE FLOSSING ON ANKLE DORSIFLEXION, LOWER LIMB SKELETAL MUSCLE CONTRACTILE CHARACTERISTICS, AND TISSUE OXYGENATION: A RANDOMIZED CROSSOVER STUDY**

TEO, J., MUKHERJEE, S.

*NANYANG TECHNOLOGICAL UNIVERSITY*

INTRODUCTION: Tissue Flossing (TF) as a self-myofascial release technique has gained attention as a pre-activity intervention to improve range-of-motion (ROM) and athletic performance [1]. However, the exact physiological mechanisms underlying these effects are poorly understood [2,3]. Initially involving both occlusion and movement under compression [4], recent studies have instead used floss bands to only induce occlusion on stationary participants [5]. This study investigated if movement is an essential component of TF and assessed whether TF leads to any neuromuscular or hemodynamic changes.

METHODS: Twenty-four high-intensity intermittent team sport athletes (age: 21-30years; height: 173.08 ± 5.68cm; weight: 70.14 ± 13.06kg) participated in a randomized crossover study. Participants underwent both movement TF (MTF) and sta-

tionary TF (STF) for quadriceps (RF, VL, VM) and calf (GL, GM) muscles. Three assessments were performed: the weight bearing lunge test (WBLT) for ankle dorsiflexion (DFROM), tensiomyography (TMG) for muscle contractile characteristics (Tc, Td, Tr, Ts, Dm), and near-infrared spectroscopy (NIRS) for tissue oxygenation (TSI%, O2Hb). Measurements were taken pre-intervention and post-intervention at 30-minute intervals (Pre, Post5, Post30, Post60). Repeated measures ANOVAs were used to detect changes across protocols and time points. Significance was set at $p<0.05$.

RESULTS: Two-way ANOVAs for both WBLTs only revealed significant main effects of time [$F(3,69)=4.42$, $p=0.007$; $F(3,69)=7.39$, $p<0.001$]. Calf TMG analysis showed significant main effects of time for GMTc [$F(3,69)=3.07$, $p=0.034$], GMTd [$F(3,69)=6.63$, $p=0.001$], GLDm [$F(3,69)=8.16$, $p<0.001$]. Quadriceps TMG analysis showed significant main effects of time for RFTc [$F(3,69)=4.16$, $p=0.009$], VLTc [$F(3,69)=5.84$, $p=0.001$], VLTd [$F(3,69) = 8.21$, $p < 0.001$], VMTd [$F(3,69)=3.03$, $p=0.035$]. Additionally, a significant interaction was observed for VLTd [$F(3,69)=3.50$, $p=0.020$]. Calf NIRS analysis showed a significant main effect of time for TSI% [$F(4,184)=5.786$, $p<0.001$] and O2Hb [$F(4,184)=20.727$, $p< 0.001$] along with a significant interaction effect [$F(4,184)=3.122$, $p=0.016$]. Quadriceps NIRS analysis showed significant main effects of time for TSI% [$F(4,180)=12.081$, $p<0.001$] and O2Hb [$F(4,184) = 36.953$, $p<0.001$].

CONCLUSION: This study provides quantitative evidence on changes in WBLT, TMG, and NIRS measurements following an acute bout of either MTF or STF. While both produced significant time-dependent neuromuscular and hemodynamic changes, there were no substantial intervention-specific differences. Results suggest that occlusion is likely the primary driver of these changes, but it cannot conclusively rule out the importance of movement under compression.

[1] Cheatham et al. Sports 2024; 12: 312

[2] Konrad et al. Front Physiol 2021; 12: 1–13

[3] Gao et al. Apunts Sports Medicine 2024; 59: 100453

[4] Starrett & Cordoza. Victory Belt Publishing; 2015

[5] Winchester et al. Int J Environ Res Public Health 2022; 19: 11548

## Oral Presentations

### OP-SH13 Physical Education I

**FACTORS INFLUENCING BULLYING ATTITUDES IN TEACHER CANDIDATES: THE ROLE OF GENDER, TEACHING EXPERIENCE, PERSONAL AND SOCIAL RESPONSIBILITY**

TEMIZ, C., GÁL, A., SOÓS, I.

*HUNGARIAN UNIVERSITY OF SPORTS SCIENCE*

INTRODUCTION: Attitudes towards bullying serve a precondition for effectively combating bullying shaping intervention preferences to prevention strategies. However, teachers' attitudes and their perceived responsibilities often follow a recurring pattern while some teachers feel responsible for intervening in cases of bullying, others tend to be reluctant and overlook the issue. Breaking this cycle requires raising awareness and providing comprehensive training for preservice teachers (PST). By examining the attitudes and perceived sense of responsibility of PST, this study offers insights into how teacher education can develop more effective anti-bullying strategies.

METHODS: The study sample consisted of 67 fifth-year physical education PST. Data were collected using modified Hungarian versions of Personal and Social Responsibility Scale and Attitudes Towards Bullying Scale. Additionally, participants reported gender and teaching experience. Data were analysed by using Jamovi Software employing descriptive, Mann-Whitney U test, correlation, regression, and mediation analyses.

RESULTS: PSTs had high levels of personal responsibility ($M=5.19$, $SD=0.70$) and social responsibility ($M=5.43$, $SD=0.72$) but their attitudes remained moderate ($M=3.50$, $SD=0.40$). Results indicated ($U=345$, $P=0.007$, $r=0.3839$) that female PSTs ($Mdn=3.76$, $IQR=0.56$) had higher attitudes than males ($Mdn=3.24$, $IQR=0.59$). PSTs with teaching/coaching experience had higher personal responsibility ($U=205$, $p=0.041$), social responsibility ($U=189$, $p=0.019$), but no significant difference was found in attitudes ($U=237$, $p=0.128$). A positive and significant relationship found between personal responsibility ($\rho=.361$, $p=.003$), social responsibility ($\rho=.444$, $p<.001$) and attitudes. Social responsibility was a statistically significant ($\beta=0.224$, $p=0.005$) and positive predictor of attitudes. It had a significant direct ($\beta=0.224$, $p=0.003$) and total ($\beta=0.269$, $p=< .001$) effect on attitudes, while the indirect effect of personal responsibility was not significant ($\beta=0.045$, $p=0.317$).

Discussion: The findings indicate that while PST exhibit high level of personal and social responsibility their attitudes towards bullying remain moderate.This may stem from their sense of responsibility but lack of knowledge on how to intervene.The higher proactive attitude among female PST may be attributed to their greater empathy or sensitivity to bullying. Individuals, with teaching experience demonstrated a stronger responsibility in combating bullying, likely due to their exposure to more incidents in real educational settings.Another key finding is that social responsibility emerged as a key determinant in combatting bullying, whereas personal responsibility had no direct effect.This suggests that anti-bullying training should go beyond fostering personal awareness to cultivating a cooperative and supportive community. Consequently, PST may strive to transform not only their classrooms but the broader school culture.

**INVESTIGATION INTO THE RELATIONSHIP BETWEEN PHYSICAL EDUCATION TEACHERS' EDUCATIONAL METHODS AND STUDENTS' MOTIVATION AND BEHAVIOUR, FROM THE PERSPECTIVE OF PERSONAL AND SOCIAL RESPONSIBILITY**

SOOS, I., WHYTE, I., ASZALOS, I., DUNAI, P., VALERO-VALENZUELA, V., SZEKERES, D., HAMAR, P.
*HUNGARIAN UNIVERSITY OF SPORTS SCIENCE*

Teaching Hellisons model of personal and social responsibility is one of the most important roles of school education as it promotes better behaviour from students in their social environments and teaches them responsibility for themselves and others.

Personal and social responsibility (PSR) does this by developing skills, values, and virtues. such as respect for others, participation and effort in activities, self-direction towards positive values, caring for peers, transferring this knowledge to other areas of life, and supporting others to become more personally and socially responsible. As such, PSR prepares young people for life and helps to ensure successful transitions to adulthood.

Following University Ethics Committee approval (ethics ID number: 2913/2020) primary and secondary school physical education teachers from two settlements in Hungary were recruited for data collection (n=67; mean age of 49.1 years (s=11.4); teaching experience of 17.8 years (s=14.1); 48.6% were female). Participants voluntarily completed the Personal and Social Responsibility Questionnaire, the Behaviour Regulation Motivation Questionnaire, and the Black Pedagogy Scale. In addition, they also stated in writing whether they preferred to employ a traditional (disciplinary behaviour-type) or an autonomous (enjoyment-oriented) educational method during their work.

The results of descriptive statistical analysis showed that 2.9% of the respondents preferred to use traditional (disciplinary behaviour-type) educational methods during their work compared with 22.9% who preferred autonomous (enjoyment-oriented) methods. An amalgam of both educational methods were considered beneficial by 74.3% of the teachers, depending on the situation.

According to the results obtained by univariate analysis of variances (one-way ANOVA), no significant results were obtained. In summary, student motivation and student behaviour perceived by teachers were independent of teachers' educational methods. Since the number of respondents who preferred the method of education that required discipline was small, we deleted it from the database. We kept the autonomous and the combined methods of education on which a Kruskal-Wallis non-parametric test was performed to examine for differences. Confirming our previous results, no significant differences between the variables were found.

Our conclusion is that the joint use of both educational methods (traditional and enjoyment-oriented) is important during educational work as that was the most preferred way of optimising student motivation, developing personal and social responsibility, and shaping positive behaviour.

Further research is recommended to include a larger sample for greater representativeness and to involve students and parents to ensure that perceptions of other key stakeholders are considered.

**PHYSICAL EDUCATION TEACHERS EXPERIENCE INFLUENCES THEIR EMOTIONAL REACTIONS AND DETERMINE THE APPROPRIATE USE OF SANCTIONS**

HAMDI, F., ELLOUMI, A.
*UNIVERSITY OF JENDOUBA*

INTRODUCTION: The acceptance of deviant behaviours varies depending on the teacher, the activity, the class, and the school context (Richoz, 2010). The reaction to an emotional situation depends on our nature and past emotional experiences. The memory of our emotional experiences shapes how we emotionally engage in certain situations and our emotional states affect our behavioural response (Lazarus 2004). According to Maheu (2007). "Punishment serves to express the adults anger, often by reproducing what they have experienced. Punishment is a quick way to exert pressure without much thought." It has been hypothesized that novice physical education (PE) teachers experience stronger emotional intensities when facing conflicts with their students compared to experienced teachers. The aim of the current study was to investigate the PE teacher use of sanctions and their emotional experience.

METHODS: We interviewed 4 schools' categories of actors: 6 PE inspectors, 7 headmasters, 18 PE teachers (experienced and novices), and 6 students. Firstly, PE inspectors were interviewed, to identify students deviant behaviours and teachers reactions and to analyse the causal attributions of teacher-student conflicts (Goyette, et al., 2010). Next, we conducted an interview with headmasters. In the third phase, we interviewed PE teachers through a semi-structured interview. Finally, to identify and explain students deviant behaviours during PE lessons and the reactions of their teachers, we analysed 6 case study of students whose deviant behaviours ranged from verbal and physical aggression to absenteeism. Tropes (https://www.tropes.fr) software was used for semantic analysis.

RESULTS: The analysis showed that novices PE teachers were afraid of the consequences, or the "reaction", of the disruptive students and that they struggled to sanction their students in a determined, consistent, and deterrent manner. Novices PE teachers complained about the lack of academic training on how to manage conflictual situations with, or deviant behaviours of, their students. Moreover, they had trouble in managing their own emotions. They easily become angry in response to deviant behaviours of their students, which explained their excessive use of exclusion as a punishment. However, absenteeism and unpunctuality remained two deviant behaviours that are neglected by both novice and experienced PE teachers.

Discussion: Discipline is an educational need that help students to set boundaries and limits. It is important to explain them which behaviours are acceptable in the class and help them to be aware of the consequences of inappropriate behaviours. However, it is important to note that it is both possible and desirable to establish a hierarchy of sanctions that teacher administer depending on the severity of the transgression. Experienced teachers place more emphasis on discussions with students, which help them to understand why they were sanctioned.

**ENHANCING FAIR PLAY, INCLUSION, AND PHYSICAL ACTIVITY IN PRIMARY EDUCATION: A MIXED-METHODS INTERVENTION STUDY**

RUSSO, G., PAGANELLI, V., CECILIANI, A.

*UNIVERSITY OF TUSCIA*

INTRODUCTION: Fair play, respect, and inclusion are essential for children's psychosocial development and can be effectively promoted through physical education (PE). Research highlights that PE can foster moral decision-making and social integration (Opstoel et al., 2020); however, less is known about its impact in early childhood.

This study evaluates the impact of a structured PE intervention, grounded in social learning theory, on fair-play attitudes, moral decision-making, social behavior, and physical activity (PA) levels in primary school children.

METHODS: A seven-month intervention was conducted with 64 children (aged 9–10 years). The program integrated classroom-based lessons and structured PE activities emphasizing respect, fairness, and collaboration.

A mixed-methods approach was used, including validated questionnaires such as PAQ-C (PA levels), FPPEQ (fair play), AMDM-Q (moral decision-making), YSVQ-2 (sport values), RSEQ (self-esteem), and PSE (physical self-efficacy), and semi-structured interviews with teachers and students. Linear mixed-effects models were used to analyze quantitative data, while thematic analysis was applied to qualitative responses.

RESULTS: PA levels significantly increased over time, particularly among previously inactive children ($F(2, 10.63) = 10.63$, $p < .0001$). Self-esteem also improved ($F(2,90.24) = 7.05$, $p = .002$). However, moral decision-making and fair-play attitudes showed limited changes. Team-sport participants exhibited higher acceptance of cheating ($F(2,61.19) = 5.38$, $p = .007$) and gamesmanship ($F(2,64.51) = 3.52$, $p = .035$) than individual-sport or inactive students.

Qualitative findings suggested improved emotional regulation, self-regulation, and peer respect. Teachers noted fewer conflicts and better classroom behavior, while students demonstrated increased awareness of inclusion, teamwork, and sportsmanship.

Discussion: This study supports the integration of fair-play education in PE to enhance children's social and emotional development. While quantitative findings showed limited change in moral attitudes, qualitative evidence suggested improved interpersonal behaviors, aligning with previous research on fair-play education (e.g., Domínguez et al., 2021). Additionally, the increase in PA among inactive children highlights the broader benefits of structured PE beyond social aspects, consistent with previous interventions promoting PA in school settings (Dobbins et al., 2013). However, future research should explore long-term effects and examine external reinforcements beyond the school setting.

References

Dobbins et al. (2013). Cochrane Database Syst. Rev., 2, CD007651.

Domínguez et al. (2021). Eur. J. Contemp. Educ., 10(2), 308–320.

Opstoel et al. (2020). Eur. Phys. Educ. Rev., 26(4), 797–813.

**PERFORMATIVE ACTIONS AT UNIVERSITY: AN OPPORTUNITY TO INCREASE EQUALITY IN SPORT**

TORRENTS MARTÍN, C., CALVO-ESTELRICH, C., GARCÍAS DE VES, S.

*INEFC UNIVERSITY OF LLEIDA*

INTRODUCTION: This research examines how arts-based methodologies, particularly letter writing, Creative Dance, and Performance, can serve as powerful tools for raising awareness about gender inequality in sports within a university setting. Overcoming inequality in sports demands not only the efforts of athletes but also critical reflection on sports and transformative actions within educational institutions, especially those responsible for training future sports professionals. At INEFC, University of Lleida, a creative performance is held annually for International Women's Day, where women from the community share their experiences of discrimination in sports while students support them through movement, expression, and Creative Dance. This study assessed the impact of the creative intervention "The Equality Queens, the Reverse Parade," on student performers and the broader university community.

METHODS: 157 students enrolled in the Creative Dance course within the Physical Activity and Sports Sciences Degree participated as performers. Female participants and women in the community were invited to write letters to "Equality Queens" (inspired by Spain's Magical Kings tradition), outlining their desired changes to eliminate gender-based discrimination in sports. A total of 107 letters were collected. Meanwhile, students created choreographies to traverse the university campus, distributing these letters to the audience in a parade-like performance, emulating the traditional parade of the Magical Kings where children give letters with their wishes to the Kings.

A thematic analysis was performed on the collected letters to identify key themes and issues raised by the participants. Additionally, a post-performance questionnaire was created and given to 64 student performers to assess the intervention's impact on their perspectives and the university community.

RESULTS: Thematic analysis revealed recurring issues faced by women in sports, including systemic discrimination, underrepresentation in media, unequal access to opportunities, and the challenge of balancing professional and personal roles. Participants reported that Creative Dance was key in fostering empathy, enhancing expressive abilities, and sparking a meaningful dialogue about gender inequality.

Discussion: Innovative, embodied, and creative interventions are crucial to addressing gender inequality in sports. This study demonstrates that, despite progress in increasing womens participation in sports, gender inequalities remain a significant structural barrier. The analyzed proposal, aligned with the principles of arts-based knowledge translation, emerges as an effective educational tool for promoting social change. Creative methodologies can foster critical reflection, empathy, and empowerment among participants, offering a pathway to inspire social change through educational practices.

## 13:15 - 14:30

## Oral Presentations

### OP-PN15 Endurance Physiology II

**PROFILE OF ULTRA-ENDURANCE RUNNERS: PHYSIOLOGICAL DIFFERENCES FROM LONG-DISTANCE RUNNERS**

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*LITHUANIAN SPORTS UNIVERSITY*

INTRODUCTION: While ultra-endurance sports are growing in popularity, the prerequisites for successful participation and adaptation to such training remain vague. The aim of the study was to compare physiological profile between ultra-distance runners and long-distance runners.

METHODS: Road runners competing in 24-h races (ULTRAs, n=13) or distances 10 km to marathon (LDRs, n=12) arrived to the laboratory in an overnight fasted condition and performed resting metabolic rate measurement followed by oral glucose tolerance test. Anthropometric, muscle and tendon ultrasonography as well as muscle force and power tests were then conducted, after which athletes performed a progressive 4-min step treadmill test to exhaustion to assess the lactate curve, heart rate response, running economy, and fat oxidation, as well as to determine maximal oxygen uptake ($VO_2$max). Additionally, blood volume, plasma volume and total hemoglobin (Hb) mass were measured using the CO rebreathing.

RESULTS: Despite being of similar competitive level (personal bests for IAAF scores), age, training experience and body weight ($p>0.05$ for all), ULTRAs had more body fat (mainly due to larger upper body skinfold thickness, $p<0.001$), even if they had been training by substantially larger volume in terms of distance run and hours spent training ($p<0.01$ for both).

Both absolute and relative to body weight plasma volume ($p<0.01$) and blood volume ($p<0.05$) were larger in LDRs, while Hb concentration, total Hb mass and Hb mass per body weight did not differ between the groups ($p>0.05$ for all). Resting metabolic rate was similar and relative fat oxidation identical between the groups. There were no obvious differences in glucose handling and associated lactate disposal rate between the groups during oral glucose tolerance test.

Heart rate and lactate response to exercise were the same for the two groups, while maximal oxygen uptake was larger in LDRs (66.7 (5.1) vs. 59.1 (6.4) ml/kg/min, $p=0.004$). In our conditions, neither maximal fat oxidation rate, nor the associated running speed differ between ULTRAs and LDRs. Running economy was comparable between the groups (206 (19) and 214 (22) ml/kg/km in ULTRAs and LDRs, respectively, $p=0.347$).

Contractile properties of knee extensors and muscle power measured as different vertical jump parameters did not differ between the groups. Achilles tendon and calf muscle structural properties as well as passive stiffness of plantar flexors were also similar between the groups.

CONCLUSION: Ultra-distance runners exhibit largely similar physiological profile as long-distance runners, but do not have that large maximal oxygen uptake, at least to some extent due lower total blood volume and higher percentage of upper body fat.

**IMPACT OF A NON-STOP 230 KM ULTRAMARATHON ON MARKERS OF BLOOD RHEOLOGY, NITRIC OXIDE PRODUCTION AND OXIDATIVE STRESS**

GRAU, M., BRUNS, J., STÜCHER, M., MUNK, M., JOHN, L., SCHULZ, S., BIZJAK, R., WITZEL, J., SIEBERS, M., SIEBERS, C., BIZJAK, D.

*GERMAN SPORT UNIVERSITY COLOGNE*

INTRODUCTION: Ultramarathon events represent an extreme challenge for the human body and its physiological systems. Their impact on the red blood cell (RBC) system is underexplored and in particular changes in RBC deformability and aggregation, both critical for blood flow in the microcirculation, remain poorly understood. Additionally, the role of modifiers

such as nitric oxide (NO) metabolism in these processes has not been fully elucidated. This study aimed to investigate changes in hematological and hemorheological parameters, as well as markers of the NO pathway, during a 230 km non-stop ultramarathon.

METHODS: Twelve participants (3f/8m; 48±8 years, 71±14 kg, 176.7±8.1 cm) finished the ultramarathon race. Blood samples were taken before and 5 minutes after the race and parameters were either analyzed immediately or processed and frozen at the appropriate temperature until measurement. Data were tested for normal distribution using the Shapiro-Wilk test and pre-post differences were calculated using either the paired t-test or the Wilcoxon matched-pairs signed rank test.

RESULTS: Results revealed significant changes in RBC properties post-race. The osmoscan curve, representing deformability under an osmotic gradient, showed a distinct left-shift ($p<0.001$) and the mean cellular volume ($p<0.001$) and intracellular water content ($p=0.08$) both decreased, while the mean cellular hemoglobin concentration increased ($p<0.01$). These findings might be related to dehydration which causes cell shrinkage, mimicking increased fragility. However, haptoglobin levels and RBC count were not significantly altered which might indicate that cell lysis might not acutely be relevant in this setting. RBC deformability, measured using ektacytometry, increased ($p<0.05$) and correlated moderately with elevated RBC nitrite levels ($r=0.41$, $p<0.001$), suggesting a shear stress-dependent activation of NO production and its positive influence on deformation. RBC aggregation, obtained from a syllectogram, increased ($p<0.001$), and the time to half-maximal aggregation was reduced ($p<0.001$). These changes were independent of hemoconcentration, as hematocrit remained unaltered post race. Levels of free reactive oxygen and nitrogen species (ROS/RNS) and S-nitrosylation of RBC cytoskeletal spectrins decreased significantly ($p<0.05$), raising questions about the interplay between oxidative stress and NO metabolism. Remaining hematological variables remained unaltered.

CONCLUSION: In summary, the data indicate that ultramarathon participation exerts profound effects on RBC properties and its potential effect on microcirculatory blood flow. This study thus contributes to understanding the hemorheological adaptations to extreme endurance challenges and underscores the need for longitudinal studies to evaluate their long-term impact on RBC properties.

**LONGITUDINAL ANALYSIS OF PERCEIVED MUSCLE FATIGUE AND SORENESS IN MARATHON RUNNERS: COMPARING MUSCLE FATIGUE RESPONDERS AND NON-RESPONDERS**

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*UNIVERSITY OF STUDIES DANNUNZIO CHIETI-PESCARA*

INTRODUCTION: The relation between muscle fatigue and marathon running is well established [1], but not all individuals respond to it in the same way. Overall fatigue, muscle fatigue, and muscle soreness are commonly experienced by marathoners. This analysis aimed to observe whether perceived overall muscle fatigue and soreness ratings over 8 weeks would differ in marathoners responding or not to a muscle fatigue protocol.

METHODS: Data from 17 habitual marathoners (15 males, aged: 38±12 y, height: 1.81±0.09 m, weight: 70±9 kg, VO2max: 64±12 ml/kg/min) were analyzed. Training workload was measured using a chest strap. HR was used to compute total TRIMP (tTRIMP), composed of anaerobic TRIMP (anTRIMP) and aerobic TRIMP (aTRIMP), where (aTRIMP = z1+z2; anTRIMP = z3+z4+ z5). Runners kept a diary where they self-reported on a 0 to 10 scale overall fatigue, muscle fatigue and soreness every morning, evening, and before and after each training. Prior to the 8-week observation period (W38-45), they visited our laboratory twice for VO2max and muscle fatiguability tests. The fatiguability tests consisted of a 10-minute baseline submax run and baseline maximal voluntary contractions (MVCs), then 100 drop jumps from a 40 cm height step with a 20-second rest between each jump, followed by an isometric contraction to muscle failure at 30% MVC output. This fatigue protocol was immediately followed by post-MVCs and a 10-minute run at the same speed as baseline.

RESULTS: Runners were divided into responders (R) who showed an MVC drop ≥20% and non-responders (NR) who did not. Pre- and post-fatigue MVCs, as well as pre- post-fatigue submax run HR, differ between R and NR (ΔMVC for R was -38%, and for NR=-2%, ΔHR for R was 10 bpm and for NR 4 bpm). During the 8 weeks a difference was found between the R and NR groups in overall fatigue ratings ($F(1,382)=10.34$, $p<0.001$); once followed-up it revealed differences at: W40 $F(1,53)=4.88$ $p<0.05$; W42 $F(1,53)=4.27$ $p<0.05$; W43 $F(1,51)=7.01$ $p<0.011$. Muscle soreness ratings showed a significant effect of group R vs. NR ($F(1,382)=9.89$ $p=0,002$); when followed up, there were not significant effects. Muscle fatigue ratings showed a significant difference between R and NR ($F(1,382) =20.43$ $p<0.05$), and follow-up showed differences at W38, W40, and W43 ($F(1,41)=7.29$ $p=0.01$; $F(1,53)=9.91$ $p=0.003$; $F(1,51)=4.57$ $p<0.05$). Overall ($r=0.40$, $r =0.26$, $p<0.001$), muscle fatigue ($r=0.40$, $r =0.37$, $p<0.001$), and muscle soreness ratings ($r=0.40$, $r =0.24$, $p<0.001$) significantly (within-subject) correlated with tTRIMP and anTRIMP, but not with aTRIMP.

CONCLUSION: This study confirms that not all athletes respond to muscle fatigue equally. Interestingly, those who did not respond in the lab had higher overall fatigue and muscle fatigue ratings in training, while muscle soreness did not differ from responders. Future studies should investigate the reasons behind these differences and whether they differ in competition results.

1. Del Coso et al., (2017)

**COMPARISON OF METABOLIC AND STRESS RESPONSES OF RUNNERS PARTICIPATING IN MARATHON AND ULTRAMARATHON RACES**

BIZJAK, D., MUNK, M., JOHN, L., SCHULZ, S.V.W., BIZJAK, R., WIESING, A., LÜDERS, N., WITZEL, J., GRAF, J., KIRSTEN, J., SIEBERS, M., GRAU, M.
*UNIVERSITY HOSPITAL ULM*

INTRODUCTION: Marathon as the longest Olympian running distance is considered the ultimate frontier for the majority of recreational athletes, where musculoskeletal, cardiovascular and nutritional adaptation are required for reaching the finish line. Ultramarathon (all distances above 42.195 km) imposes even more stress on the athlete's body systems, but the respective stress extent compared to marathons are still insufficiently examined.

METHODS: Female and male participants of an ultramarathon (UM 100/160.9/230 km) and a marathon competition (MA) were examined regarding personal characteristics, nutritional strategies, race nutrition composition, energy expenditure/intake, motor skills, energy and cell metabolism as well as objective and subjective stress response. Pre and Post race, questionnaires, blood/saliva sampling, as well as body composition analysis were applied. The relative difference for the aforementioned parameters was calculated and compared between MA and UM.

RESULTS: 60 marathon (23% female) and 43 ultramarathon (37% female) runners finished the race. MA were younger, had lower body fat mass and less running training years compared to UM. Energy deficit after the race ranged from 2385 (MA) to 5221-8562 kcal (UM), while energy fueling during MA were provided by 90% carbohydrates, 5% fat and 5% protein, and during UM by 82% carbohydrates, 10% fat and 8% protein, respectively. Despite higher creatine kinase values in UM, other damage markers increased similar between running distances. Stress biomarkers increased more in MA, while inflammation was more pronounced and hunger/satiety hormones were more disturbed in UM. Both conditions showed a high immune system activation (e.g. leucocytes), while subjective exhaustion was higher in ultramarathon participants.

CONCLUSION: Running velocities and distances can be extremely different between recreational athletes participating in MA and UM events, resulting in distinct metabolic and cellular stress responses. Nevertheless, discrepancies between fueling strategies with less available recommendations during UM competition, which still mostly relies on individual experience, might contribute to the observed cellular damage and subjective fatigue. Optimizing energy intake by e.g. increased fluid protein intake might be a useful in-race and regeneration strategy as well as differential intervention/regeneration approaches for the different running distances that still has to be determined in more controlled settings.

**THE INFLUENCE OF SOLAR RADIATION ON SELF-PACED CYCLING TIME-TRIAL PERFORMANCE**

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INTRODUCTION: Solar radiation plays a crucial role in human heat balance with black-globe temperature, an indication of how hot it feels in direct sunlight, often 10-15ºC higher than dry-bulb (i.e. ambient) temperature. During outdoor sporting competitions, athletes are exposed to varying solar loads, often for extended periods of time. Despite this, there is minimal research on the influence of solar radiation on self-paced exercise performance. The aim of this study was to systemically investigate the impact of radiant heat load on thermal and cardiovascular strain, and time-trial performance, in well-trained male cyclists.

METHODS: Ten endurance trained male cyclists and triathletes participated in this study (mean ± SD: age = 40 ± 11 yr, height = 1.81 ± 0.04 m, body mass = 78.1 ± 7.6 kg, VO2PEAK = 4.7 ± 0.5 L·min−1). Participants completed four experimental 700-kJ time-trials in a counterbalanced order in an environmental chamber set to 35°C and 40% relative humidity with 3.5 m.s-1 facing airflow. Each trial was completed with six radiant heat lamps placed behind the participant producing either 0 W·m-2 (CON), 234 W·m-2 (LOW), 434 W·m-2 (MOD), or 760 W·m-2 (HIGH). Data were analysed using linear mixed effects models with results presented as means with [95% confidence intervals].

RESULTS: Mean power output in CON (251 W [225, 276]) was higher than in LOW (5 W [1, 9], P=0.013), MOD (7 W [3, 10], P<0.001), and HIGH (8 W [5, 12], P<0.001). There were no other significant differences in power output between all other radiant heat load conditions. Mean rectal temperature (Tre) was 38.4°C [38.2, 38.5] in MOD, which was significantly higher than in CON (0.20°C [0.13, 0.27], P<0.001), LOW (0.07°C [0.00, 0.14], P=0.039), and HIGH (0.08°C [0.01, 0.15], P=0.020). Mean Tre in LOW (38.3°C [38.2, 38.5]) and HIGH (38.3°C [38.2, 38.4]) were significantly higher than CON (38.2°C [38.0, 38.3], P≤0.001). Final Tre was 39.3°C [39.1, 39.5] in MOD, which was significantly higher than in CON (0.29°C [0.06, 0.52], P=0.016) but not LOW (0.22°C [-0.02, 0.45], P=0.069) or HIGH (0.22°C [-0.02, 0.45], P=0.072). Mean heart rate in MOD (158 beats·min-1 [146, 170]) was significantly higher than CON (3 beats·min-1 [1, 4], P<0.001) and HIGH (2 beats·min-1 [0, 3], P=0.019) but not LOW (1 beat·min-1 [-1, 2], P=0.278). Whole-body sweat rate (2.2 ± 0.6 L·h-1, all P≥0.712) and percent body mass loss (1.1 ± 0.7%, all P≥0.324) did not differ between trials.

CONCLUSION: In hot ambient conditions, low to high radiant heat loads lead to modest changes in performance relative to conditions without radiant heat. The changes in performance were accompanied by small increases in thermal and cardiovascular strain. Future studies are required to better understand how more extreme radiant heat loads, akin to those faced by athletes in certain geographical locations, influence physiological strain and self-paced exercise performance.

# Oral Presentations

## OP-PN27 Muscle Damage and Repair

### EFFECT OF DECELERATION INTENSITY DURING REPEATED SPRINTS ON MUSCLE STIFFNESS AND DAMAGE KINETICS

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INTRODUCTION: In team sports, horizontal deceleration (DEC) is a critical locomotor skill underlying sudden changes of velocity [1]. However, the effects of DEC during a repeated-sprint ability (RSA) test on muscle damage and underlying recovery kinetics are underexplored, despite the potentially damaging nature of recurrent DEC [2] due to the predominant eccentric muscle contractions [3]. This study therefore aimed to investigate the effects of different DEC intensities during an overground RSA test on subsequent kinetics of rectus femoris (RF) stiffness and serum creatine kinase levels ([CK]) to assess muscle damage.

METHODS: Twelve participants (25±3.5 yrs) randomly performed a running RSA test [3 sets of 8 × 20 m; 20-s passive recovery between sprints, 5-min rest between sets] i) without DEC constraint after 20-m sprint (DECfree), ii) with enforced DEC of moderate intensity (DEC10; 10-m braking distance), and iii) with enforced DEC of intense intensity (DEC5; 5-m braking distance). Sprint time and DEC performances were assessed using timing gates and radar gun, respectively. RF stiffness and [CK] were assessed at rest before RSA test (baseline) and post 24 h, 48 h and 72 h using ultrasound elastography and dry-chemical colorimetry, respectively.

RESULTS: There was no significant effect of condition (p=0.463) for the best sprint time in each set, but a significant effect of time (p=0.004). Mean DEC was significantly lower in DEC5 (-3.57±0.32 m/s2) than DEC10 (-2.52±0.37 m/s2, p<0.001) and DECfree (-1.82±0.30 m/s2, p<0.001), and lower in DEC10 than DECfree (p<0.001). There were significant effects of condition, time and interaction (all p<0.001) for relative stiffness vs. baseline. Relative stiffness were significantly higher in DEC5 than DEC10 and DECfree post 24 h (+16.4±3.2 vs. +9.8±4.2 and +4.5±5.7 %, respectively, p=0.007 and p<0.001), 48 h (+15.9±4.7 vs. +6.5±5.1 and +3.3±4.8 %, respectively, both p<0.001) and 72 h (+10.8±4.9 vs. +3.6±5.4 and +0.2±3.8 %, respectively, both p<0.001). There were significant effects of condition (p=0.012) and time (p<0.001) for relative [CK] vs. baseline. Pooled relative [CK] for all time points were significantly higher in DEC5 than DECfree (+141±180 vs. +66±98 %, p=0.019), while DEC10 (121±144 %) was not significantly different from either DEC5 (p=1.00) or DECfree (p=0.053). Pooled relative [CK] for all three conditions significantly increased at post 24 h (+171±151 %, p<0.001), 48 h (+111±175 %, p<0.001) and 72 h (+51±80 %, p=0.002).

CONCLUSION: Repeated intense decelerations during repeated sprints induced an exacerbation of relative stiffness and creatine kinase levels over several days, peaking after 24 h and remaining elevated above baseline after 72 h. These findings indicate that the intensity of deceleration should be considered in order to adequately prepare the musculotendinous system and mitigate the damaging effects.

[1] Harper, Sports Med, 2019

[2] Howatson, J Strength Cond Res, 2009

[3] Hewit, Strength Cond J, 2011

### RUNNING SHOES WITH ADVANCED FOOTWEAR TECHNOLOGY MITIGATES EXERCISE-INDUCED MUSCLE DAMAGE AND HEMOLYSIS

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*ASICS CORPORATION*

INTRODUCTION: During running, a greater mechanical stress (i.e., vertical load) is applied to the lower extremity at each ground contact, which promotes exercise-induced muscle damage and hemolysis. It has been shown that Advanced Footwear Technology (AFT) improve running performance by reducing the metabolic demand of running [1]. These shoes are designed with a combination of several components, including a compliant and resilient midsole foam. Thus, AFT shoes have a high cushioning function compared to traditional racing flats. Considering that the softer surface during running reduces the mechanical stress on the musculoskeletal system and the sole [2], the AFT shoes may attenuate exercise-induced muscle damage and hemolysis compared to traditional racing flats. Therefore, the purpose of present study was to determine the effect of AFT shoes on exercise-induced muscle damage and hemolysis after 2-h running.

METHODS: Nine endurance athletes performed a 2-h treadmill running at 70% of maximal oxygen uptake (VO2max) wearing AFT shoes (METASPEED SKY PARIS, ASICS) (AFT trial) or conventional running shoes (HYPER SPEED 2, ASICS) (CON trial) on different days (Days 1 and 2). We measured blood samples and the drop jump (DJ) index before and after running to evaluate exercise-induced muscle damage and hemolysis. In addition, all subjects performed 15-30 straight running trials on a 50-m over-ground at 70% of VO2max on Day 3 (on different day than Days 1 and 2). Kinetic and kinematic data were collected simultaneously using a 24-camera motion capture system and three force plates during over-ground running. We also calculated vertical loading rate and negative muscle mechanical work (an indication of eccentric muscle contraction) by using the musculoskeletal simulation (OpenSim).

RESULTS: Blood myoglobin (Mb) levels (an indication of muscle damage) significantly increased after 2-h running in both trials. However, blood Mb elevations following running tended to be lower in the AFT trial than in the CON trial (P = 0.07). Moreover, reduction in DJ index after 2-h running was significantly greater in the CON trial than in the AFT trial (P = 0.03). Blood haptoglobin (Hap) levels significantly decrease (an indication of hemolysis) after 2-h running in both trials. However, the CON trial showed a greater reduction in blood Hap levels compared to AFT trial (P = 0.02). Loading rate (P = 0.001) and negative muscle mechanical work in gastrocnemius (P = 0.006) and soleus (P = 0.02) during over-ground running were significantly lower in the AFT trial than in the CON trial.

CONCLUSION: The AFT shoe attenuated exercise-induced muscle damage and hemolysis after 2 hours of running compared to the traditional racing flats.

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[2] Impellizzeri FM, Rampinini E, Castagna C, Martino F, Fiorini S, Wisloff, U. Br J Sport Med 42: 42-46, 2008.

**THE EFFECT OF ECCENTRIC EXERCISE-INDUCED MUSCLE DAMAGE ON CRITICAL POWER & FINITE WORK CAPACITY**

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INTRODUCTION: It is well established that severe intensity exercise performance is impaired following eccentric exercise-induced muscle damage (EIMD) [1, 2]. Given that performance during exercise within the severe intensity domain can be robustly predicted based on the hyperbolic power-duration relationship and its two parameters, critical power (CP) and the finite work capacity above CP (W'), it is likely that one or both of these variables are impaired with EIMD. However, no study has tested this hypothesis. This study assessed the effect of EIMD on CP and W' measured during a 3-minute all-out test (3MT).

METHODS: 15 recreationally active participants (age = 25 ± 4 years, 3 females, VO2peak = 46.8 ± 8.7 ml·kg·min-1) completed two, 3-minute all-out tests (3MT), one under control conditions (Control) and one 24 h following a bout of damaging eccentric exercise (Damage). CP, W', peak power output (PPO), cardiopulmonary and electromyographic (EMG) data were collected during each 3MT. Potentiated twitch response (Qtw,pot) and maximal voluntary contractions (MVC) of the knee extensor muscles were used to assess the degree of damage incurred.

RESULTS: EIMD reduced MVC and Qtw,pot by 32 and 30%, respectively ($p < 0.001$, $d \geq 1.14$). Paired t-test results showed that EIMD resulted in a reduction in CP from 241 ± 72 W to 231 ± 66 W ($p = 0.037$, $d = 0.15$), W' from 16.57 ± 4.5 kJ to 14.76 ± 3.9 kJ ($p = 0.008$, $d = 0.45$) and PPO by 776 ± 180 W to 696 ± 152 W ($p = 0.023$, $d = 0.48$). There was no difference in EMG during cycling between damage and control ($p = 0.766$). However, VO2, VCO2 and VE were lower for damage than control ($p \leq 0.02$).

CONCLUSION: These results demonstrate that EIMD reduces CP, W' and PPO. Possible determinants of reduced CP with EIMD include a reduction in gross efficiency [3] and/or an impairment in muscle oxidative capacity [4]. Reductions in W' might be attributable to reduced glycogen stores and/or a more rapid rate of accumulation of intramuscular metabolites [4, 5], while the reduced MVC and Qtw,pot 24hrs post damage suggest that impaired contractile function is at least partially responsible for these reductions in PPO. The results shown in this study add new insight into the determinants of reduced severe intensity exercise performance with EIMD.

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**EXPLORING THE EFFICACY OF PALMITOYLETHANOLAMIDE (PEA) VERSUS NSAIDS IN ALLEVIATING SYMPTOMS ASSOCIATED WITH EXERCISE-INDUCED MUSCLE DAMAGE**

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*LIVERPOOL JOHN MOORES*

INTRODUCTION: Ultra-endurance running (>42.195km), often involves extensive downhill running (DR), leading to exercise-induced muscle damage (EIMD), of which pain and loss of function are key markers. Consequently, anti-inflammatory and pain medication use is common in athletes during competition and training. NSAID use in athletes is controversial, may not have ergogenic benefits and may be associated with adverse effects, including gastrointestinal and renal dysfunction. Palmitoylethanolamide (PEA), an endogenous fatty acid with anti-inflammatory and analgesic properties, offers a potentially safer alternative with no known side effects. This study investigates the efficacy of PEA and the NSAID, Ibuprofen (IBU) compared to Placebo (PLA), in alleviating symptoms of EIMD induced by laboratory DR protocol.

METHODS: Twelve healthy individuals were acclimated to DR during a 4-week training programme, consisting of 10 (15-30min) sessions on a motorised treadmill at different negative gradients (-5/-10/-15%) and a running speed equivalent to 60-65% VO2max. After session 9, participants were randomised in a double-blind manner to receive: PLA (maltodextrin), PEA (600mg/day), or IBU (800mg/day) along with 4% deuterium oxide (D2O) for 10 days for muscle protein synthesis measurement. At day 3 of supplementation, participants performed a 50-minute DR (-15-17%) to induce muscle damage. Blood for the analysis of kidney function and maximal isometric voluntary torque (MIVT) and voluntary activation (VA) was measured pre- and immediately post-DR and at 24h, 48h, 5d and 7d post-exercise. A Visual Analog Scale (VAS) was used daily during the 7d recovery to assess pain. A two-way mixed ANOVA was used to detect changes between time and condition, with significance set at $p \leq 0.05$. All data are expressed as mean±.

RESULTS: There was a significant effect of time on MIVT (Nm/Kg) ($p < 0.001$), but no significant effect of condition ($p = 0.40$) or interaction ($p = 0.91$). MIVT decreased with a loss of approximately 19% from PRE (3.1 ± 0.1) to POST (2.5 ± 0.2, $p = 0.003$), and further reductions observed at 24h (2.4 ± 0.2, $p = 0.006$), and 48h (2.5 ± 0.2, $p = 0.005$). Similarly, there was a significant effect of time on VA (%) ($p < 0.001$), but no significant effect of condition ($p = 0.34$) or interaction ($p = 0.07$). VA decreased from PRE (87.7 ± 0.9) to POST (71.4 ± 2.3, $p < 0.001$), 24h (78.9 ± 1.7, $p = 0.002$), and 48h (79.8 ± 1.3, $p < 0.001$). There was a significant effect of time on pain scores ($p < 0.001$), but no significant effect of condition ($p = 0.96$) or interaction ($p = 0.49$). Peak pain scores did not differ between conditions ($p = 0.32$); however, only the PLA group reported pain until day 7, while PEA and IBU reported pain until day 5.

CONCLUSION: Neither PEA nor IBU compared to PLA, significantly improved muscular function or peak pain scores, suggesting the modulation of inflammation through these interventions does not substantially influence neuromuscular recovery from a bout of downhill running inducing EIMD.

**THE DOSE-RESPONSE EFFECTS OF HYDROLYSED CURCUMIN ON RECOVERY, INFLAMMATION AND OXIDATIVE STRESS FOLLOWING EXERCISE-INDUCED MUSCLE DAMAGE IN MALES.**

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*ST MARYS UNIVERSITY*

INTRODUCTION: Polyphenols, specifically curcumin, are used in the aid of recovery post muscle damage. One method to improve curcumin bioavailability that is yet to be investigated with recovery is curcumin in a hydrolysed (liposomal) form. The aim of this study was to investigate the effect of two different dosages (750mg and 1500mg) of a novel hydrolysed curcumin supplement on physiological recovery following a bout of exercise induced muscle damage (EIMD).

METHODS: Using a randomised, placebo controlled, double-blind design, 34 recreationally active male participants (age: 27 ± 6 years; height: 180 ± 7.3 cm; body mass: 82 ± 11.3 kg) completed a supplementation trial over 7 days. Participants were randomly assigned to one of three groups; PLA: 2 x 750 mg/day placebo (identical supplement formulation without curcumin), LOW: 1 x 750 mg curcumin and 1 x 750 mg placebo; HIGH: 2 x 750 mg/day curcumin. Participants started supplementation 48h before exercise induced muscle damage continuing throughout the study. EIMD protocol consisted of 8 x 10 repetitions incorporating a 5s eccentric phase on the leg press machine. FORD, FORT, CK, IL-1B, Il-4, IL-6, IL-10, TNF-α and IL-1RA, PPT, VAS, BORG, thigh girth, and vastus lateralis diameter (ultrasound), isokinetic peak power and muscle endurance levels (50% peak power held until exhaustion) were collected Pre, Post, 24h, 48h, and 72h after EIMD. A two-way mixed measures ANOVA was used to investigate possible differences in absolute and relative changes (%) in biomarkers and performance indicators between the groups (PLA, LOW, and HIGH) and within groups across time points (Pre-EIMD, Post-EIMD, 24, 48, and 72 hours post muscle damage).

RESULTS: The HIGH group demonstrated superior effects in significantly reducing subjective pain, CK, FORT, and IL-6 levels during recovery days ($P < 0.05$). Notably, a significant difference ($P < 0.05$) was observed between the LOW and HIGH groups in the muscle endurance test at 24h post-exercise, with the HIGH group exhibiting a slower recovery. No other differences in performance measures were seen.

CONCLUSION: This study suggests there may be a dose-response relationship between curcumin dosage and recovery markers, proposing that higher doses (1500 mg/day) appear to reduce soreness, oxidative stress, and inflammation to a greater extent than lower doses (750mg/day). Furthermore, these findings support previous clinical research indicating that curcumin may exert a protective effect at the cellular level by significantly attenuating CK release post-exercise, thereby mitigating muscle damage. However, the data also suggest the potential for a non-linear, "inverse U-shaped" relationship between curcumin dosage and muscle performance during recovery

## Invited Symposium

### IS-AP02 Female health and menstrual cycle research; do we need to change our approach? A call for action

**RESEARCH AND REALITY: FEMALE HEALTH MONITORING IN DIVERSE ENVIRONMENTS**

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Intentional monitoring of female health alongside performance has gained popularity in the lab as an opportunity to: i) examine the potential influence of menstrual (or hormonal contraceptive) phase on acute responses to exercise and performance; ii) establish menstrual status as part of, or prior to inclusion in research. In field settings monitoring female health alongside performance also provides information that may help to: i) identify recurring patterns of negative and positive symptoms that may influence performance or subjective feelings of performance; ii) detect early warning signs of low energy availability and/or low carbohydrate availability as well as overtraining/accumulated physical/social/psychological stress; and iii) to promote health literacy and empower female athletes. Monitoring female health alongside performance is an essential tool for bridging the gap between research and practice to better understand the relationships between female athlete health and performance. When carefully planned and implemented, monitoring may, on both case and population levels, serve academics and researchers as well as those working within sport i.e. athletes, coaches, and multidisciplinary teams including physicians, physical therapists, and pyschologists1. As a compo-

nent of female health and performance monitoring, several approaches to menstrual cycle tracking are available. Where methodological recommendations for research regarding the menstrual cycle have been published2,3,4,5, a "gold standard" protocol for tracking menstrual cycles in field settings has yet to be developed/identified. Furthermore, tracking hormonal contraceptive cycles and menstrual disturbances/dysfunction has received significantly less attention where methodological considerations may require further development. Nevertheless, tracking cycle characteristics and symptoms of athletes with menstrual disturbances/dysfunction or using hormonal contraceptives may also provide meaningful and valuable information for athletes, coaches and multidisciplinary teams. The purpose of this presentation is to discuss the suggested approaches and rationale for tracking menstrual and hormonal contraceptive cycles (incl. menstrual disturbances/dysfunction) in female athletes "in the field" including how this data can potentially contextualise other health and performance data in a way that is meaningful for athletes. The feasibility and potential limitations of different analysis methods from traditional paper and pencil records to more sophisticated digital applications and biochemical measures for use in the field will be addressed. References 1Burden et al. Int J Sports Physiol Perform 2024; Ahead of Print. 2Elliott-Sale et al. Sports Med 2021; 51(5):843-861. 3Smith et al. Int J Sport Nutr Exerc Metab 2022; 32(2):114-127. 4Schaumberg et al. J Sci Med Sport 2017; 20(11):965-969. 5Janse de Jonge et al. Med Sci Sports Exerc. 51(12):2610-2617.

**THE EFFECT OF THE MENSTRUAL CYCLE ON PERFORMANCE; METHODOLOGICAL CHALLENGES AND THE IMPORTANCE OF DURABILITY**

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Research on the effect of the menstrual cycle on performance has gained much interest over the last five years. Although this is encouraging, most studies do not find differences in performance outcomes (1), while self-reported effects of the menstrual cycle on training habits and performance by athletes clearly do (2,3). This discrepancy may be explained by the variation in individual responses to the menstrual cycle and the effect it has on performance. This variation can lead to not finding significant differences at group level, while at an individual level, clinically meaningful changes might be observed in certain athletes. Another possible contributing factor might be that most performance tests in these studies are conducted in a rested (fresh) state rather than a fatigued state. Recently, Erp et al. (4) showed that performance characteristics in highly versus less successful male professional cyclists were similar in a fresh state but differed significantly in a fatigued state. In line with this, van Erp and Lamberts (5) showed similar outcomes in female professional cyclists in the top-5 versus not top-5 finishers. These findings highlight the importance of durability when monitoring and predicting performance. In addition, it also raises the question of whether the menstrual cycle impacts performance more clearly and with less variation between individuals in a fatigued state. This presentation will discuss the challenges and limitations of conducting group analysis within menstrual cycle research and how to overcome these, while also discussing the importance of durability testing female cyclists. As part of this, we will present some new and novel data from a study in which female-trained cyclists (23 ± 5 years; 4.4 ± 0.6 $W \cdot kg^{-1}$) performed a standardised submaximal warm-up test and a 20-min time trial test before (fresh) and after (fatigued) a 60km submaximal ride during which they burned an average of 22 $kJ \cdot kg^{-1}$. Besides providing new and novel insights into improving menstrual cycle research, practical insight will also be provided on how to monitor the menstrual cycle and the impact on performance in the field on an individual level. References 1 Mc Nulty et al. Sport Med. 2020;50:1813-1827 2 Brown et al. Int J Sports Physiol Perform. 2024;19:1012-1020 3 Solli et al. Int J Sports Physiol Perform. 2020;21:1324-1333 4 van Erp et al. Med Sci Sports Exerc. 2021;53:1903-1910 5 van Erp and Lamberts. Int J Sports Physiol Perform. 2022;17:1070-1076

**TRANSLATION TO THE REAL WORLD; THE COLD, HARD REALITY OF NEEDING TO PERFORM ON ANY DAY**

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As female athletes keep pushing the barriers of human performance, focus is increasingly being placed on data collection and analysis to facilitate more informed decision making. A key part of this involves the monitoring of female health markers alongside wellness and performance measures. Integrating these data streams aids with contextualisation and helps to identify times where an athlete may show altered physiological, physical or psychological readiness. The acceleration in female athlete research over the past decade has clearly demonstrated the significant inter- and intra- individual variation in response to changes in endogenous and exogenous hormones through a menstrual cycle and/or in response to use of hormonal contraception (1,2). For some, this may manifest in adverse symptoms at particular times, that have the potential to negatively impact exercise participation and performance, alternatively many feel times where they get a boost or feel a positive response (3). The increase in data collection has facilitated a means for better identifying and understanding these responses. With the ongoing emergence of scientific rationale for the aetiology of menstrual cycle-related symptoms alongside an increased understanding of the natural physiological response to hormonal changes, it makes prudent sense to look at means for both reducing symptoms and optimising support around overt changes in markers of readiness (3,4). This is of particular relevance in elite sport, where margins are fine, ensuring an athlete is able to perform at their best on any day is fundamental. This presentation will provide several case reports from team and individual elite athletes, outlining how strategies have been implemented to optimise readiness and wellness based on the longitudinal monitoring of multiple data streams. 1. McNulty KL et al. Sports Med. 2020;50(10):1813-1827. 2. Oester C et al. J Sci Med Sport. 2024;27(6):373-384. 3. Antero J et al. Front Physiol. 2023;14:1110526. 4. Gaskins AJ et al. Am J Epidemiol. 2012;175(5):423-31.

Invited Symposium

## IS-BM07 The aging brain in motor control and balance learning: from molecules to neurons and networks

### REBALANCE THE BRAIN: THE EFFECT OF AGING AND PHYSICAL ACTIVITY ON CORTICAL INHIBITION AND EXCITATION

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Aging is a natural physiological process that leads to changes in function, which can result in reduced motor performance, cognitive decline, and impaired motor learning and consolidation. However, contrary to mid-20th-century beliefs, healthy aging is not associated with the same widespread neural loss seen in neurodegenerative diseases. As a result, there is growing interest in understanding how aging affects specific neural subpopulations and their synaptic connections. In particular, research on age-related changes in inhibitory neurons, which represent the most complex and diverse group of brain cells playing a critical role in modulating the activity of entire neural circuits, is considered crucial. Gamma-aminobutyric acid (GABA), one, if not the main inhibitory neurotransmitter in the central nervous system, is used by approximately one-third of neurons as their main form of communication. It appears that aging is associated with a decline in global GABA levels across in various brain regions and this decline in GABAergic function results in an imbalance between inhibitory and excitatory activity, disrupting multiple brain circuits. As a consequence, it impairs not only motor and cognitive behaviors but also neural plasticity. It is important to note that not only GABA concentration plays an important role but also the ability to task-specifically up- or downregulate intracortical inhibition is important. It was for example shown that skilled experts (e.g. piano and badminton players) were able to modulate intracortical inhibition in a task-specific fashion whereas novices showed much less modulation indicating that with motor learning, inhibitory processes can be modulated. With respect to aging, recent evidence suggest that longer training periods can also cause changes in the modulary capacity of the brain and that these in intracortical inhibition are associated with improvements in performance. In this talk, I will address the importance of the cortical inhibitory network for motor control and motor learning and how aging and certain pathologies affect these inhibitory networks causing an imbalance between cortical excitation and inhibition. Furthermore, I will address how motor learning (e.g. balance learning, strength training) in general and particularly in the elderly will affect cortical inhibition and how the changes in the cortical inhibitory network might be related to other outcome measure such as sleep quality.

### POSTURAL CONTROL, BALANCE TRAINING AND THE (MICRO-)STRUCTURE OF THE AGING BRAIN: THE CASE FOR QUANTITATIVE MRI

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Age-related deterioration in postural control is an important factor decreasing quality of life. A healthy brain, characterized by intact gray (GM) and white matter (WM), is vital for the efficient functioning of neural networks during daily life tasks, thus playing a critical role in maintaining and restoring mobility and balance in aging. Atrophy, which is usually measured based on structural magnetic resonance imaging (MRI), is one of the most important changes in healthy and especially in pathological aging of the brain. Consequently, most MRI studies investigating age-related changes in balance performance (including falls) and balance training-induced neuroplasticity focused on meso- and macroscopic shape of the brain as assessed with T1-weighted imaging (morphometric analysis). Usually, the volumes of the cortex and/or subcortical gray matter are measured and correlated with balance performance, or tracked longitudinally. When reviewing the results from these studies, it becomes clear that a comprehensive understanding of postural control and balance can only be achieved by studying distributed cortical and subcortical brain areas and their interconnecting fibre tracts, whereby the latter in particular have been largely neglected to date. A further problem is that the conventional analysis approach is relatively unspecific with regard to neurobiological tissue properties, since morphometric results also depend on cortical thickness, surface area and tissue density. Last but not least, since microstructural changes in the brains of older people, specifically pertaining to synapses, typically precede meso- and macroscopic atrophy, it is likely that the morphometric analysis approach has also limited sensitivity to detect training-induced changes and brain-behavior correlations. As a possible way forward, I will discuss how quantitative multicontrast MRI weighted towards diffusion, relaxation times and magnetisation transfer can be used in combination with advanced biophysical modelling to address these problems. The unprecedented insights into the relationship between GM/ WM microstructure and balance offered by such a novel approach are demonstrated based on unpublished data from two randomised controlled trials of balance training in older adults in which our laboratory was involved. I will draw attention to how multivariate combinations of MRI-derived metrics can uncover microstructural information that is typically concealed when focusing on single metrics, and I will discuss neuroplasticity and brain-behavior correlations against the background of previous studies. It is hoped that these novel multicontrast estimates of brain anatomy ("in-vivo histology") will be increasingly used in the field of movement neuroscience, with potential applications in early diagnosis, guiding treatment and assessing individual response to training and therapy.

**METABOLIC CHANGES IN AGING: CURRENT EVIDENCE AND THE IMPACT OF PHYSICAL ACTIVITIES**

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Aging affects brain structure, function, and metabolism, often leading to declines in cognition and motor performance. Proton magnetic resonance spectroscopy ($^{1}$H MRS) is a valuable non-invasive tool for studying age-related brain metabolite changes. Current studies focus on key metabolites such as N-acetylaspartate (NAA), linked to neuronal health; choline-containing compounds (Cho), involved in cell membrane and myelin metabolism; myo-inositol (mI), a glial marker and osmolyte; glutamate and GABA, the major excitatory and inhibitory neurotransmitters, and creatine (Cr), an energy metabolite. Decreases in NAA and increases in mI have been consistently observed with age, suggesting possible neural loss in grey matter, axonal damage in white matter, demyelination, inflammation, or glial activation. As the brain consumes high levels of energy, it is sensitive to ATP (adenosine triphosphate) fluctuations. ATP production and energy transport are essential for supporting neural function. Mitochondrial ATP is mainly synthesized through ATP synthase, using adenosine diphosphate (ADP) and inorganic phosphate (Pi). Phosphorus magnetic resonance spectroscopy ($^{31}$P MRS) measures phospho-metabolites involved in energy and membrane phospholipid metabolism, supporting the study of neuroenergetics and brain health. Our previous study revealed a metabolic network linking NAD metabolism with phospholipid turnover, energy production, and aging. Comparing younger and older subjects, we observed distinct metabolic profiles, including increased PCr, glycerophosphocholine (GPC), and glycerophosphoethanolamine (GPE) levels, alongside a rise in ATP synthase activity and declines in ATP and phosphoethanolamine (PE) levels. These findings highlight $^{31}$P MRS as a powerful tool to uncover metabolic changes, supporting new therapeutic approaches targeting energy pathways in aging. Moreover, MRS can monitor energy metabolism and biochemical changes during cognitive or motor tasks, enabling analysis of activity-induced metabolic shifts. So far, a key question to address in aging-related brain research is whether motor learning can counteract brain changes associated with aging. Balance learning, a promising intervention, has been shown to enhance postural stability, structural and functional connectivity adaptations. However, most studies focus on young adults, it remains unclear if similar plasticity effects occur in older adults and what is underlying molecular mechanism. In this talk, I will first give an overview about age-related metabolic changes, focusing on neurotransmitters and energy metabolites, and then explore how advanced MRS techniques can map regional and functional brain changes. Finally, I will share findings from our recent study on long-term balance and strength training in older adults, examining how physical training may enhance brain metabolism and counteract aging-related decline in motor performance.

## Invited Symposium

### IS-PN03 From Sea to Space - Human Physiology and Performance in the Extreme Environments Underwater, High-Altitude, and Weightlessness.

**ARTERIAL PARTIAL PRESSURE OF OXYGEN VARIATIONS IN BREATH-HOLD AND SCUBA DIVING: STATE-OF-THE-ART**

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According to Boyle's law and current diving physiology, divers' arterial blood gas (ABG) levels vary proportionally to environmental pressure underwater. As experimentally demonstrated in hyperbaric chambers, the arterial partial pressures of O2 (PaO2) in SCUBA divers increase during the descent and progressively normalize when resurfacing. In breath-hold divers (BHDs) instead, PaO2 rises during the descent - as lungs compress - but progressively falls when resurfacing due to metabolic consumption and redistribution in re-expanding lungs. This work summarizes the PaO2 from ABGs obtained in the last 4 experimental campaigns on BHDs and SCUBA divers in the real underwater environment. All the experiments were approved by the institution's ethics committee and included healthy, expert SCUBA divers or BHDs. After inclusion, an arterial cannula was inserted into the radial artery of the non-dominant hand. The ABGs were drawn in different conditions: resting at the surface after cannulation; immediately before diving, after controlled ventilation, in water, face submerged; at depth (-15 mfw or -42 mfw), with BHDs using a sled or fins, and SCUBA divers before and after pedaling on a bike; at surface (after -15 mfw or -42 mfw dives). A scatter plot was used to describe PaO2 distribution in different protocols. Lung ecography have been performed at depth. 34 subjects were included in the study (8 for SCUBA diving), and 150 samples were obtained. Different protocols were applied during these experiments, explaining the variability among the PaO2 results. When at rest, out of the water, all the subjects showed to mirror physiological data. After the pre-dive controlled ventilation, a slight increase can be noted, probably due to water compressing the chest and the lungs of BHDs. Five BHDs out of 14 at -15mfw and 6 out of 20 at -42 mfw did not develop the predicted hyperoxemia at depth, potentially due to lung atelectasis or interstitial edema as reported by lung ecography. At the surface, PaO2 values diminished, with the lowest measured on BHDs using fins to dive. SCUBA divers developed the predicted hyperoxemia at depth without variations after pedaling on the submerged bikes and returned to normal values at the surface. PaO2 in SCUBA divers seems to follow diving physiology predictions; instead, BHDs show higher variability, probably due to environmental stress exerted on the lungs, resulting in lung edema or atelectasis, which affects gas exchange.

**DOES MAXIMAL EXERCISE AT HIGH-ALTITUDE EXACERBATE THE BRAIN'S INFLAMMATORY RESPONSE?**

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The interplay between hypoxia and exercise on the immune response is complex [1,2]. For example, the anti-inflammatory and immunosuppressive effects of strenuous exercise [3] may play a role in immune system sensitization and prevalence of infection at high-altitude [4,5]. Further, pro-inflammatory stress at high-altitude is implicated in the etiology of high-altitude illnesses [6,7]; however, it is controversial whether/how exercise alters pro-inflammatory mediators and therefore the implications of exercise on high-altitude illnesses. How acclimatization to high-altitude affects immune sensitization/suppression and hypersensitivity of inflammatory responses in the brain has not been investigated, particularly following maximal exercise. This talk will discuss the brain's inflammatory response to both 'practical' cycling exercise at a low intensity and in response to acute exhaustive cycling at sea level and following 6-8 days at 3,800 m. Healthy adults (n=12, 6/6 females/males) received radial arterial and internal jugular venous catheterizations to assess trans-cerebral exchange of inflammatory cytokines. Data were obtained prior to and following 60 minutes of steady-state semi-recumbent cycling at an altitude-specific intensity to elicit maximal fat oxidation, and at 5 minutes post- an incremental maximal exercise test. These results indicate that high-altitude per se reduces systemic pro-inflammatory cytokines at rest. Further, 6-8 days of acclimatization at 3,800 m does not provoke immune suppression or mediate elevations in systemic pro-inflammation in response to maximal exercise. Although acute maximal exercise per se does not provoke inflammatory stress in the brain, it appears that the additive duration/intensity effect of prolonged low-intensity exercise followed by acute maximal exercise – irrespective of altitude – provokes a shift toward trans-cerebral net release of pro-inflammatory cytokines. Exposure to high-altitude does not exacerbate pro-inflammatory stress in the brain in response to maximal exercise. Although not directly tested, the current exercise intervention did not initiate any symptoms of altitude illness or headache. As pro-inflammatory stress is implicated in the pathophysiology of altitude illness [6,7], these data support that, in the context of the current experimental study following acclimatization to 3,800 m, this duration and intensity of exercise is not a trigger for altitude illness via pro-inflammatory stress. These data provide insights into the tolerability of acute maximal exercise at high-altitude. [1] Vats et al. (2006). DOI: 10.1016/j.cmet.2006.05.011. [2] Weinberg et al. (2015). DOI: 10.1016/j.immuni.2015.02.002. [3] Shaw et al. (2018). DOI: 10.1016/j.cyto.2017.10.001. [4] Facco et al. (2005). DOI: 10.1249/01.mss.0000162688.54089.ce. [5] Feuerecker et al. (2019). DOI: 10.1111/all.13545. [6] Pham et al. (2021). DOI: 10.3389/fphys.2021.676782. [7] Turner et al. (2021). DOI: 10.1152/japplphysiol.00861

**SPACEFLIGHT PHYSIOLOGY: THE ROLE OF COUNTERMEASURES FOR HEALTH AND PERFORMANCE IN WEIGHTLESSNESS**

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Prerequisites for human performance during spaceflight are survival in the extreme space environment and solutions to maintain health in weightlessness. Habitat and life-support solutions keep astronauts alive against the imminent threats of vacuum, temperature, and carbon dioxide accumulation, and countermeasures are implemented to maintain health and attenuate cardiovascular and musculoskeletal deconditioning. Specific risks associated with weightlessness, such as hypoxia, hypercapnia, and changes in pressure, are similar to those encountered in underwater and high-altitude environments. This talk discusses the physiological adaptations in weightlessness and the role of countermeasures and gravitational stress in maintaining health and performance during spaceflight. Current plans of national space agencies and commercial providers will increase the number of people in space, and tasks like extra-vehicular activities, the return to a gravitational field, and future planetary explorations demand intact high performance to ensure safety and mission success. Current countermeasures include engineering, medical, and exercise interventions, but astronauts continue to return with impaired vision and losses in bone mineral density, muscle mass, and strength [1–3]. Determining the necessary amount of gravity to maintain astronaut health remains a critical challenge. While 1G on Earth appears optimal, it is unclear how much gravitational stress is needed in space to achieve similar health outcomes. Weightlessness induces a cranial fluid shift with central hypervolemia, increased intracranial and intraocular pressures, and reduced venous return [4], suspected to cause the observed ocular morphology and vision changes during and following long-duration spaceflight [5,6]. Furthermore, the lack of gravitational stress deconditions the cardiovascular and musculoskeletal systems, reducing aerobic capacity and increasing the risk of bone fracture during planetary landings and orthostatic intolerance after returning to a gravitational field. While the International Space Station offers various countermeasures, medical support, and evacuation strategies, future long-duration spaceflight will amplify current risks while posing severe volume and weight limitations, demanding novel and comprehensive countermeasure solutions. [1] Comfort et al. (2021). DOI 10.1007/s40279-021-01496-9 [2] Ong et al. (2023). DOI: 10.1038/s41433-023-02522-y. [3] Scott et al. (2023). DOI: 10.1038/s41526-023-00256-5. [4] Roberts and Petersen (2019). DOI: 10.1001/jamaneurol.2018.4891. [5] Laurie et al. (2020). DOI: 10.1001/jamaophthalmol.2019.5261. [6] Macias et al. (2021). DOI: 10.1001/jamaophthalmol.2021.0931.

Oral Presentations

OP-AP13 Training and Testing III - Interval / Sprint Training

**ADAPTATIONS TO HIGH-INTENSITY INTERVAL TRAINING AND SPRINT INTERVAL TRAINING ARE INFLUENCED BY AN ATHLETE'S LOCOMOTOR PROFILE**

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INTRODUCTION: High-intensity interval training (HIIT) is frequently used to improve maximal physiological (e.g., $VO_2$max) or locomotor variables (e.g., maximal aerobic speed (MAS), maximal sprinting speed (MSS)) (Rosenblat et al., 2020). HIIT involves repeated bouts at intensities between the second lactate threshold and MAS, or sprints above MAS, i.e., sprint interval training (SIT). Previous literature does not favor one format over the other for physiological and locomotor adaptations (De Oliveira-Nunes et al., 2021). However, no study has analyzed the influence of an athlete's locomotor profile on adaptations to HIIT and SIT. Therefore, we aimed to 1) evaluate differences in physiological and locomotor adaptations to HIIT vs. SIT and 2) analyze the influence of the locomotor profile on those adaptations.

METHODS: Twenty-seven trained, male and female runners (27.67±7.45 years; n=12 women) completed pre- and post-testing comprising a 40-m sprint test to assess sprint performance (t40) and MSS and an incremental treadmill test to determine $VO_2$max, MAS, velocity at lactate threshold 1 and 2 (vLT1 and vLT2), peak treadmill speed (vpeak), and running economy (RE). Anaerobic speed reserve (ASR) was calculated by subtracting MAS from MSS and speed reserve ratio (SRR) as a ratio of MSS and MAS. The latter served to categorize participants as endurance, hybrid, or speed types. Further, they were stratified and assigned to six weeks training of two sessions HIIT (4-6x 4min/2min @90-95% MAS) or SIT (6-10x 20s/3min all-out sprinting) per week. Linear mixed models (Outcome=Time x Group + (1 | ID)) and linear models (%change=Group x Type) were calculated.

RESULTS: Both groups showed significant improvements in MAS and vpeak ($p \leq 0.03$; $d \geq 0.87$), while MSS and t40 only improved in the SIT group ($p \leq 0.04$; $d \geq 0.84$). ASR declined and vLT2 inclined in the HIIT group only ($p=0.01$; $d=0.41$). $VO_2$max, vLT1, and RE did not change significantly ($p \geq 0.08$; $d \leq 0.71$). Independent of the group, MAS incline ($p \leq 0.02$; $d \geq 2.25$) and ASR decline ($p \leq 0.02$; $d \geq 1.70$) was higher for the speed compared to hybrid or endurance types. Endurance types improved t40 more in the SIT than HIIT group ($p=0.003$; $d=-2.03$) and more than hybrid types ($p=0.03$; $d=2.03$). $VO_2$max of speed types decreased in SIT but not in HIIT ($p=0.04$; $d=-1.81$).

CONCLUSION: In conclusion, both HIIT and SIT improved endurance performance in trained runners, with SIT showing additional benefits for sprinting and HIIT for endurance (vLT2). Locomotor profiles influenced adaptations, with speed types showing greater MAS improvements and ASR declines, while endurance types benefited more from SIT in terms of t40. These results suggest that both training methods are effective and the specific benefits can vary based on the prescribed form of high-intensity exercise as well as the athletes locomotor profile. This highlights the potential of considering individual locomotor profiles when designing high-intensity training programs to optimize desired adaptations.

**HOW THE APPLIED LOAD DURING THE PREPARATORY PERIOD AFFECTS CHANGES ON THE ANAEROBIC AND PSYCHOMOTOR FATIGUE THRESHOLD**

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INTRODUCTION: The preparation period is a key time when players returning from a rest break are expected to improve their physical performance quickly and substantially in order to compete in a league lasting many weeks (Csala et al. 2021). The aim of this study was to investigate how the anaerobic threshold (ANT) and psychomotor fatigue threshold (PFT) change with the insertion of the 30-min block of high intensity interval training (HIIT) and normal training implemented during the preparatory period.

METHODS: Twenty selected U-19 players playing daily in a professional football team were studied. The team was randomly divided by a group of players. The first group realized two times per week a 30-min block of HIIT exercises (HIIT), and the second group realized normal training (CON). The research was carried out in the Exercise Research Laboratory. The players performed an incremental progressive all-out test at the beginning of the round and after the preparatory period lasting 4 weeks. The measurement of lactate (LA) determined anaerobic threshold (ANT), whereas the choice reaction time (CRT) indicated psychomotor fatigue threshold (PFT) among other selected physiological parameters. The repeated-measure analysis of variance (ANOVA) compared mean values for the examined variables using the Fisher post hoc test.

RESULTS: One of our main results is that the applied loads in the HIIT group significantly raised the anaerobic threshold at the velocity running from 13.20 to 14.49 km/h ($p \leq 0.000$). In contrast, the CON group did not show any significant change, remaining at 13.26 km/h before and 13.20 km/h after the 4-week preparation period. Regarding the psychomotor fatigue threshold, the HIIT group initially reached 14.00 km/h, and after the preparation period, it significantly increased to 15.44 km/h ($p \leq 0.000$). While the CON group also showed an increase, it was not statistically significant (from 13.75 to 14.12 km/h).

CONCLUSION: One advantage of HIIT is its ability to improve physiological parameters and performance in a short amount of time (Buchheit and Laursen 2019). Finally, it was shown that the group performing an additional 30-minute block of interval training tested thresholds shifted towards higher loads - higher running speed. In addition, no significant changes were observed in the control group. This indicates that coaches should incorporate HIIT exercises in the preparatory period.

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**THE FREQUENCY OF REPEATED-SPRINT TRAINING IN HYPOXIA DOES NOT IMPACT OVERALL PHYSIOLOGICAL AND PERFORMANCE ADAPTATIONS IN MALE UNIVERSITY BASKETBALL PLAYERS**

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INTRODUCTION: Repeated-sprint training in hypoxia (RSH) provides greater training adaptations than a similar training performed in normoxia (RSN) in competitive athletes [1, 2]. RSH is recommend to be performed 2 to 3 sessions per week over several weeks at a simulated altitude of around 3000 m [1, 2]. However, implementation can be challenging due to limited access to a hypoxia environment, e.g., few infrastructures, congested schedules (e.g., work, school). Thus, it is important for athletes and coaches seeking to optimise training implementation to understand the minimal dose (e.g., frequency) of RSH required for desired training benefits. In particular, adhering to the recommended frequency (i.e., 2 to 3 sessions per week), can similar adaptations be attained by replacing some RSH sessions with RSN? This study aimed to determine effects of frequency of RSH on physiological and performance adaptations in male university basketball players.

METHODS: Nineteen male university basketball players competing at a national level (20 ± 1 yrs, 181 ± 9 cm, 78 ± 12 kg, maximal oxygen uptake [VO2max]: 55.6 ± 5.7 ml·kg-1·min-1) completed 6 training sessions consisting of 2 to 3 sets of 5 to 6 repetitions of 6-s all-out cycle sprints (inter-sprint rest: 30 s; inter-set rest: 300 s) over 2 to 3 weeks. While 9 of them performed all 6 sessions in normobaric hypoxia at a simulated altitude of 3000 m (HYPO), the remaining 10 players performed RSH and RSN alternately (i.e., 3 sessions each, MIX). Before and after the intervention, average power (AP) during a 6-s all-out cycle test, and maximal incremental power (MIP) and VO2max achieved in an incremental cycle test were determined.

RESULTS: A two-way (time and group) analysis of variance showed a significant main effect of time in all parameters (AP, MIP and VO2max, $p < .05$), whereas a significant time-by-group interaction effect was not observed in any of those parameters. Consequently, the magnitude of improvements was similar between the groups (HYPO vs. MIX: AP, 7.2 ± 7.7 vs. 9.8 ± 13.9%; MIP, 3.0 ± 3.5 vs. 3.5 ± 3.2%; VO2max, 2.9 ± 4.6 vs. 4.0 ± 7.7%).

CONCLUSION: The frequency of RSH over a short period of time does not seem to impact physiological and performance adaptations in young male basketball players. Although RSH has been shown to be more effective than RSN in induing adaptations [1, 2], combined effects of RSH and RSN remained unknown. The findings of this study indicate that 50% of RSH sessions can be replaced by RSN without diminishing the degree of adaptations, thus offering flexible options for athletes and coaches, especially when facing congested schedules and limited access to a hypoxic environment.

References

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**MEDIAL GASTROCNEMIUS STIFFNESS IS NOT CORRELATED WITH SPATIOTEMPORAL VARIABLES DURING 100-M SPRINT RUNNING IN COLLEGE SPRINTERS**

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INTRODUCTION: Passive muscle stiffness affects the power output of the muscle-tendon unit (1). It has been shown that the stiffness of the medial gastrocnemius (MG) was negatively correlated with 100-m race time in well-trained sprinters (2). This finding implies that MG stiffness is related to determinants of sprint running performance (i.e., spatiotemporal variables, such as step frequency, step length, flight time, stance time, flight distance, and stance distance [3]). However, this possible relationship has not been explored yet. Meanwhile, a previous study (4) reported that the stiffness of MG was correlated to drop jump height, suggesting that the stiffness may also be correlated with the flight distance during sprint running through rapid explosive force production. This study aimed to elucidate the relationships between MG stiffness and spatiotemporal variables during 100-m sprint running.

METHODS: Participants were twenty-one male college sprint runners (100-m best record: 11.03 ± 0.29 s). The shear wave velocity of MG was measured using an ultrasound scanner as an index of muscle stiffness at passive and active (during isometric plantarflexions at 20% and 50% of maximal voluntary contractions [MVC]) states. Participants performed 100-m maximal sprint runs, while their running times were measured using timing gates. Their sprint motions were recorded

with a high-speed camera (250 fps) to determine spatiotemporal variables at 50-60 m interval. Pearsons correlation analysis was used to investigate the relationships between two measured variables.

RESULTS: The shear wave velocity of MG at passive and active states was not significantly correlated with any spatiotemporal variables at 50-60 m interval (p = 0.057 to 0.937), even when considering the effect of body height. In addition, the shear wave velocity of MG at passive and active states was not significantly correlated with 100-m sprint running time (p = 0.143 to 0.659).

CONCLUSION: The present findings imply that the stiffness of MG has no significant effect on the spatiotemporal variables of the sprinters with 100-m sprint running time of around 11 s. A possible explanation for the lack of correlation between the shear wave velocity of MG and flight distance is the small contribution of MG to horizontal ground reaction force during sprint running (5). In addition, the MG stiffness was not significantly correlated with 100-m race time, unlike the previous study (2). This inconsistency may be associated with differences such as the best race time of 100-m (11.03 ± 0.29 s vs 10.88 ± 0.33 s). Our results suggest that athletes and coaches may not need to emphasize MG stiffness when planning training programs.

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**THE IMPACT OF UPPER BODY STRENGTH AND BODY COMPOSITION ON 500-METER FLAT-WATER SPRINT KAYAK PERFORMANCE**

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INTRODUCTION: Strength training plays a crucial role in enhancing performance in flat-water sprint kayaking. However, the specific physical attributes that should be prioritized in strength training remain unclear due to limited research in sprint kayaking. This study aims to elucidate the relationship between upper body strength, anaerobic power, body composition, and performance in the 500-meter flat-water sprint kayak event.

METHODS: 32 competitive kayak athletes (22 international-level, 23 men, 9 women) participated in two official 500 m on-water sprint kayak events in which their performance was recorded (114.0 ± 6.6 s). Within one week of the event, maximal dynamic strength, maximal isometric strength, maximal power output, and strength-endurance was assessed in the bench press and bench pull exercises. Body composition was assessed using dual-energy x-ray absorptiometry (DEXA) and anaerobic peak power (Ppeak) was assessed in a 5-s all-out ergometer sprint test. A partial least squares (PLS) regression analysis was conducted to evaluate the relationship between the dependent variable and the independent variables.

RESULTS: The age, height, body mass, lean body mass, and body fat percentage of the kayak athletes were 20.0 ± 3.3 years, 180.0 ± 7.9 cm, 77.9 ± 10.2 kg, 62.6 ± 9.7 kg, and 17.6 ± 5.3%, respectively. The PLS regression analysis revealed that the independent variables explained 51.5% (adjusted R2) of the variance in the 500m race performance using one latent factor in the model. The most important independent variables were lean mass of the torso (Variable importance in the projection (VIF) = 1.146), maximal dynamic strength in bench press (VIF = 1.129), lean mass of the arms (VIF = 1.079), and maximal dynamic strength in bench pull (VIF = 1.036).

CONCLUSION: Performance in the 500-meter flat-water sprint kayak event is influenced by lean body mass, particularly in the upper body, and maximal dynamic strength in the bench press and bench pull exercises. While this study does not establish a causal relationship, it suggests that strength training for kayak athletes should prioritize increasing upper body lean mass and enhancing maximal dynamic strength in the bench press and bench pull exercises.

## Oral Presentations

### OP-BM04 Neuromuscular Physiology II

**COMPREHENSIVE ANALYSIS OF THE NEURAL, MUSCULAR AND MECHANICAL DETERMINANTS OF THE RATE OF FORCE DEVELOPMENT**

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INTRODUCTION: The neuromechanical determinants of the rate of force development (RFD) have been widely investigated, each time within a different framework, often analyzing only a subset of the relevant neuromechanical variables. Studies

have examined central and peripheral factors such as neural drive estimates, motor unit recruitment, muscle contractility and excitability, fascicle behaviour, muscle-belly gearing, and tendon stiffness. However, these factors have rarely been assessed in combination, limiting the ability to understand the factors influencing rapid force capacity comprehensively. In the present study, we aim to provide a wider perspective on the determinants of isometric RFD.

METHODS: Right limb knee extensors of 32 healthy young adults (15 F) were tested in isometric conditions. The procedure included: evoked contractions (single and octets stimuli); 5s maximal isometric voluntary contractions to measure maximal voluntary force (MVF); 15 isometric burst-like contractions. HD-EMG from vastus lateralis, vastus medialis and rectus femoris were recorded throughout the session, while B-mode ultrasound data of the patellar tendon and vastus lateralis fascicle were recorded only during voluntary contractions. The root mean square (RMS) of HD-EMG of burst-like contractions was normalized to the peak-to-peak amplitude of the M-wave and then averaged. The patellar tendon stiffness was computed from 0-50% of MVF and 50-100% of MVF. Fascicle and belly shortening velocity and architectural gear ratio were derived from fascicle and belly length changes. Correlation and stepwise multiple linear regressions were run between each time-locked RFD metric and the other neuromuscular variables.

RESULTS: RFD at 25 and 50 ms are mainly explained by mean normalized RMS (R2 0.68 and 0.83, respectively). RFD at 75 ms is explained by mean normalized RMS, tendon stiffness up to 50% of MVF and octet's RFD at 50 ms (R2 =0.81). RFD at 100 ms is explained by octet's RFD at 50 ms, tendon stiffness in the first 50% of MVF and inversely by muscle velocity (R2 =0.88). RFD at 125 and 150 ms are explained by octets RFD at 50 ms (R2 =0.78 and R2 =0.82, respectively).

CONCLUSION: Overall, early RFD is primarily influenced by early muscle activation, whereas late RFD underscores the importance of peripheral force-generating mechanisms, i.e. muscle contractility. Interestingly, mid-phase RFD (RFD at 75 and 100 ms) appears to be shaped by a combination of muscle-tendon properties, muscle activation, and peripheral contractile characteristics.

**QUADRICEPS FORCE LOSS IS NOT DIFFERENT BETWEEN INDIVIDUALIZED AND STANDARDIZED FREQUENCIES OF NEUROMUSCULAR ELECTRICAL STIMULATION**

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INTRODUCTION: Neuromuscular electrical stimulation (NMES) over a nerve or muscle belly can evoke involuntary contractions which allow for the assessment of intrinsic contractile properties. Repeated activation of the muscle via intermittent trains of stimuli can assess fatigability (i.e., force loss), the magnitude of which is influenced by NMES parameters such as stimulation frequency. For example, we determined recently that NMES at the frequency equivalent to the mean motor unit discharge rate (MUDR) expected during a voluntary contraction at 25% of maximal knee extensor force (10Hz) induces less force loss than frequencies that exceed the mean MUDR (i.e.15 and 30Hz). Despite innate MUDR variability between people, it is currently unknown if a stimulation frequency equal to an individual's mean MUDR, which should optimally match NMES to intrinsic contractile properties, will mitigate fatigability to a greater degree than utilizing a standardized value based on population data (i.e., 10Hz). Thus, the aim of this study was to compare force loss during NMES at 10Hz vs. the frequency tailored to each participant's mean MUDR.

METHODS: Nine healthy, young adults (26+/−3y; 6 females) completed two testing sessions separated by at least 72h, identical in procedure except for stimulation frequency applied to the muscle bellies of the quadriceps. To assess strength and voluntary activation (VA), participants performed brief isometric maximal voluntary contractions (MVCs) of the knee extensors, with a single supramaximal stimulus delivered during and after each MVC. Individual MUDRs were collected using two concentric needle electrodes inserted into the rectus femoris, vastus lateralis, or vastus medialis during repeated 15-s contractions at 25% MVC force, separated by ≥90s. For each participant, all MUDRs (≥24 per muscle) were averaged to determine the individualized NMES frequency. For the 3-min fatiguing NMES protocols, current was set to initially evoke 25% MVC force. The protocols consisted of 144 contractions, each separated by 1.25s (~0.6s on and 0.65s off), with the order of frequencies counterbalanced across participants.

RESULTS: Baseline MVC force (538.6+/−189.3N) and VA (95.9+/−1.9%) were not different between sessions (p=0.231). The mean MUDR at 25% MVC force was 11.6±2.2Hz (ranging from 8.5-14.5Hz). At the end of the 3-min protocols, force loss was not different between 10Hz (26.6+/−20.6%) and individualized NMES frequencies (29.8+/−19.0%; p=0.479).

CONCLUSION: Despite matching participant knee extensor mean MUDR, NMES at a tailored frequency did not mitigate force loss compared to the standardized 10-Hz session. As the acquisition of MUDRs requires additional equipment, expertise, and time, and there was no functional benefit to a tailored NMES frequency, a standardized NMES frequency of 10Hz appears most appropriate for future studies involving intermittent stimulation of the quadriceps of young, healthy adults.

**ELECTRICALLY INDUCED TORQUE LOSS REDUCES MAXIMAL HUMAN MOTOR UNIT FIRING RATES**

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INTRODUCTION: During a sustained (e.g., 60s) isometric maximal voluntary contraction (MVC), both torque and human motor unit (MU) firing rates decline by ~50% (1,2). The mechanism(s) for these rate adaptations during muscle fatigue (i.e., torque loss) are unclear, however, modified afferent feedback and alterations in descending drive have been implicated (1,3).

The purpose was to assess whether voluntary descending drive is obligatory to reduce maximal MU firing rates with fatigue. To test this, we compared maximal MU firing rates following a sustained 60s MVC and separately following 60s of tetanic peripheral nerve stimulation at similar high torque levels. If changes in descending drive contribute to reductions in maximal firing rates with similar torque losses in both conditions then with electrically induced contractile failure maximal firing rates should not be affected, or to a much lesser degree.

METHODS: Participants (7 males and 3 females, 23.7 ± 3 years) were seated upright on a chair with their left leg placed in a custom-made dynamometer to record isometric dorsiflexor torque. A bar electrode was placed over the common fibular nerve and a supramaximal current was used to induce electrically evoked contractions.

To record single motor unit (MU) activity two tungsten microelectrodes were inserted into the tibialis anterior by two independent operators. For baseline measures, three 5s dorsiflexion MVCs, separated by 5-min rest, were performed.

On separate days, participants completed a 60s sustained MVC or 60s peripheral nerve stimulation. To mimic the firing rate decline observed during MVCs, stimulation frequency was reduced from 40Hz to 20Hz over the 60s (2). Immediately (~2s), 1.5, 3, 5 and 10min post-task, a 5s MVC was performed, and MU activity was recorded. The protocols were repeated twice on separate days to increase MU yield. Two-way repeated measures ANOVAs and mixed linear models were performed.

RESULTS: Baseline MVC torque was 40.1±10.8 Nm and tetanic nerve stimulation induced ~80% MVC.

Immediately (~2s) after both tasks MVC was similarly reduced (~30%) relative to baseline (P=0.2). Remaining post-task MVCs recovered similarly and by 10min returned to baseline (P=0.3, ~96%).

A total of 1531 MUs were analyzed. Baseline maximal MU firing rates of the tibialis anterior were 40.1±11.5 Hz. Firing rates immediately declined by ~30% post-tasks (P<0.001) but recovered similarly (~95%) by 10min with no task differences at any time point (P>0.1).

CONCLUSION: The similar reductions and recovery in firing rates in both fatiguing tasks indicate that during a high-intensity 60s task voluntary drive is not a contributor to reductions in firing rates. These findings provide enhanced evidence that peripheral factors likely originating from the fatigued muscle are responsible for firing rate reductions during voluntary efforts.

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**MOTOR UNIT BEHAVIOUR DURING ISOMETRIC CONTRACTIONS IN MASTER POWER ATHLETES**

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INTRODUCTION: Motor unit (MU) discharge rate and its modulation are key factors implicated in the loss of force-generating capacity and physical function with older age. However, there is limited knowledge of MU discharge rate modulation at higher forces or rates of force development (RFD) and whether the age-related neuromuscular alterations can be offset with higher physical activity levels. Therefore, we compared tibialis anterior (TA) MU discharge properties in older master athletes to older and young controls.

METHODS: Twenty-two power master athletes (MA; 74±6 yrs, 6 females; competing in throwing, jumping or sprint events), 22 older (OC; 76±4 yrs, 6 females) and 22 young controls (YC; 24±4 yrs, 6 females) performed two unilateral maximum voluntary isometric contractions to assess maximal voluntary force (MVF), followed by five rapid contractions (~80% MVF) to assess RFD (maximal slope of the force-time curve from onset), and submaximal, triangular ramp contractions (30, 50 and 70% MVF). Electromyographic (EMG) signals were recorded from TA using a 64-channel electrode.

EMG signals were decomposed into individual MU spike trains using a Convolution Kernel Compensation algorithm. For rapid contractions, initial (first 5 spikes) and steady (20 spikes on the contraction plateau) discharge rate and MU recruitment speed were calculated. During triangular contractions, we calculated the peak discharge rate, and discharge rate hysteresis (ΔF) as an estimate of the contribution of persistent inward currents to the MU discharge rate.

RESULTS: The groups differed in dorsiflexion MVF (main effect: p=0.0496), however, post hoc testing did not suggest any specific between-group differences (MA: 344 [305, 383] N, OC: 288 [255, 322] N, YC: 348 [310, 385] N; p=0.0496). The groups also differed in the ability to express the available force rapidly (p=0.0018), with greater RFD noted for YC (432 [405, 459] %MVF/s) compared to MA (372 [345, 399] %MVF/s, p=0.0074) and OC (346 [318, 373] %MVF/s, p=0.0001). Nevertheless, this was not accompanied by between-group differences in MU recruitment speed (p=0.3407), or the initial (p=0.1223) or steady MU discharge rate (p=0.2286) during rapid contractions.

Regardless of contraction intensity, MU discharge rate and ΔF during submaximal contractions were greater in YC (26.4 [25.0, 27.9] pps, 5.6 [5.0, 6.1] pps) compared to both OC (21.1 [19.6, 22.5] pps, 3.8 [3.2, 4.3] pps; p<0.0001) and MA (21.6 [20.1, 23.0] pps, 3.8 [3.3, 4.3] pps; p<0.0001).

CONCLUSION: Both older groups exhibited smaller RFD compared to young adults, which was not accompanied by differences in MU discharge rate during rapid contractions. During submaximal contractions, younger individuals compared to

both older groups exhibited greater discharge rate, possibly due to the greater contribution of persistent inward currents. These results suggest that the age-related neuromuscular alterations are evident even in highly active individuals.

**ACUTE EFFECTS OF ECCENTRIC AND CONCENTRIC MUSCLE FATIGUE ON NEUROMUSCULAR PERFORMANCE AND SINGLE-LEG JUMPS: A RANDOMIZED CONTROLLED CROSSOVER STUDY**

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INTRODUCTION: Both concentric (CON) and eccentric (ECC) muscle actions regularly occur in everyday life. However, the underlying mechanistic explanations of ECC are poorly understood (1). Moreover, short-term effects of ECC training remain inconsistent (2). Therefore, this study aimed to investigate the acute effects of CON and ECC muscle fatiguing exercises on neuromuscular performance and single-leg jumps.

METHODS: At two sessions 36 sports students randomized performed five sets of 15 maximal isokinetic knee extensor contractions (ROM: 5-95°, 40°/s), either CON or ECC. Before and after all sets, isokinetic strength of the muscle action, not performed in the exercises, was also assessed. Surface electromyography (sEMG) of the vast. lat., vast. med,, and rect. fem. as well as torque were measured. Before and after the strength tests, five single-leg counter-movement jumps were performed on a force plate wearing an inertial sensor system.

The effects of fatiguing muscle exercise type (CON and ECC) and time (PRE and POST) on measures of maximum strength (CON, ECC), sEMG (sum of signals relative to torque), and jump data (height, knee flexion) were analysed by traditional parametric tests and Statistical Parametric Mapping (SPM).

RESULTS: After ECC a significant reduction in the maximum CON strength by 10±12% ($p<.001$) was observed, while the maximum ECC strength remained unchanged. In contrast, after CON significant reductions were found in maximum CON (22±14%, $p<.001$) and ECC (10±11%, $p<.001$) strength. No significant changes in jump height were observed after ECC, while it decreased after CON (17±7%, $p<.001$). Knee flexion during the jump was reduced after CON (11.4±8.3%, $p<.001$) and ECC (10.5±18.7%, $p=.029$).

The angle-specific SPM showed no relevant interaction effects (exercise type x time) for CON and for ECC strength, but significant time effects almost over the entire ROM in both exercise types. In CON strength a main effect for exercise type was found with higher values for the ECC. For sEMG the SPM revealed comparable results (significant interaction and main effects) in CON and ECC strength with higher sEMG increases after CON compared to ECC exercise. The anterior-posterior and vertical force differed between PRE and POST in CON predominately during the mid and late jumping phase, while in ECC no substantial effects were found.

CONCLUSION: Maximum ECC strength remains almost unaffected by ECC exercises, whereas CON strength decreases following both muscle action exercises. The strength losses after CON exercises are more pronounced and affect both muscle actions. Additionally, maintaining post-fatigue torque levels requires increased neuromuscular activation, especially after CON.

The lower acute effects in eccentric fatiguing exercises may have implications for training strategies in rehabilitation and athletic performance optimization.

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## Oral Presentations

### OP-AP08 Machine Learning in Team Sports

**GPS-DERIVED METRICS AND MACHINE LEARNING MODELS FOR INJURY PREDICTION IN PROFESSIONAL RUGBY UNION PLAYERS**

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INTRODUCTION: In sports, injury prevention is a key factor for success. Although injuries are challenging to predict, new technologies and the application of data science can provide valuable insights [1]. This study aimed to predict injury risk among professional rugby union players using machine learning (ML) models and optimized injury prevention strategies by pinpointing effective models and position-specific risk factors.

METHODS: Data from sixty-three professional rugby union players during three seasons were analyzed, categorizing into forwards and backs, further classified into five specific positions (tight five, back row, scrum-half, inside backs, outside backs). The dataset included GPS data and derived metrics such as total workload in the 1, 2, and 3 weeks prior to injury, acute-to-chronic workload ratio (ACWR) over different time windows, monotony, and strain. Five ML classification models—Logistic Regression, Naïve Bayes (NB), Support Vector Machine, Random Forest (RF), and eXtreme gradient boosting (XGBoost) — were applied separately for different player positions to assess injury prediction.

RESULTS: For forwards and backs, NB excelled in recall and balanced accuracy, while RF and XGBoost led in F1 score and AUC. Position-specific analysis showed RF achieving the highest balanced accuracy (0.81) and F1 score (0.68) for tight five players, whereas XGBoost dominated AUC (0.85). Scrum-half positions yielded poor model performance across all metrics. Inside and outside backs saw competitive results from NB and XGBoost, with NB leading in recall (0.69) and balanced accuracy (0.78) for outside backs. Additionally, feature importance analysis highlighted position-specific risk factors: forwards prioritized sprint running (SR, >25 km·h-1) monotony and high-speed running (HSR, 18-21 km·h-1) strain, while backs emphasized low-intensity accelerations and total distance. Tight five players were most influenced by SR monotony and exponentially weighted moving average ACWR 3:14, whereas inside backs relied on very high-speed running (VHSR, 21-25 km·h-1) and accelerations >3 m·s-2.

CONCLUSION: In conclusion, our ML-based approach can effectively predict injuries, particularly when applying a combination of GPS-derived metrics. Additionally, key characteristics indicative of injury risk for players in various positions have been successfully identified. These findings underscored the potential of ML to enhance injury prediction and inform tailored training strategies for athletes.

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**A COMPARATIVE ANALYSIS OF NETWORK METRICS IN MEN'S AND WOMEN'S FIFA WORLD CUPS: EVALUATION OF CONTEXTUAL INFLUENCES ON PERFORMANCE**

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INTRODUCTION: Despite the significant developments in women's football, there remains an excessive parametrization based on men's football, hereby creating a dearth of attention on women players performance and even more so on the disparities in performance between genders. In this study, we compared the women's and men's network metrics at both team and player levels according to contextual factors, aiming to determine how the women's passing performance differs from the men's.

METHODS: We analyzed the 128 matches (2816 observations of players) from the 2023 Women's World Cup and 2022 Men's World Cup. A total of 11 network metrics from both the team's and player's level and five contextual factors were considered. Linear mixed models were used to identify the differences between the men's and women's passing performance. For the team and player level analysis, using Team ranking, Quality of opposition, and Match stage as independent variables, and network metrics as dependent variables, the team as a random effect. For the positional and formation analysis, Gender as the independent variable, network metrics were the dependent variable and team as the random effect.

RESULTS: For the team-level analysis, according to the Team strength, Average Degree, Average Weighted Degree, and Density of the top 16 teams were significantly higher than the bottom 16 teams in both world cups ($p<0.001$). For the Quality of the opposition, only the women's World Cup showed significant differences when facing the top 16 teams ($p<0.001$). According to formation analysis, all the variables showed a significant gender difference ($p<0.05$).

For the player-level analysis, for Team strength, all variables exhibited statistical differences ($p<0.001$). For the analysis of position level, gender differences emerged in most of the variables except for women's Centre Forward ($p<0.05$).

CONCLUSION: The top 16 teams in both cups exhibited better team cooperation, suggesting the possession-based play style (Average Weighted Degree, Average Degree, DENSITY, Closeness Centrality, and Eigenvector Centrality increased). Women's teams' performance is less stable than men's when facing the top 16 teams (Relative to the men's data, the gap between the womens bottom 16 teams and top 16 teams is larger and statistically significant). Better team cooperation and coordination can emerge in men's 1-4-4-2 and women's 1-3-5-2 because the Average Degree, DENSITY, and Average Clustering Coefficient reached the highest level among all formations. Except for CF, most of the positions in the men's World Cup had better passing performance than the women's cup, CB showed a central role in team cooperation in both cups because Weighted-Out Degree, Weighted-In Degree, Weighted Degree, and Out Degree reached the highest level among all positions. This study provides a base for the specific analysis of performance indicators, informing coaches about specific demands of the womens game with consequences for practice design.

**PREDICTION OF NEXT-DAY SUBJECTIVE FATIGUE IN PROFESSIONAL SOCCER PLAYERS: A MACHINE LEARNING APPROACH**

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INTRODUCTION: Predicting the state of fatigue in soccer players is useful to design training and optimize performance. Therefore, the aim of this study was to explore, using a framework of big data analytics, the most important predictors of daily fatigue in a group of professional soccer players using inexpensive and practical data monitoring tools.

METHODS: Six Italian third division (Serie C) professional soccer teams took part in this study, which included a total of 171 players for a total of more than 34.000 data collected. Every morning, the players rated fatigue, sleep quality, muscle soreness, stress and mood. After each training session or match, the session Rating of Perceived Exertion (sRPE) was obtained and multiplied by duration to calculate the Training Load (TL). Finally, some contextual factors, (i.e. distance to previous and next match) were also recorded. Four machine learning models were trained and tested to predict players'

subjective next day fatigue: i) Decision Tree classifier (DTC); ii) XGBoost classifier (XGB); iii) Random Forest Classifier (RFC); iv) Logistic regression (LR), in order to assess their ability to predict the players' daily fatigue.

RESULTS: Machine learning models can accurately predict the players' subjective fatigue (accuracy 79-84%) using practical and inexpensive training monitoring tools. Specifically, in the prediction of next day subjective fatigue, the main influential factor was the fatigue rating of the previous day. The mediation analysis shows a statistically significant direct influence of TL on next day subjective fatigue. This relation is strongly mediated by muscle soreness, sleep quality and stress. The other perceived items do not mediate this relationship.

CONCLUSION: Sport scientists and coaches can use the framework of big data analytics proposed in this paper to predict their players' fatigue status, understanding the influence of other perceptions, judgements and TL characteristics in order to improve the decision-making process when designing a training plan.

In particular, field experts could maximize the training effect by controlling the fatigue status of the soccer players simulating the scheduled training program, in order to maximize players' readiness and reduce the potential drops in performance associated with daily fatigue in a real-world scenario. Finally, this approach can be very useful for practitioners of amateur and grassroots with a limited budget. Both status and internal load measures' data collection, as shown above, is virtually free and it can be taken into account in assessing fatigue by our model.

**ML-BASED SCENE CLASSIFICATION USING TRACKING DATA FOR PLAYER COORDINATION ANALYSIS IN TEAM SPORTS**

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INTRODUCTION: Popular professional sports teams such as soccer and basketball have introduced advanced measurement technology to strengthen their teams. In order to innovate team training, it is necessary to develop a tracking data analysis method that evaluates organizational ability rather than individual ability, and we have developed a method for evaluating cooperation between players using transfer entropy [1]. However, in order to evaluate the validity of the proposed method and make it easier to understand, it is necessary to compare it for each similar play scene such as attack and defense. In this study, we aim to build a system that can evaluate player-to-player coordination while simultaneously classifying scenes from the tracking data of player and ball movement trajectories using a deep learning model.

METHODS: First, we designed a deep learning network to classify scenes from the tracking data of player and ball movement trajectories, and evaluated its accuracy. Based on previous research [2], we applied a convolutional neural network (CNN) that takes the player and ball movement trajectories as input. In this evaluation, we considered using existing professional sports tracking data as training and verification data for building the deep learning model, and applied tracking data from the NBA professional basketball league and the J1 professional soccer league in Japan. In basketball, we classified whether or not a score was scored, and in soccer, we classified whether or not a player entered the area near the goal.

Next, we calculated the transfer entropy between players for each classified scene and evaluated whether the evaluation of cooperation between players in each scene showed the same trend as existing knowledge.

RESULTS: The accuracy of scene classification using tracking data was high, with an AUC of 0.92 for basketball and 0.87 for soccer. We calculated and compared the transfer entropy between players in scenes predicted to have a high probability of scoring opportunities and other scenes. As a result, we found that the transfer entropy of the attacking team of the opposing team was significantly higher in situations predicted to have a high probability of scoring opportunities than in other situations. These results were similar to those obtained in a previous study [1] that used a classification judged by a professional coach to be of high organizational performance.

CONCLUSION: From these results, we confirmed that a deep learning model trained from existing tracking data can accurately classify scenes such as scoring opportunities, making it easier to interpret the evaluation of cooperation between players using transfer entropy, and leading to the development of practical systems.

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**AN INNOVATIVE RPE-BASED APPROACH USING MACHINE LEARNING TO ANALYZE STARTERS AND SUBSTITUTES TRAINING LOAD IN SOCCER**

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INTRODUCTION: Current methods to distinguish starters from substituted are typically based on playing time. Not considering physical demands and internal load of different positions, can leading to inconsequential training and recovery protocols.

The aim of this study was to apply the k-means approach to effectively classify players based on their session-RPE and to provide specific session-RPE thresholds to discriminate starters and substitutes' match load.

METHODS: We analyzed 1,450 player-matches from four professional Italian Serie A teams, using video match analysis to measure total distance (TD) and high-intensity activities: metabolic power events (MPE), high-speed running (HSR), and

very high-speed running (VHSR). Players were divided based on the role as follows: forwards and wingers (FWs), midfielders (MFs), side-backs (SBs), and center-backs (CBs); Individualized sRPE zones (Very Low, Low, Medium, High, Very High) were identified with the K-means clustering approach discriminating starters from substituted.

RESULTS: FWs, MFs, and SBs were considered substituted, and compensatory training was recommended, when the sRPE was within the Medium sRPE zone. However, compensatory training focused on VHSR was recommended at sRPE ≤ low for FWs and MFs, and at sRPE = very low for SBs. CBs were defined as starters when reporting sRPE values ≥ Low sRPE, and VHSR training was always recommended.

CONCLUSION: Implementing this sRPE-based method offers a more accurate assessment of player workloads, enabling tailored compensatory training.

## Oral Presentations

### OP-AP07 Combat Sports

**INTRA & INTER SESSION RELIABILITY OF A NOVEL ISOMETRIC BENCH PRESS ASSESSMENT IN ELITE PROFESSIONAL BOXING ATHLETES**

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INTRODUCTION: Professional boxing is a dynamic combat sport, whereby two competitors exchange punches. A boxing punch is a complex action involving biomechanical and neuromuscular elements, with end range impact resulting from enhanced peak force (PF), impulse, and rate of force development (RFD). Despite similar upper body movement patterns, traditional strength assessments such as the dynamic bench press one repetition maximum are not positively associated with punch impact outcomes, as this does not accurately reflect punching kinetics or kinematics, likely due to the 'sticking point' early in the concentric phase of the motion. To that end, isometric testing assessments potentially offer a more valuable insight into examining end range PF, impulse and RFD at various boxing punch specific joint angles. Therefore, this study aimed to evaluate the intra and inter session reliability of a novel isometric bench press (ISOBP) protocol on force-time characteristics in elite professional boxing athletes.

METHODS: Following a standardised warm-up, ten professional boxers completed the ISOBP three times within sessions, conducted across one familiarisation and two main trials each separated by a period of 48 hours. The ISOBP was conducted within an adjustable isometric rig, at 105° and 145° boxing punch specific joint angles, confirmed by a hand-held 360-degree goniometer. A padded bench was placed over two calibrated force plates to capture PF, impulse, and RFD variables. Multiple intraclass correlation coefficient (ICC) analyses utilising average measure two-way mixed and absolute agreement parameters, alongside typical error and coefficients of variation (CVs) to determine the magnitude of measurement error (≤10% classified as acceptable) were used to assess intra and inter session reliability.

RESULTS: Intra session reliability was good to excellent for PF, force at specific intervals, absolute impulse, and longer-epoch RFD measures (ICCs = 0.86-0.99; CVs = 2.0-9.3) at both angles. Inter session reliability was also good to excellent for PF and absolute impulse <100ms at 105° (ICCs = 0.89-0.96; CVs = 3.6-4.3). However, reliability was poor for all RFD, most net force and impulse outcomes, and shorter-epoch measures.

CONCLUSION: The ISOBP demonstrated reliable intra session measurement of PF, interval-specific force, absolute impulse, and longer-epoch RFD, making it useful for evaluating strength training effectiveness and setting performance benchmarks. However, for longitudinal monitoring only inter session PF and impulse <100ms in the 105° ISOBP were reliable, so other variables should be interpreted with caution. For outcome metrics with poor inter session reliability, standardisation of protocol conditions, testing frequency and incorporating additional measures of neuromuscular function are critical to provide a more global view of an athlete's capacity or progress. This approach, along with the use of typical error scores, ensures that observed changes reflect actual improvements alternate to natural variability in performance.

**RELATIONSHIP BETWEEN A FORCE-VELOCITY-POWER PROFILE IN LANDMINE PUNCH EXERCISE AND BOXING PUNCHES FORCE AND VELOCITY.**

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INTRODUCTION: In boxing, force and velocity of punches are discriminating performance parameters (Lenetsky et al., 2018; Loturco et al., 2016). A recent study has validated a force-velocity-power (FVP) profile for a landmine punch exercise (LPE), having technical similarities with a boxing punch which could be helpful for a simple training monitoring (Gusciglio & Morin, 2023). However, the FVP profiles parameters obtained (F0, V0 and Pmax) were not analyzed in relation to punches force and velocity, which was the objective of this study.

METHODS: 27 experimented boxers (23.9± 4.4 years old, 75.8± 10.2kg) performed LPE with a 10kg bar consisting in 2 sets of 4 repetitions with an additional load corresponding to 20% and 50% of their body mass (Gusciglio & Morin, 2023). An accelerometer (Delsys, USA, 500Hz) was fixed to the bar to record its acceleration and determine its linear velocity. Theorical mechanical parameters of FVP were calculated using a custom-made spreadsheet (F0, V0, and Pmax). Participants

also performed 6 rear cross and hook punches with maximal intensity and their habitual technique on a 3D force plate (AMTI, USA, 2000Hz) fixed to a vertical support and covered by a body shield. A kinematic marker was placed on the rear arm glove at the 1st metacarpal level to registered punches 3D velocity (Qualysis, Sweden, 200Hz). Maximal punches velocity and force impulse were determined. Pearson's correlations were made to investigate the relationship between these variables and FVP theorical parameters. Fisher's z was calculated to determine the effect size.

RESULTS: LPE F0 (10.6 ± 1.5 N/kg) was significantly correlated with cross (51.7± 10.9N.s; $r^2$=0.29; ES=0.61; p<0.01) and hook force impulses (41.4± 14.8N.s; $r^2$=0.33; ES=0.65; p<0.01). LPE V0 (3.2± 0.42m/s) was significantly correlated with hook velocity (14.5± 1.3m/s; $r^2$=0.2; ES=0.48; p=0.02) but not with cross velocity (9.9± 0.6m/s; $r^2$=0.15; p=0.051). LPE Pmax (8.6± 1.6 W/kg) was also significantly correlated with cross ($r^2$=0.22; ES=0.51; p=0.02) and hook force impulse ($r^2$=0.24; ES=0.53; p=0.01) but only with cross velocity ($r^2$=0.28; ES=0.60; p<0.01).

CONCLUSION: F0 and Pmax of LPE are significantly correlated with the impulse of rear hook and cross punches but V0 was only significantly correlated to cross velocity. Thus, LPE seems to be an effective, fast and low-cost tool to help monitoring the force and power development of boxers. Nonetheless, the moderate correlation magnitudes should be considered and could be influenced by the movements' technical differences, where LPE requires a higher vertical component. It might be interesting to develop a FVP profile on a movement simulating a punch with different loads attached to a pulley and replicate this study.

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**RAPID WEIGHT LOSS, TECHNICAL PERFORMANCE, SCORING EFFICIENCY, AND COMPETITIVE SUCCESS IN ELITE JUDO ATHLETES**

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INTRODUCTION: Rapid weight loss (RWL) is a common strategy among combat sports athletes [1]. While previous studies have explored the impact of RWL on strength, endurance, and decision-making [2], its relationship with specific performance variables remains unclear. Therefore, this study investigated the correlation between RWL and key performance indicators in judo.

METHODS: Thirty-three judo athletes (age: 21.0 ± 2.2 years; judo grade: 1st dan) competing at national and international levels were monitored during an official competition. Body mass (BM) was recorded 10, 7, and 3 days before the weigh-in, on the day of the weigh-in, and competition day using a Tanita BC-558 scale with a precision of 0.1 kg. The BM reduction was calculated from seven days before the weigh-in to the official weigh-in. Performance metrics were assessed as follows: winning rate - the ratio of matches won to total matches competed; number of attacks per match - the total number of attacks divided by the total matches performed; technical variability - attack diversity, considering different attack sides and directions; and scoring index - the total points scored divided by the total number of attacks, reflecting scoring efficiency. Pearson correlation analyses were conducted to assess the relationship between the magnitude of RWL and performance variables, whereas logistic regression was used to analyze the association between BM reduction and medal success. A significance level of $p < 0.05$ was applied.

RESULTS: BM reduction over the seven days before weigh-in (4.1 ± 1.6%; 3.9 ± 1.5 kg) showed no significant correlation with winning rate (r = 0.015, 95%CI: -0.33, 0.36, p = 0.935), number of attacks per match (r = 0.012, 95%CI: -0.33, 0.35, p = 0.947), nor technical variability (r = -0.077, 95%CI: -0.41, 0.27, p = 0.669). However, a significant negative correlation was observed between BM reduction and the scoring index (r = -0.392, 95%CI: -0.65, -0.07, p = 0.024). Additionally, a greater BM reduction during the analyzed period increased the likelihood of winning a medal (OR = 1.63; 95%CI: 1.04, 2.56; p = 0.033).

CONCLUSION: Although BM reduction over the seven days before weigh-in did not significantly influence the winning rate, number of attacks, or technical variability, it was negatively associated with the scoring index. This finding suggests that greater BM reduction may impair scoring efficiency. Moreover, logistic regression indicated that greater BM reduction over ten days increased the odds of winning a medal.

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[1] Artioli et al. (2010) Med Sci Sports Exerc. 42(3), 436-442; [2] Dos Santos et al., (2024), Phys Act Nutr. 28(3).

**OPTIMAL VS MEASURED FORCE-VELOCITY PROFILE AND CORRELATIONS OF ITS MECHANICAL OUTPUTS WITH GENERAL AND SPORT-SPECIFIC PERFORMANCE TESTS AMONG ADOLESCENT FENCERS**

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INTRODUCTION: Rate of force development and power output are crucial in combat sports (Turner et al., 2020). Fencing actions are executed in <300ms, confirming the importance of neural factors and intrinsic muscle properties during the initial phase of contraction. Force Velocity Profile (FVP) in adolescent fencers can therefore allow the exploration of their neuromuscular function limits, since adult fencers differed significantly from their optimal FVP (Giroux et al., 2016).

METHODS: Eighteen fencers (age: 14.6±1.1 years, maturity offset (MO): 1.18±1.38 years, training experience (TE): 7.5±2.1 years) carried out, anthropometric, countermovement jump (CMJ), long jump (LJ), 5m sprint (S5) and change of direction fencing test (COD). Measured and optimal FVP were evaluated via unloaded and loaded squat jumps (SJ) of 20, 40 and 60% body weight. Best trial with each load was retained for the FVP assessment through a linear computation model (Samozino et al., 2008). Maximal theoretical measured and optimal force (F0 & F0th), velocity (V0 & V0th) and FVP slope (Sfv & Sfvopt), maximal power output (Pmax) and force-velocity imbalance (FVimb) were computed. Angle of optimal FVP slope was set at 30°, which corresponds to the push-off angle during lunge execution (Giroux et al., 2016). Depended variables T-test was used to investigate differences between FVP measured and optimal mechanical outputs. Pearson correlation (bivariate and partial controlling MO and TE) coefficients (r) was used to evaluate relationships of FVP mechanical outputs with anthropometric measurements and performance tests. Significance was set at p<.05.

RESULTS: Significant differences were revealed between measured and optimal force (28.36±5.31 vs 41.4±7.69 N/Kg, t=-6.06, d=-1.97, p<.001), velocity (4.41±1.63 vs 2.87±0.39 m/s, t=4.962, d=1.3, p<.001) and slope (-7.47±3.39 vs -14.42±24.44 N*s/m*kg, t=7.699, d=2.57, p<.001). Bivariate correlations showed significant relationship of TE with FVimb (r=.479, p<.05) and body fat with Pmax, F0th and V0th (r=-.520~-.554, p<.05). Performance tests except S5 were significantly correlated with V0th (r=-.567~.768, p<.02) and Pmax (r=-.607~.608, p<.01). F0th was correlated only with SJ (r=.511, p<.05) and COD (r=-.605, p<.01). Partial correlations, enhanced the aforementioned correlations revealing a new one between LJ and F0th (r=.526, p<.05).

CONCLUSION: Adolescent fencers' FVP differed significantly (force and velocity) from their optimal one. Performance correlations with Pmax, highlights its crucial role in sports like fencing. Since most of the fencers had a high force deficit and their performance correlated only with F0th and V0th, training must enhance their force qualities in order to optimize their gains. Partial correlations revealed the crucial role of MO and TE on moderating fencers' neuromuscular performance during adolescence.

1. Turner et al., (2020) 2. Giroux et al., (2016) 3. Samozino et al., (2008)

**COMPARISON OF PHYSIOLOGICAL RESPONSES AND PERFORMANCE DECLINE BETWEEN A SIMULATED WRESTLING BOUT AND A NOVEL SPORT-SPECIFIC HIGH-INTENSITY TEST IN ELITE GRECO-ROMAN WRESTLERS**

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INTRODUCTION: Greco-Roman wrestling is a demanding sport requiring high levels of strength, power, anaerobic endurance and aerobic capacity to sustain high-intensity efforts with limited recovery during training and competition [1, 2]. This compared the physiological responses and performance decline between a simulated wrestling bout and a novel sport-specific high intensity laboratory test (HIT).

METHODS: Seven elite Greco-Roman wrestlers (age: 26.1 ± 8.8 yrs, BMI: 27.3 ± 3.8 km/m2). completed two main tests: one in the laboratory where the HIT was conducted, and another on the wrestling mat, where a simulated wrestling bout (WRE) was performed. Both tests included 6 min of exercise time allocated in two 3 min rounds, with 1 min rest in between. In WRE each round included 2 x 1.5 min wrestling separated by 30 s or rest. In HIT each round consisted of 2 x [20s wrestling movement + 10s rest] followed by 30s of maximum isometric pull on a seated rowing machine. The wrestling movement included back and forth body motion between a baseline and three light sensors placed 1.8 m to the front, front-right and front-left of the wrestler (at 30o angles). The light sensors were touched as fast as possible in a random order determined by a computer. The number of successful touches and the force applied during the isometric pull were recorded. Counter-movement jump (CMJ) and handgrip strength (HaG) were evaluated before the first and after the second round. Blood lactate (BL) was measured at rest, between the two rounds, immediately after and 3 min after the second round. Heart rate (HR) was monitored continuously from the start until the first minute of recovery.

RESULTS: A two-way ANOVA showed a significant 14.5 ± 4.5% decrease in CMJ after HIT (p<0.003), whereas a smaller, non-significant decrease was observed after WRE (6.2 ± 6.8%, p=0.103). HaG declined similarly in both tests (11.9 ± 5.1%, p=0.01). BL increased equally in HIT and WRE by the end of each test (17.1 ± 1.5 vs. 15.0 ± 2.6 mmol/L in HIT and WRE, respectively), but remained higher 3 min post HIT compared to WRE (15.8 ± 1.3 vs. 15.0 ± 2.9 mmol/L, p=0.04). Average pull force decreased by 21 ± 14% only in the second round in HIT. Peak HR reached 96.1±0.4% and 96.8±3.2% of HRmax during HIT and WRE, with HR remaining above 90%HRmax for 5.3 ± 1.0 and 5.8 ± 2.6 min in each test, respectively.

CONCLUSION: The HIT closely replicated the physiological demands of a competitive 2×3 min Greco-Roman wrestling bout and may serve as a valid tool for assessing sport-specific fitness in wrestlers. The high physiological demands of Greco-Roman wrestling were evident in this study and may inform the design of effective sport-specific training programs.

1. Skugor et al. (2023). J. Funct. Morphol. Kinesiol, 8, 90

2. Markovic et al. (2022). J. Hum. Kinetics, 83: 267-276

# Oral Presentations

## OP-PN26 Mixed Physiology - Sleep, Brain and Blood Biomarkers

### EFFECTS OF SWIMMING PRACTICE AT NIGHT ON SLEEP IN MALE SWIMMERS

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INTRODUCTION: For athletes, both intense exercise and adequate recovery are important to improve performance (Laursen, 2010; Bird, 2013). Inadequate quantities and quality of sleep following exercise can lead to impaired muscle functions and recovery of endurance performance (Fullagar et al., 2015). Previous studies have shown that high-intensity exercise at night reduces sleep quality (Oda and Shirakawa, 2014; Aloulou et al., 2019). However, these studies utilized land exercise (e.g., running, cycling), and the effects of swimming on sleep have not been elucidated. Therefore, the purpose of the present study was to clarify the effect of swimming exercise at night on subsequent sleep quality. We hypothesized that swimming exercise at night would disrupt sleep quality.

METHODS: Ten male swimmers (mean±SD; age: 19.9±1.3 yrs, height: 174.6±4.8 cm, weight: 69.0±5.1 kg) performed two trials on different days with a randomized, counterbalanced order. Between 6:30 p.m. 8:30 p.m., participants performed either (i) a 2h swimming practice session including high-intensity exercise (SWIM) or (ii) maintaining the rest without exercise (CON). Subsequently, participants in both trials took a shower and ate prescribed dinner at the same time, and then slept from 11 p.m. to 7 a.m. Blood lactate concentrations were measured before and immediately after exercise (or rest). Moreover, core body temperature was measured continuously using a pill thermometer from 30 min before exercise (or rest) until the next morning. Sleep quality was assessed using electroencephalograms (EEG).

RESULTS: Blood lactate concentrations markedly increased after exercise (pre: 1.9±0.6 mmol/l vs. after: 20.3±3.9 mmol/l, $p<0.001$ ). Mean core body temperature was significantly elevated during the swimming exercise compared to CON (SWIM: 37.8±0.4°C vs. CON: 37.1±0.2°C, $p<0.001$). However, no significant difference between conditions was found at bedtime (11 p.m.) and during sleep. Total REM sleep time was significantly decreased in SWIM compared with CON (SWIM: 82.4±27.1 min vs. CON: 107.6±39.5 min, $p=0.039$). However, other sleep variable (time of stage N1, 2, 3, total sleep time, sleep efficiency, sleep onset latency, REM sleep latency and wake after sleep onset) did not significantly differ between trials.

CONCLUSION: Strenuous swimming practice at night (6:30 p.m.-8:30 p.m.) increased core body temperature but it did not change markedly sleep quality in male swimmers.

### EFFECT OF PRE-SLEEP ALPHA-LACTALBUMIN SUPPLEMENTATION ON THE HABITUAL SLEEP AND PERFORMANCE OF SPORTSPEOPLE WITH SLEEP DIFFICULTIES.

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INTRODUCTION: Up to 78% of athletes report poor quality sleep, with the average athlete obtaining less than seven hours per night (1). Acutely, insufficient sleep impairs technical and tactical performance, with the accumulation of sleep debt also seen to affect endurance (2, 3). As a result, poor-sleeping athletes are particularly vulnerable to performance decline. Prior research within poor-sleeping individuals suggests that the acute supplementation of a whey protein rich in the amino acid tryptophan (TRP), alpha-lactalbumin (ALAC), may be an effective strategy to improve sleep and physical performance (4, 5). Therefore, this study investigated whether sub-chronic supplementation of ALAC in the evening would improve the sleep and physical performance of a poor-sleeping athletic population.

METHODS: Twenty-four athletically trained participants (females, n=7) with sleep difficulties (Athlete Sleep Screening Questionnaire: 8.6 ± 2.2, Pittsburgh Sleep Quality Index: 10.0 ± 3.0) completed this double-blinded, counterbalanced, randomised, cross-over trial. Participants were supplemented with 40 g of ALAC (1.9 g TRP) or an isocaloric placebo two hours prior to individualised bedtimes for seven consecutive nights within habitual settings. To minimise dietary influences on TRP levels, participants consumed standardised low-protein dinners (0.2 g/kg body weight) two hours prior to the supplement, with habitual diet replicated across trials. Sleep was assessed nightly using actigraphy, while subjective sleepiness, mood, and recovery questionnaires were completed every morning and evening. Following the seven-day supplementation period, physical performance testing was completed (i.e., 30-second countermovement jump test, Yo-Yo Intermittent Recovery Test Level 1, and reaction time) at Deakin University in a standardised sequence under controlled conditions.

RESULTS: Compared to control, objective number of awakenings were increased (CON: 10.25 ± 5.28, ALAC: 11.01 ± 5.79; $p=0.031$), average jump height was reduced (CON: 28.58 ± 5.53 cm, ALAC: 27.68 ± 5.14 cm; $p=0.037$), subjective physical and mental performance capability were declined in the evening ($p<0.001$), and evening negative emotional states ($p=0.001$) were reduced during the ALAC condition. No other sleep, performance, or subjective outcomes were influenced following ALAC supplementation.

CONCLUSION: Seven days of ALAC supplementation may not improve the sleep and physical performance of an athletically trained population with mild-moderate sleep difficulties. Future research should recruit populations with more severe

sleep difficulties and measure sleep architecture over an extended period to fully ascertain the effects, and potential benefits, of ALAC supplementation for athletes.

(1) Walsh et al. 2021; (2) Fullagar et al. 2015; (3) Roberts et al. 2019; (4) Miles et al. 2021; (5) Gratwicke et al. 2022

**RANGER SALIVARY HORMONE ASSESSMENT FOR DEPLOYED RESILIENCE AND PERFORMANCE PLUS EVALUATION OF NOCTURNAL ENDOCRINE RECOVERY (SHARP+ENER) STUDY**

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INTRODUCTION: During military training, physical activity and psychological stress drive increased average cortisol levels and glucose mobilisation which, if sustained, may impair physical and mental health. An inverse relationship is commonly observed between cortisol and androgens which may impede physical and mental training outcomes. This study aimed to explore cortisol, androgen and glucose changes during the RANGER Assessment Cadre (RAC), a 10-day advanced selection course where candidates undergo intense exercise for selection into this elite regiment.

METHODS: Observational study of glucocorticoid and androgen profiles, overnight glucose, stress and sleep during the RAC. Saliva was sampled at 0530, 0700, 1500, 1800 and 2200 on days 1 and 10, continuous interstitial glucose (Dexcom G7) and physical activity and sleep (GENEActiv) were measured throughout. Perceived stress scale (PSS) and Connor-Davidson Resilience-10 (CDRISC-10) were measured on days 1 and 10. Salivary cortisol, cortisone, testosterone (T), androstenedione (A4) and dihydroepiandrostenedione (DHEA) were measured via tandem mass spectrometry. Morning cortisol rise (0530 to 0700) and areas under the 5-point day curve (AUC) were calculated. Days 1 and 10 were compared using t-tests.

RESULTS: 17 men completed the study, aged 22 ±8 years. From day 1 to 10, morning cortisol rise and area under the curve (AUC) cortisol decreased (d 1.81, d 0.67, both $p<0.05$), and morning cortisol:cortisone ratio decreased (d 0.99, $p=0.03$) but did not change at other times of day ($p>0.3$). We found no change in morning androgens ($p>0.7$) but a marked increase in evening T, A4 and especially DHEA (d 0.91, d 1.5, d 5.3, respectively, $p<0.0001$; 13.3- fold rise in DHEA, 18.6-fold rise in DHEA:cortisol ratio). Mean overnight glucose increased (4.3±1.0 mmol/L vs 5.2 ± 0.9 mmol/L, $p<0.001$). Participants slept 6.2±2.2 hours per night including 1.7±1.3 hours on night 5. PSS and CDRSIC-10 were 11 ±5 and 34 ±4 respectively on day 1 and did not change by day 10 ($p>0.7$).

CONCLUSION: After an arduous 10-day cadre, morning cortisol and cortisol:cortisone decreased and evening cortisol was unchanged, yet overnight hyperglycaemia was demonstrated, suggesting metabolic dysregulation and increased average cortisol exposure. A dissociated cortisol-androgen response, with a pronounced rise in evening preandrogens, is a novel finding and may represent a buffering response to preserve the cognitive impact of sleep deprivation.

**THE EFFECTS OF CONTACT FOOTBALL ON BLOOD BIOMARKERS OF BRAIN INJURY AND CEREBROVASCULAR FUNCTION**

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INTRODUCTION: The association between increased brain blood biomarker concentration and concussion in collegiate contact sport athletes [1] supports the notion that repetitive trauma causes blood brain barrier disruption [2]. Blunted heart rate (HR) and blood pressure (BP) in concussed athletes during sympathetic nervous system (SNS) activation reveals that alterations in cardiovascular function occur following a mild brain injury [3]. Lower body negative pressure (LBNP) is a widely used approach to acutely increase SNS activity. Additionally, hypercapnia is used to assess vasomotor capacity of the brain. Thus, this study aimed to assess cardiovascular and cerebrovascular health in junior Canadian football athletes during a season, using blood biomarkers glial fibrillary acidic protein (GFAP) and neurofilament light polypeptide (Nf-L) as an index of injury, and to also evaluate cardiorespiratory and cerebrovascular function during LBNP and hypercapnia. We hypothesized that biomarkers would be elevated post-game compared to pre-game; and cardiorespiratory and cerebrovascular responses to LBNP and hypercapnia would be blunted post-season compared to pre-season, indicating a potential relationship between contact sport, cardiorespiratory and cerebrovascular function.

METHODS: 14 male junior football athletes had venous blood samples collected 24hrs pre- and 12hrs post-game, which were analyzed for GFAP and Nf-L. Cardiorespiratory and cerebrovascular responses to LBNP (-20, -40, and -60 mmHg) and 3-minute stages of hypercapnia (+5 and +10 mmHg; end tidal forcing system) were evaluated by measuring HR (electrocardiogram), BP (finger photoplethsmography) and blood velocity in the middle and posterior cerebral artery (MCA & PCA; transcranial doppler ultrasound).

RESULTS: GFAP concentration increased from 45.88+16.70pg/ml pre-game to 53.99+32.89pg/ml post-game ($P=0.004$). Nf-L trended towards a decrease ($P=0.06$). During LBNP, no changes in MCAv or PCAv were observed from baseline to -60 mmHg in both the pre- and post-season (both days; $P>0.9$). Mean arterial pressure (MAP) remained stable, while HR increased with intensity ($P<0.009$) and was elevated post-season compared to pre-season at –60 mmHg of LBNP ($P<0.02$). The MCAv and PCAv response to hypercapnia did not change post-season compared to pre-season (MCAv, $P>0.9$; PCAv, $P>0.3$). Also, HR and MAP increased with hypercapnia, but there was no difference when comparing post-season to pre-season response. (HR, $P>0.1$; MAP, $P>0.2$).

CONCLUSION: This data demonstrates that GFAP acutely increases after a game of contact football, potentially indicating mild brain injury occurrence without a concussion diagnosis. Despite this rise in GFAP, only the HR response to LBNP was different post- compared to pre-season, as no differences in the cerebral blood flow response to LBNP and hypercapnia were observed. The clinical implications of these findings remain to be fully elucidated.

References:

1. McCrea et al. (2020) 2. Marchi et al. 2013 3. Johnson et al. (2020)

**CATECHOLAMINE, STEROID, AND GROWTH HORMONE RESPONSES TO LOW-LOAD BLOOD FLOW RESTRICTION AND HIGH-LOAD RESISTANCE EXERCISE IN WELL-TRAINED MEN**

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INTRODUCTION: Low-load resistance exercise performed with blood flow restriction (LL-BFR) is often used as a substitute for traditional high-load resistance exercise (HL-RE) for stimulating muscular hypertrophy and strength adaptations, and can induce robust elevations in salivary endocrine markers (1,2). Whether LL-BFR induces greater blood-derived hormonal responses than HL-RE has yet to be investigated in individuals of a higher resistance training status and is of particular importance should LL-BFR be sought for use with healthy athletic populations. Therefore, the purpose of this study was to compare acute testosterone (T), cortisol (C), epinephrine (EPI), norepinephrine (NE) and 22kDa growth hormone (GH) responses to LL-BFR and an ecologically valid bout of HL-RE in well resistance-trained individuals.

METHODS: Twelve healthy resistance-trained men ($\bar{x}$±SD: age=24.1±3.6yr; body mass=88.6±13.8kg; back squat 1RM=162.5±40.6kg) performed acute bouts of bilateral seated leg extensions consisting of 4 sets taken to momentary task failure with either low-load (30%1RM) and continuous BFR (LL-BFR) or high-load (70%1RM) and no BFR (HL-RE). A randomized crossover design with a 1-week rest period was used with time of day matched within-subjects. Upon arrival between 1200-1800, an antecubital vein was cannulated by certified phlebotomists and a 30min passive rest commenced where 24hr dietary recalls were performed by a registered dietician, followed by the pre-exercise blood draw. Blood was then sampled within 60sec (IP) and again at 5min post-exercise (+5min). Concentrations of T, C, EPI, NE, and GH were quantified via enzyme-linked immunoassays with intra- and inter-assay coefficients of variations for all analytes <5%, and <6%, respectively. Paired-samples t-tests compared total repetitions (REPS) completed and the volume-load lifted (V-L) between conditions, with 2x3 (Condition x Time) repeated measures analyses of variance performed for all analytes.

RESULTS: Greater REPS (d=2.37, p<.001) and less V-L (d=2.86, p<.001) was performed during LL-BFR. No significant Condition x Time interaction effects were found for any hormone measured (p>.05). Both LL-BFR and HL-RE elicited significant elevations in T, C, EPI, NE, and GH, evidenced by significant main effects for Time (p<.05).

CONCLUSION: LL-BFR and HL-RE both notably elevate the potent ß2 adrenergic receptor (ß2AR) agonist EPI (IP: 1.29±0.44 and 1.35±0.60nmol·L-1, respectively), and the androgenic steroid T (+5min: 27.4±12.9 and 29.0±14.3 nmol·L-1, respectively). Thus, skeletal muscle ß2AR mediated hypertrophic signaling cascades may be comparable following acute bouts of LL-BFR and HL-RE. When exposure to lower RE intensities and resultantly less V-L is desired, athletes may perform LL-BFR in place of HL-RE and experience no statistical difference in acute hormonal responses.

REFERENCES:

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2. Luebbers et al., 2025. doi: 10.3389/fphys.2024.1507445

## Oral Presentations

### OP-SH14 Decision Making

**EXPLORING THE DYNAMICS OF GROUP DECISION-MAKING ADVANTAGES ACROSS VARIOUS SPORT TYPES THROUGH SFT AND LBA**

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30th Annual ECSS Congress Prague/Czech Republic

Exploring the Dynamics of Group Decision-Making Advantages Across Various Sport Types Through SFT and LBA

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INTRODUCTION: Previous research has extensively examined the cognitive advantages at the individual level that athletes develop through their specific sport. However, these advantages at the group level remain underexplored. This study

investigates how sport type (team vs. individual) influences group decision-making and hypothesizes that team sport athletes will exhibit superior group decision-making abilities compared to individual sport athletes.

METHODS: 60 collegiate athletes participated, half from individual sports (track and field, swimming) and half from team sports (basketball, soccer, volleyball). Athletes were paired within the same sport type as a dyad and completed a visual search task both collaboratively and individually. We used AAND(t) from Systems Factorial Technology, a measure that compares group and individual performance while accounting for both information efficiency and accuracy, and vDiff from the Linear Ballistic Accumulator, which assesses the differences in information accumulation rate, a parametric measure of group decision making benefit, across the two sport types.

RESULTS: Although RT, accuracy, and vDiff showed no significant differences across group, the AAND(t) revealed that the benefits of group decision-making were greater for team sport athletes than for individual sport athletes in the earlier time intervals. This suggests that the group decision-making benefits of team sport athletes emerge primarily in the early processing stages.

Discussion: The results indicate that the dynamic and interactive nature of team sports may enhance athletes ability to navigate complex and fast-paced decision-making scenarios. These findings highlight the potential of sport-specific cognitive training in shaping decision-making skills, particularly within team sport environments.

**COMPARING THREE NEAR-THE-END SESSION TIMEPOINTS ON SHORT TERM REMEMBERED AFFECT IN CONTINUOUS AEROBIC ACTIVITY**

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Affect-related cognitions such as remembered affect (i.e., how pleasant/unpleasant an exercise session is recalled) have been associated with future exercise behavior. However, memories of an episode steadily decrease in time after its termination, leaving it prone to heuristics and biases. The peak and end rule is a theoretical postulate proposing that the affective peaks and end encountered influence how an episode will be affectively remembered. Research in the exercise context has supported this influence but with considerable heterogeneity in what should be considered end affect and, therefore, what moment of the end of the session can better predict remembered affect. In light of this, the objective of the present study was to investigate the predictive power of three near-the-end session time points (during, immediately after, and one minute after completion) on remembered affect, in three continuous aerobic sessions performed with different intensities.

This experimental study involved 36 physically active males (Mage = 27.92; SD = 5.82 years) performing three 17-minute treadmill exercise sessions at different intensities (i.e., light, moderate, and vigorous) in a counterbalanced order. The affective response was measured seven times with the Feeling Scale but only the right before the end of the fundamental phase (FS5; 15'45"), immediately after the fundamental phase (FS6; 16'), and one minute after the fundamental phase (cool-down; FS7; 17') measures were used for this study. Remembered affect was measured two minutes after finishing the protocol with a Visual Analog Scale. Single linear regression analyses were applied across intensities with FS5, FS6, and FS7 as the dependent variables to test which near-the-end moment was the best predictor of remembered affect.

All three near-the-end time points significantly predicted remembered affect across the different exercise intensities. In the light-intensity session, FS5 was distinctively the best predictor (47%; 24% for FS6; 18% for FS7), also accounting for more variability (42%) than the other time points in the moderate-intensity session (35% for FS6; 20% for FS7). However, in the vigorous-intensity session, FS6 was the best predictor (59%), with the other moments also demonstrating considerable explanatory power (50% for FS5; 46% for FS7).

The affective response at the end of a continuous aerobic exercise session can predict how pleasant or unpleasant it will later be recalled. However, the last measurement during the fundamental phase was the best remembered affect predictor with light and moderate intensity, while for vigorous intensity, the measurement immediately after the fundamental phase presented the higher explanatory power. These nuances should be considered by practitioners when organizing an aerobic exercise session, particularly regarding the chosen intensity at the end of the fundamental phase and its potential consequences on how the session will be later recalled.

**MAIN EFFORT MANAGEMENT STRATEGIES IN SHORT TRAIL RUNNING: QUALITATIVE ANALYSIS BY SELF-CONFRONTATION**

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INTRODUCTION: Trail races are endurance running events characterized by many constraints (distance, positive altitude difference, obstacles, technicality, …) that the runner must manage efficiently to perform well. To optimize effort management in this context, it is necessary to understand how trail runners' particular possibilities for feeling, thinking and acting which are embedded in the race topography, environment and circumstances. A qualitative approach using the self-confrontation method would appear to be a very appropriate way to investigate the main effort management strategies used by runners in the specific context of short trail running.

METHODS: 7 subjects participating in a short trail race (10 to 30km) were equipped with a GoPro, a Garmin watch and a Stryd accelerometer to record traces of their activity (video, GPS data, heart rate and stride frequency). In the 5 days following the race, each subject participated in a self-confrontation interview. They were asked to describe for each relevant

event what they feel, think and the decisions they make according to race chronology. Triangulation procedure and thematic analysis were used to determine main effort management strategies during short trail race. Analyses were performed using the Grand Unified Theory (GUT) model as a theoretical framework (Glazier, 2017).

RESULTS: Four major effort management strategies emerge from our results, three of which relate directly to the choices made by the runner (adaptation strategies; anticipation strategies; and automated behaviors or habits) and one of which concerns his/her level of vigilance (focused to unfocused). We also identified 10 critical elements that were directly concerned by the strategies: (a) running pace, (b) running pattern, (c) choice of trajectory and course, (d) positioning in relation to others, (e) equipment, (f) nutrition and hydration, (g) external interactions, (h) well-being and comfort, (i) preparation and training, and (j) goal and performance. All these various critical elements may be affected by one or more strategies at the same time. The analysis also identified the main key moments during the race and their chronology.

CONCLUSION: The results of this qualitative research were successful to identify main effort management strategies during short trail running. The data from this study provide a better understanding of how runners control themselves throughout the race, especially in delicate moments. Knowledge and proper use of these strategies could be used to optimize performance.

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**RESTING-STATE BRAIN FUNCTION IN COLLEGE STUDENTS ENGAGED IN COMBAT SPORTS: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: Long-term physical exercise is known to induce changes in brain plasticity. While extensive research has examined the effects of aerobic exercise, basketball, and badminton on brain plasticity in college students, the impact of combat sports on brain function remains underexplored. Combat sports, due to their high intensity and mental demands, may have unique effects on neuroplasticity. This study aims to investigate the influence of combat sports participation on brain function in university students, addressing a gap in the current literature.

METHODS: This study included three groups of participants. The experimental group consisted of 14 university students (8M6F, aged 20.9 ± 2.3 years) who practiced Combat Sports (Taekwondo, Judo, Brazilian Jiu-Jitsu, Chinese kickboxing, Muay Thai) for an average of 2.4 ± 0.9 years. The aerobic exercise group had 15 students (9M6F, aged 22.0 ± 2.3 years) with 2.2 ± 1.0 years of aerobic exercise experience. The sedentary control group included 17 participants (7M10F, aged 20.3 ± 1.2 years) who exercised less than 3 times per week. All participants provided informed consent and met the inclusion criteria for their respective groups. All participants were right-handed, free of major medical conditions, and had no contraindications for MRI scanning. Brain imaging data were acquired using a Philips 3T scanner with a 32-channel standard head coil. T1-weighted images (T1WI) were collected to capture structural brain signals. Additionally, echo-planar imaging (EPI) sequences were used to acquire resting-state blood-oxygen-level-dependent (BOLD) signals. During the scanning session, participants were instructed to "relax and not think about anything, keep their eyes closed and stay awake." The data were preprocessed using RestPlus12 software, followed by the calculation of fractional Amplitude of Low-Frequency Fluctuations (fALFF). Based on previous research, regions of interest (ROIs) were defined in the left premotor cortex (PMC), supplementary motor area (SMA), dorsal premotor cortex (dPMC), mid temporal gyrus (MTG), and bilateral hippocampus(Hipp). The fALFF signals from these ROIs were extracted for statistical analysis. A one-way ANOVA was first conducted to compare the three groups, followed by pairwise comparisons using t-tests.

RESULTS: The ANOVA revealed significant differences among three groups in PMC ($F = 13.509$, $p = 0.000$), dPMC ($F = 5.809$, $p = 0.006$), MTG ($F = 5.013$, $p = 0.011$), HippL ($F = 10.338$, $p = 0.000$). The Combat group exhibited significantly higher fALFF than the controls in the left PMC ($p < 0.001$), SMA ($p = 0.05$), dPMC ($p = 0.008$), and MTG ($p = 0.004$). Additionally, compared to the aerobic group, the Combat group demonstrated higher fALFF in the left dPMC ($p < 0.001$), while lower fALFF in the HippL ($p = 0.017$).

CONCLUSION: The current findings may suggest that long-term participation in Combat Sports leads to functional reorganization and optimization in brain regions related to mo

**A RANDOMIZED, CONTROLLED TRIAL INVESTIGATING THE ACUTE NEUROCOGNITIVE EFFECTS OF AEROBIC EXERCISE ON HOT ASPECTS OF COGNITIVE CONTROL IN YOUNG ADULTS**

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Background: Evidence suggests that moderately-intense exercise elicits temporary improvements in cool aspects of cognitive control. In contrast, the sensitivity of its hot components, including risky decision making and regard processing, still remains unclear. These cognitive abilities have a unique predictive value for decision making in motivationally significant situations and for the avoidance of unhealthy behaviours among young adults in particular. We examined the effects of a single bout of aerobic exercise on risky decision making and underlying cognitive processes by combining behavioural and neurocognitive assessments. Additionally, we investigated exercise-induced effects on response inhibition to contrast benefits for cool and hot aspects of cognitive control.

Method: 60 participants (aged 24.0 ± 2.9 y) were randomly allocated to an intervention group, who performed 20 min moderately-intense running on a treadmill, and a control group, who watched a video. Computer-based and modified versions of the Go/NoGo task and Iowa Gambling task were administered before and after these sessions. The feedback-related negativity (FRN) and P300 components of event-related brain potentials elicited by wins and losses during the Iowa Gambling task were recorded with electroencephalography.

Results: We found no group differences in pre- to posttest changes in error rates on the Go/NoGo task and learning of long-term consequences on the Iowa Gambling task. However, there was a time by group interaction indicating a greater increase in the bias for infrequent losses in the intervention compared to the control group. With regard to event-related potentials, there was a time by group interaction supporting a greater increase of P300 amplitude and decrease of negativity of the FRN from pre- to postest in the intervention compared to the control group. Following the intervention, a higher P300 amplitude was correlated with a higher bias for infrequent losses.

Conclusion: Acute aerobic exercise does not necessarily enhance performance on cool and hot aspects of cognitive control in young adults. However, an exercise session can alter the strategy in risky decision making by increasing the preference of less frequent, but larger losses over more frequent, smaller losses. On a neurocognitive level, this effect can partly be attributed to a better anticipation of outcomes of decisions and a higher maintenance of the feedback significance.

## Oral Presentations

### OP-AP43 Running II - Ultra and Long Distance

**ANAEROBIC CAPACITY AND POWER IN ENDURANCE RUNNING – THERE IS MORE THAN LACTATE.**

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INTRODUCTION: The anaerobic metabolism contributes 10 to 50% of total energy demand during endurance exercise of 8 to 2 min and is understood well on a cellular level.(1,2) Nonetheless, its role for endurance performance is a matter of debate. Uncertainty concerning valid measurement of anaerobic capacity and power (3,4) could be a confounding factor for addressing this debate. Hence, purpose of this study was to collect 13 different metrics of anaerobic capacity and power, test within-variable relationships and assess explained variance for 3- and 12-min running performance.

METHODS: 40 trained male and female runners completed three test days. The first two days incorporated a 3- and 12-min time trial (TT) to assess running performance, critical speed (CS) and finite distance capacity (D'). Additionally, participants completed a 100-m sprint (v100, MSS, cLamax, ASR, SRR) and jump test (CMJ). The third day consisted of an incremental test to exhaustion and a 4-min TT one hour thereafter. Gas exchange was recorded to assess maximal aerobic speed (MAS), VO2max, running economy, and maximal accumulated oxygen deficit (MAOD, %ANAER). Maximal post-test lactate concentration was measured for all exhaustive tests (LaRT, LaTT3, LaTT4, LaTT12). Interaction between anaerobic variables and explained variance of TT performance was tested through (multiple) regression analysis.

RESULTS: Metrics of anaerobic power (v100, MSS, CMJ, cLamax) displayed high interrelationships ($r=0.76$-$0.98$, $p<0.001$). Anaerobic capacity metrics were interrelated to a moderate extent in the case of MAOD, %ANAER, D' and LaTT3 ($r=0.34$-$0.66$, $p<0.05$), but LaRT, LaTT4, LaTT12 showed weak or absent relationships with MAOD, %ANAER and D' ($r<0.47$). Anaerobic power explained 15- 51% of the variance for 3-min and up to 19% for 12-min TT performance. Capacity metrics (MAOD, %ANAER, D') 13- 36% and 1- 13% for 3- and 12-min TT, respectively. No variance in TT could be explained by post-exhaustive lactate measures. Multiple regression models increased explained variance to 86% and 89% for 3- and 12-min TT. VO2max explained greatest variance for both TTs, and anaerobic metrics (MAOD, D') contributed to higher explained variance for 3-min TT but failed to do so for 12-min TT.

CONCLUSION: Amongst trained runners, both anaerobic power and capacity seem to be relevant for short but not longer duration endurance running. This is in line with previous work, which suggests high energy contribution from anaerobic pathways in short endurance exercise.(1) Absent relationships of post-exhaustion lactate and endurance performance may be attributed to the measurement of a net concentration, which can be influenced by various factors.(2) In accordance with previous articles,(3) we recommend caution with post-exhaustion lactate when testing trained runners. MSS, CMJ, MAOD and D' can be viable alternatives based on our results.

1) Gastin (2001) Sports Med

2) Robergs et al. (2004) Sports Med

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**DURABILITY OF PARAMETERS ASSOCIATED WITH ENDURANCE PERFORMANCE IN MARATHON RUNNERS**

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INTRODUCTION: Physiological models of marathon performance typically consider the maximal oxygen consumption (VO2max), the fraction of VO2max that can be sustained (VO2 at lactate threshold [VO2LT]), and running economy (RE) [1]. However, these parameters deteriorate during or after prolonged exercise [2]. The resilience to this deterioration has been termed 'durability' and exhibits considerable heterogeneity [3] but has not been studied extensively in running. Furthermore, it is unclear whether parameters that are typically measured in a rested state, when measured after a prolonged bout of running, can be used to predict marathon performance. The aims of this study were to examine: i) changes to physiological parameters associated with marathon performance following prolonged exercise, ii) the association of fresh and fatigued physiological parameters with marathon performance, and iii) whether marathon performance (i.e., average running speed during the marathon) could be better predicted using physiological parameters measured after prolonged exercise.

METHODS: Eighteen runners (11 males, age: 41±12 yrs, marathon finish time: 197.5±32.5 min) participating in the 2024 London Marathon underwent two incremental exercise tests to measure VO2peak, VO2LT, and RE. Tests were conducted in a fresh state (FRE), and in a fatigued state, after a 90-minute run at LT (FAT). Paired samples t-test was used to test for differences in VO2LT, VO2peak, and RE between FRE and FAT. To investigate the relationship between laboratory-derived measures in both FRE and FAT, as well as the percentage change from FRE to FAT, and marathon performance, Pearson product-moment correlation coefficient was used. Significance was set at $P<0.05$. A linear regression analysis assessed if VO2LT and RE measured in FAT and FRE conditions could be used to predict marathon performance.

RESULTS: Reductions in VO2peak (FRE: 56.7±7.2 ml·kg-1·min-1 vs. FAT: 53.4±6.3 ml·kg-1·min-1) and VO2 at LT (RE: 43.4±6.0 ml·kg-1·min-1 vs. FAT: 40.7±6.5 ml·kg-1·min-1) were evident (both $P<0.001$), but RE remained unchanged ($P=0.125$). Marathon performance was strongly correlated with FRE VO2peak ($r=0.809$), VO2LT ($r=0.693$), and RE ($r=-0.481$), as well as FAT VO2peak ($r=0.812$), VO2LT ($r=0.781$), and RE ($r=-0.628$) (all $P<0.01$). The percentage change in VO2LT between FRE and FAT was associated with marathon performance ($r=0.543$, $P<0.05$). Marathon performance was strongly predicted by combining VO2LT and RE from both FRE ($R2=0.883$) and FAT (R2 0.933) conditions (both $P< 0.001$).

CONCLUSION: Prolonged running impairs key physiological parameters associated with endurance performance, and the degree of this deterioration, i.e., durability, is associated with, and helps explain marathon performance. Marathon runners and coaches should consider quantifying durability for accurate predictions of performance and talent identification.

[1] Joyner & Coyle (2008)

[2] Jones (2024)

[3] Maunder et al. (2021)

**PROJECT FURTHER: NEUROMUSCULAR RESPONSES TO A 6-DAY ULTRAMARATHON IN FEMALES**

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INTRODUCTION: Participation in an ultra-endurance event is associated with the development of neuromuscular fatigue (i.e., force loss) due to suboptimal drive from the central nervous system as well as impaired muscle contractile function. This study aimed to quantify, in females, both central and peripheral mechanisms of fatigue in the muscles that lift the toes (i.e., the dorsiflexors) following a multi-stage ultramarathon.

METHODS: Ten females (26-47 years; 1.57-1.82 m; 49.3-132.6 kg), with diverse running experience and athletic backgrounds, participated in a 6-day ultramarathon staged around a 2.5-mile loop in La Quinta, California. Athletes completed neuromuscular testing 2-4 days prior to, and 24 hours following the event. A custom-built isometric ankle myograph was used to measure maximal voluntary as well as electrically-evoked torques of the dorsiflexors. Electrically-evoked responses were obtained by stimulating the common fibular nerve via a hand-held bar electrode. A single stimulus was delivered during the plateau phase of maximal voluntary contractions (MVCs) and ~1 second post-MVC in order to quantify levels of neural drive (i.e., voluntary activation; VA). To indirectly assess peripheral fatigue and temporary muscle damage, torque responses were recorded after a single pulse (i.e., the resting twitch; RT) as well as 1-second trains of low- and high-frequency stimulation (10 and 100 Hz, respectively).

RESULTS: By the end of the event, a range of 112.2-560.3 miles had been run by the athletes. Mean MVC torque as well as VA were not different between pre- and post-event measures (32.8±8.0 vs. 29.5±6.9 Nm and 99.8±0.5 vs 98.6±2.6%, respectively; $P\geq0.117$). Peak torque and the peak rate of torque relaxation of the RT increased by ~14.5 and 14.8%, respectively from baseline following the event ($P\leq0.020$). Peak torque of the 10-Hz tetanus increased by 19.1% ($P=0.023$), but the 100-Hz response was not different ($P=0.540$). The ratio of 10:100 Hz torque was also not different from baseline to 24 hours post-event (0.50±0.18 vs 0.53±0.11; $P=0.340$).

CONCLUSION: In conclusion, despite the long distances achieved among the athletes, there was no evidence of muscle damage or impairments to voluntary muscle strength and neural drive 24 hours following the 6-day ultramarathon. Our findings contribute to the growing narrative that females exhibit exceptional resistance to peripheral fatigue following ultra-endurance events.

**ULTRAMARATHON RUNNERS SLEEP PATTERNS: PRIOR TO, DURING, AND FOLLOWING A 217KM BRAZILIAN ULTRAMARATHON**

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INTRODUCTION: The interest in ultramarathons has increased in the last years, and sleep deprivation is one of the main physiological challenges faced by runners in this sport. Although research in the sleep-sports relationship is growing, there is a lack of objective data regarding ultramarathon runners sleep. Therefore, the aim of our study is to analyze athletes' sleep before, during, and after a race using actigraphy, and to evaluate their sleep behavior.

METHODS: We evaluated 15 male athletes, with a mean of 45.1±10.5 years old, who participated in Brazil 135 Ultramarathon and covered 135km (n=4) or 217km (n=11). Wristwatch actigraphy (n=13) was used to measure sleep before (7 days), during, and after the race (7 days). Athletes also answered the Athlete Sleep Behavior Questionnaire (FACUNDO et al., 2021).

RESULTS: Athletes completed 135 km between 27:49-32:55 hours, while 217 km runners did between 36:24-51:49 hours. Most athletes (54%) did not define a sleep strategy for the race. The majority (53%) was classified with poor sleep behavior, and using "technology that emits light" before bed was the most frequent habit. Actigraphy also objectively indicated poor sleep, as only 15.39%, 61.54%, 30.77%, and 38.46% of the athletes slept for more than eight hours the week before (6 days), the day before, the day after, and the week (6 days) following the race, respectively. Although the average sleep latency in the 4 periods was adequate (<30 min), the Wake After Sleep Onset (WASO) was greater than the recommended (<20 min) for 83.33%, 83.33%, 69.23% and 84.62% of the athletes in the week before, the day before, the day after and in the week after the race, respectively. The average of total sleep time (TST) during the race was 67±86 min, and there was a positive correlation between TST during the race and the TST ($p=0.05$ and $r=0.56$) and sleep efficiency ($p<0.01$ and $r=0.85$) on the night following the competition. When comparing sleep in the four evaluated periods, there was a significant difference between the TST ($p=0.05$). In the week before the race the athletes slept less than on the day before ($p=0.05$) and after the competition ($p<0.01$). It is also noted that the average TST during the following week was greater than the sleep time on the night immediately after the race ($p=0.05$).

CONCLUSION: Most ultramarathon runners had poor sleep quality and high WASO levels. Despite not having a set sleep plan for the race, it has been observed that many runners attempted to obtain more sleep than usual the night before. The increased TST the week after the ultramarathon suggests that there may be a sleep rebound taking place sooner rather than later.

Reference: FACUNDO LA, ALBUQUERQUE MR, ESTEVES AM, et al. (2021). Cross-cultural adaptation of the Brazilian version of the Athlete Sleep Behavior Questionnaire. Sleep science, 2021,14(2):150–157

Funding: FAPESP (2023/07889-5), FAPESP (2022/09447-7) and AFIP.

**ULTRARUNNING AND ITS EFFECTS ON MUSCLE, KIDNEY, CARDIAC, AND ENDOCRINE FUNCTION**

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INTRODUCTION: Ultrarunning is gaining in popularity but the impact of extreme endurance events, such as the backyard ultrarunning (BYR) discipline, on medical parameters, is lacking in literature. BYR is an extremely demanding ultra-endurance event where athletes strive to complete a 6.7 km lap every hour and concludes when the second-to-last participant quits, leaving the final runner to complete the ultimate lap. The aim of this study is to determine the influence of a BYR event on organ function (kidneys, heart), hormones, inflammatory and muscle damage parameters.

METHODS: Eleven male ultrarunners (38 ± 8 yr, BMI: 23.1 ± 1.05 kg/m², VO2max: 61.3 ± 4.4 ml/min/kg) were monitored during the "Backyard Ultra" event in Belgium (April 2023). Echocardiography was performed and blood was drawn at baseline (two weeks before the event), and (at around 24 hours) during the event. Among many other parameters, kidney parameters (creatinine, urea), inflammatory and muscle damage parameters (C-reactive protein, creatine kinase and aspartate aminotransferase), cardiac stress parameters (troponin, NT-proBNP), hormones (cortisol and testosterone) and echocardiographic parameters (left ventricular end-diastolic volume index, left ventricular global longitudinal strain, right ventricular end-diastolic area index RVEDAi, systolic pulmonary artery pressure) were measured.

RESULTS: Ultrarunning significantly increased creatinine and urea ($p \leq 0.002$), suggesting increased muscle breakdown and protein catabolism, respectively. Additionally, increased C-reactive protein, creatine kinase and aspartate aminotransferase ($p \leq 0.002$), referring to increased systematic inflammation and muscle damage, was observed. Cardiac stress markers increased ($p \leq 0.017$), cortisol showed a trend to increased levels ($p = 0.073$) and testosterone decreased ($p = 0.001$) during the event. No significant alterations were observed for echocardiographic parameters, with the exception that RVEDAi decreased ($p = 0.008$), reflecting decreased preload.

CONCLUSION: The BYR event induced significant physiological stress. The decreased testosterone and trend toward elevated cortisol suggest an endocrine response to prolonged endurance exertion. Unlike previous studies on marathon runners, which reported transient reductions in left ventricular strain, no such significant changes were found. RVEDAi (the right ventricular size in diastole) reduced which refers to reduced venous return to the right ventricle. Findings align with research on (ultra)marathon showing myocardial and muscular fatigue, and an association between endurance exercise and increased cardiac biomarkers.

Ultrarunning can be perceived as safe, but the observed physiological stress underscores the need for adequate training and recovery to mitigate potential risks. Future studies should examine the long-term effects of BYR on cardiovascular and renal function.

## Oral Presentations

### OP-PN24 Molecular Biology and Biochemistry II

**EXERCISE INTENSITY-DEPENDENT EFFECTS ON LACTATE, MATURE BDNF AND PROBDNF, AND THE INFLUENCE OF MUSCLE FIBER TYPE AND BDNF GENOTYPE**

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INTRODUCTION: A single exercise bout can increase circulating levels of exerkines essential for neuroplasticity, such as mature BDNF (mBDNF), proBDNF and lactate (LAC) [1, 2]. Increases in these exerkines may furthermore be influenced by BDNF genotype [3] and muscle fiber type (FT) [2, 4]. This study investigated acute effects of exercise intensity on mBDNF, proBDNF and LAC, and how these effects are influenced by BDNF genotype and FT.

METHODS: Healthy, physically fit adults (n=16, 8 females, 31±6 yrs, body mass index 22.4±1.5, VO2max 54.9±4.1 mL/kg/min) cycled for 20 min at 40% (I40), 60% (I60) and 80% (I80) of VO2max, separated by 30-min rest. Forearm venous plasma LAC (mmol/L), serum mBDNF (pg/mL) and plasma proBDNF (pg/mL) were analysed in blood samples taken before and after cycling at each intensity. A muscle biopsy was used to identify participants with dominance of slow-twitch (%Type I>50, n=10) or fast-twitch (%Type I<50, n=6) muscle fibers. The BDNF rs6265 polymorphism was genotyped to identify Val66Met (G/A, n=5) or Val66Val (G/G, n=11) gene carriers. Linear mixed-effects models were used to assess the effects of time, intensity, as well as interactions with BDNF genotype and FT. Associations between exercise-induced changes (delta) in LAC, mBDNF and proBDNF were assessed with Spearman correlation. A significance level was set at $p<0.05$. All summary statistics are expressed as mean ± SEM.

RESULTS: LAC increased by 51% after exercise at I60 (1.3±0.1 vs 1.9±0.2, $p<0.05$) and by 495% at I80 (1.0±0.1 vs. 5.8±0.5, $p<0,001$). mBDNF increased by 16% after exercise at I40, by 30% at I60 and by 41% at I80 (10804.4±528.8 vs 12584.1±559.2, $p<0.05$; 10972.3±472.8 vs 14213.9±555.5, $p<0.001$ and 11279.3±643.0 vs 15900.0±985.9, $p<0.001$, respectively). proBDNF increased only after exercise at I80 (211.6±79.4 vs 317.9±109.2, $p<0.001$). The I80 effect on LAC was 65% larger in G/A versus G/G carriers ($p<0.001$). The I80 effect on mBDNF was 43% larger in participants with fast-twitch FT dominance ($p<0.05$). A non-significant trend of higher proBDNF levels in G/G carriers ($p=0.06$) was shown, irrespective of time and intensity. At I80, delta LAC was positively associated with delta mBDNF ($r = 0.58$, $p=0.025$), but not with delta proBDNF.

CONCLUSION: Exercise acutely induced intensity-dependent effects on LAC, mBDNF and proBDNF. Results furthermore suggest that these effects can indeed be influenced by BDNF genotype and FT. While an indication of higher proBDNF was shown in G/G carriers, delta LAC at I80 was higher in G/A carriers. However, in contrast to previous reports of G/As negative effect on aerobic training response [3], the acute mBDNF response was independent of BDNF genotype. Finally, higher neurotrophic response to aerobic exercise (higher delta mBDNF) was indicated in individuals with fast-twitch FT dominance.

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**THE ROLE OF SEX STEROID HORMONES IN SKELETAL MUSCLE MASS, FUNCTION AND GENE EXPRESSION ACROSS THE MALE LIFESPAN**

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INTRODUCTION: The relationship between sex steroid hormones and skeletal muscle mass and function remains ambiguous in males, with much of our knowledge stemming from research relying on exogenous manipulation of testosterone. This study aimed to address the relationship between endogenous sex steroid hormones and muscle outcomes across the male lifespan.

METHODS: 82 biological males, aged 18-80 years and stratified by decade, participated in this study. Body composition was assessed via dual-energy X-ray absorptiometry (DXA) and peripheral quantitative computed topography (pQCT). Muscle strength was assessed using a leg press 5-repetition maximum (5RM) test. In a fasted state, a muscle biopsy was procured from the vastus lateralis and a venous blood sample taken. Testosterone and dihydrotestosterone were profiled using gas-chromatography mass-spectrometry, and sex-hormone-binding-globulin (SHBG) measured via immunoassay.

Free testosterone was estimated using the Vermeulen equation and the free androgen index (FAI). Transcriptomic analysis were performed using RNA-sequencing, and muscle samples were immunohistochemically stained to assess fibre morphology and type. All analyses were performed using RStudio (version 4.3.1).

RESULTS: Free testosterone ($\beta$ = -0.004, $p < 0.001$) and FAI ($\beta$ = -0.669, $p < 0.001$) decreased with age and were associated with measures of body composition and muscle strength. However, these relationships became non-significant following adjustment for age, physical activity and dietary protein ($p > 0.05$). Age was positively associated with bodyfat percentage ($\beta$ = 0.129, $p = 0.02$) but not with intramuscular or subcutaneous fat mass ($p > 0.05$), and was negatively associated with thigh muscle cross-sectional area (CSA) ($\beta$ = -0.65, $p < 0.001$), appendicular lean mass (ALM) ($\beta$ = -0.09, $p < 0.001$), ALM index (ALM normalised to height) ($\beta$ = -0.018, $p = 0.028$); relationships that remained significant following adjustment for physical activity, dietary protein, total testosterone, free testosterone, and FAI.

CONCLUSION: Our results suggest that age, not endogenous testosterone concentrations, is a primary determinant of muscle outcomes. Ongoing transcriptomic analysis aims to map muscle signalling pathways throughout the aging continuum and determine the influence, or lack thereof, of sex steroid hormones on skeletal muscle gene expression across the male lifespan.

**ENDOCRINE ADAPTATION IN THE ANTARCTIC: GLUCOCORTICOID AND ANDROGEN CHANGES DURING A 1000KM SKI EXPEDITION**

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*ROYAL CENTRE OF DEFENCE MEDICINE*

INTRODUCTION: Antarctic expeditions present extreme physiological challenges due to cold temperatures, high physical exertion, and 24-hour daylight. This observational study evaluated endocrine adaptation in nine participants (six men, three women) during a 47-day, 1,000 km unassisted ski expedition (Ex).

METHODS: Saliva was sampled at 5 times of day on 8 occasions: 30 d and 14 d before, 3 times during (1 d, 15 d, 30 d) and 3 times after the Ex (+1 d, +6 d, +30 d). Hair was sampled before, during after the expedition. Blood was sampled before and after. Cortisol, testosterone (T), and androstenedione (A4) were measured via tandem mass spectrometry, and thyroid hormones via immunoassay. Diurnal slope (DS) and Area under the curve (AUC) was calculated for saliva steroids. Body mass and body composition (skinfold thickness) was measured throughout the expedition. Body composition was measured before and after by DXA. The effect of time and sex X time were assessed with Aligned Rank Transform test.

RESULTS: Cortisol, A4 and T DS were preserved throughout the Ex. Average cortisol concentration increased during the Ex ($p<0.05$) and reverted to baseline over the next 15d with no sex differences. Morning T and T:cortisol ratio decreased during the Ex with a greater effect seen among men. Post-ex recovery of T was demonstrated in men. A4:cortisol ratio decreased during the Ex and recovered afterwards with no sex differences. No significant changes were seen in blood or hair steroid hormones. Gonadotropins in women indicated central suppression pre-expedition, normalizing post-expedition. Thyroid-stimulating hormone levels increased post-expedition without significant changes in free T3 or T4, consistent with mild polar T3 syndrome. Weight decreased during the Ex (79.7±20.6 vs 72.6±8.6kg) with near-linear decrease in FM for all participants, but a smaller rate of decrease for women than men ($p<0.05$). FFM decreased overall but with substantial inter-individual variation, being relatively preserved among women. A sex-dimorphic clustering of body composition occurred after 30d. DEXA showed regional FM loss and FFM gain, especially in the trunk.

CONCLUSION: These findings highlight the adaptability of hypothalamic-pituitary function to combined stressors of exercise, energy deficit, and cold. Exercise demands overshadowed the effects of continuous daylight in controlling hypothalamic-pituitary-adrenal and gonadal axis function. This is the first study to capture in situ endocrine responses during an Antarctic traverse, advancing our understanding of human endocrine adaptation to exercise in extreme environments.

**PERIPHERAL SKELETAL MUSCLE LAT1 CONTENT IS GREATER IN OLDER COMPARED WITH YOUNGER ADULTS AND IS NOT ALTERED DURING A 12-WEEK STRENGTH TRAINING INTERVENTION**

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INTRODUCTION: Increases in postprandial amino acid availability in muscle fibers facilitate protein synthesis and is dependent on transmembrane-bound amino acid transporters (AAT) transporting amino acids from the blood into the cell. Dysfunctional AATs may be involved in the blunted protein synthetic response to protein intake, termed anabolic resistance, in older and sedentary adults. We have shown, using Western blot analyses, that untrained older had lower cytosolic protein expression of the L-type AAT 1 (LAT1) compared to younger adults ($p<0.05$), where 12-weeks of strength training eliminated this difference. Resistance training can increase the uptake of amino acids into the cell and may normalize the anabolic resistance of aging. The purpose of this study was to investigate the localization of LAT1, which facilitates the uptake of essential amino acids, in type I and type II muscle fibers in young and older adults, before and after 12-weeks of strength training.

METHODS: Healthy young (n=25, 20-45 yrs) and older (n=25, 70-80 yrs) adults completed a 12-week whole-body strength training intervention (3 sessions/week). Before and after the intervention, we measured leg lean mass (LLM) by dual-energy X-ray absorptiometry and tested strength by leg press as one repetition maximum (1RM). Muscle biopsies were

obtained from m. vastus lateralis. Immunofluorescent analyses were performed to investigate LAT1 intensity in the membrane (M) and intracellular (IC) region and M/IC-ratio. Data were analyzed for LAT1 intensity in Type I, Type II and Type I+Type II combined (total LAT1) using two-way ANOVA for comparisons between time and age group, and t-test to compare the relative changes between young and old and between relative fiber-specific changes in each group.

RESULTS: Training increased LLM by ~1 kg in both groups ($p<0.001$). 1RM leg press increased more in the young than old (78±32 kg vs. 50±20 kg, $p<0.001$). Total LAT1 was 15% higher in M ($p<0.05$) and M/IC-ratio was 6% higher ($p<0.01$) in the old, compared with the young. For the young, total LAT1 decreased by 9±14% IC ($p<0.05$) whereas the M/IC ratio increased 5±6% ($p<0.01$). The old decreased the M/IC-ratio in Type 1 by 3±8% ($p<0.05$). The young increased whereas the old decreased the M/IC-ratio in total and fiber-specific LAT1, causing a difference in the relative change between young and old adults in M/IC-ratio ($p<0.05$).

CONCLUSION: The strength training induced increases in muscle mass and strength, which were accompanied by decreased intracellular LAT1 for the young and increased M/IC-ratio for young and older adults. The greater total LAT1 protein at the periphery of skeletal muscle in older adults is consistent with our previous Western blot analysis and could be related to a compensatory mechanism for anabolic resistance. Future research should determine the biological impact of differential total and transmembrane-bound LAT1 on transport activity and anabolism in human skeletal muscle.

**CYCLING USING ADAPTIVE FUNCTIONAL ELECTRICAL STIMULATION: A NEW APPROACH TO SIGNIFICANTLY ENHANCE PLASMA IRISIN CONCENTRATION**

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INTRODUCTION: The effect of endurance training on irisin levels has been extensively studied over the past decade [1,2]. However, no research to date has explored how this myokine responds to endurance training combined with percutaneous Neuromuscular Electrical Stimulation in humans. This study compared the acute irisin response to cycling with and without a novel Adaptive Functional Electrical Stimulation Kinesitherapy (AFESK™) technology, delivered via the VIK8 device (VIKTOR S.r.l., Italy) at both the start and end of a 6-week training period (14 sessions), aiming to evaluate the added load imposed by AFESK.

METHODS: Sixteen active male participants (age, 39±10 yrs; VO2peak, 48.0±4.8 ml·min·Kg-1) were randomly allocated to two groups and matched for VO2peak and age. The cycling (C) group performed 4x5min intervals at 60% peak power output (PPO) interspersed with 3min recovery at 40% PPO. The cycling group with AFESK (C+AFESK) followed the same training program, using the VIK8 device, which delivers electrical stimulation in synchrony with the voluntary contraction of the targeted lower limb skeletal muscles. Plasma irisin levels were evaluated before and after (15min, 24h, 48h) the first (S1) and the last training session (S14) and were detected by ELISA assay. Two-way repeated measures ANOVA (TimexGroup) and post-hoc Bonferroni were performed.

RESULTS: A significant TimexGroup interaction effect ($p=0.021$) was found. In the S1, training caused a significant increase in irisin levels from baseline (C: 7.3±1.7 ng/ml; C+AFESK: 8.2±1.5 ng/ml), peaking at 24h (C: 9.9±1.3 ng/ml, $p<0.001$; C+AFESK: 11.8±1.6 ng/ml, $p<0.001$) and returning to baseline after 48h (C: 7.2±1.7 ng/ml, C+AFESK: 8.1±1.5 ng/ml). Similarly, in the S14, irisin rose significantly from baseline (C: 7.3±1.5 ng/ml; C+AFESK: 8.6±1.5 ng/ml) to 24h (C: 10.0±1.0 ng/ml, $p<0.001$; C+AFESK: 13.0±1.6 ng/ml, $p<0.001$) and returned to baseline after 48h (C: 7.3±1.4 ng/ml; C+AFESK: 8.7±1.5 ng/ml). Before and after the training period, the increase in irisin levels from baseline to 24h post-exercise was greater in the C+AFESK group than C group (S1, $p=0.021$; S14, $p<0.001$). No significant changes in baseline concentrations were observed in either group. However, after 6 weeks, irisin levels measured 24h post-exercise were significantly higher in the C+AFESK group ($p<0.001$), while they remained unchanged in the C group.

CONCLUSION: AFESK during cycling led to a greater release of irisin one day after exercise compared to traditional cycling. The training period, with or without AFESK, does not appear to affect baseline irisin levels. The AFESK, by delivering a superimposed muscle contraction that increases muscle workload, may further enhance irisin release compared to normal cycling training, providing valuable insights into the mechanisms regulating irisin secretion.

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Oral Presentations

OP-SH22 Sociology I

**EXPLORING MEDIA FRAMEWORK FOR SPORTS MEDICINE AND PHYSICAL THERAPY ON DOUYIN: REASONING DEVICES FOR SHARED DECISION-MAKING AND FRAMING DEVICES FOR EVIDENCE-BASED REPRESENTATION STRATEGIES**

HUANG, L., BI, X., HONG, Y.
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INTRODUCTION: Recently, short-video apps, such as TikTok, shows great potential in disseminating sports health information (Lopez & Bautista, 2022; Sidorenko, Casa & Cantero, 2020), especially in one of the most professional area, sport medicine and physical therapy. This information can be used(and produced) both by professionals and non-professionals(Eghtesadi & Florea, 2020). In such an environment, exploring the dissemination principles and strategies of these contents is necessary. This study starts from the Gain-Loss Framing of health communication (Yang, 2020), uses Gamson(1981)s Interpretative Package theory, and focuses on principles/consequences such as evidence-based practice(Sackett, 1996) and shared decision-making(Vogel, 2021) in the video contents produced by professional communicators, and explores the effective strategies of short video operation.

METHODS: Content analysis is adopted in this study. Through four sets of keywords, a pool of accounts of sports medicine and physical therapy professional communicators was first established from Douyin(Chinese TikTok). After comprehensively considering factors such as the number of fans and video interactions, sampling was carried out, and 2452 videos were finally coded.

RESULTS: The results are developed from two aspects: "reasoning devices" and "framing devices" based on Interpretative Package framework. Firstly, reasoning devices refer to the roots, consequences, and principle involved in valid health communication. Under the general logic of Gain-Loss Frame, there are three gain frames namely participatory science, economical and informed ideas, and three loss frames namely paternalistic culture, time cost and goal divergence. These six frames can be understood as established content frameworks based on the principle of shared decision-making. They are part of the evidence-based practice of sports related health issues and show the ability of short video platform to provide conditions for evidence-based practice. Secondly, "framing devices" refer to the communication strategies and approaches on short video platforms. Using Rodriguez and Dimitrovas (2011) comprehensive visual framework, the four-level analysis of denotative systems, stylistic-semiotic systems, connotative systems and ideological representations provides valid evidence for visual information and representations for shared decision-making.

DISCUSSION: Short video platforms fully demonstrate the advantages of the media with the help of technological affordance. The frameworks of the contents presented by professional communicators shows a consistent ideology, which is an acknowledgement and new implementation of evidence-based practices in the field of sport medicine and physical therapy. It also brings about a digital imagination of shared decision-making.

**NORWEGIAN FOOTBALL CLUBS AND FANS HAVE DECLARED WAR ON VAR: "IT'S NOT HERE TO STAY"!**

JOHANSEN, B.
*UNIVERSITY OF AGDER*

INTRODUCTION: Norwegian Premier League (NPL) have used the Video Assistant Referee (VAR) for the last two season increasing the correctness of referees' decisions from 87% to 97% (1). Still, VAR continues to spark substantial debate primarily among football supporters, players, and executives including concerns over match flow and delays (2). To improve stadium experience and time management, the Norwegian Football Federation (NFF) introduced in 2024 season the "goal button", quickly confirming goals, avoiding in secureness among supporters to whether VAR is investigating the goal or not. Furthermore, average match delay has been reduced from 81 to 41 seconds per match during this season. Nonetheless, many of the elite football clubs in Norway have decided to oppose VAR. The aim of this study is to explore the arguments for this statement considering VAR execution in NPL.

METHODS: This research utilizes official data from the NPL for seasons 2023 and 2024, focusing on VARs incidents in four key scenarios: goals, penalties, direct red cards, and cases of mistaken identity. This study analysed 480 matches, and time delay was noted from when the referee halted play for VAR checks. A qualitative document analyse (3) was conducted exploring official documents from board decisions in the 32 top clubs in football in Norway. The decision and recommendations for abandoning VAR from the Norwegian Top Football (NTF), representing elite football clubs in Norway, were also examined.

RESULTS: A total of 3695 incidents were reviewed by VAR, out of these, 2853 were quickly resolved, while 842 required further investigation. VAR upheld the initial decision in 725 cases but altered the outcome in 117 instances. Of these, 57 were factual checks (e.g., offside), with an average match delay of 44 seconds. The remaining 60 necessitated on-field reviews by the match official, with match delay averaging 1 minutes and 43 seconds. Subsequently, in January 2025 decided 19 of the 32 elite football club to vote for the removal VAR mainly rooted in concerns such as "ruining the moment", "killing the game", "incredibly sad and boring", and "lack of clarity for when VAR is used". The NFT board decision followed most of the clubs and recommend that VAR should be scrapped from NPL.

CONCLUSION: NTF representing the elite football clubs in Norway are putting pressure on NFF for abandoning VAR in 2025. If they succeed, Norway will be the first country in the world to abolish the controversial system. However, despite recommendations from NTF, representing the elite clubs and thereby also their football supporters, NFF and its executive board have decided a proposal to keep VAR in Norwegian football in the future. Accordingly, the destiny of VAR in Norwegian football is very must up in the air. Will VAR stay or not?

1. Norwegian Football Federation, (2024), www.fotball.no/dommer/var-rapporten/

2. Scanlon et al., (2022), Soccer & Society.

3. Morgan, 2022), The Qualitative Report.

**"IT WAS CLEAR FROM HIS CHILDHOOD HE WAS DESTINED TO BE A TOP STRIKER": FOOTBALL 'TALENT' NARRATIVES IN THE ITALIAN SPORTING PRESS**

MORGANTI, G., BLACKWOOD, T., LASCU, A., RUSCELLO, B., STRASSOLDO DI VILLANOVA, F., PADUA, E., KELLY, A.L.

*SAN RAFFAELE OPEN UNIVERSITY OF ROME*

INTRODUCTION: Research revealed variability in how talent is defined, identified, selected, and developed across contexts and cultures [1]. Studies investigating athlete development environments suggested media and press as sociocultural influences [2]. They frame and disseminate concepts and themes influencing collective understandings and ideals, indirectly shaping practitioners' preferences and expectations and athletes' behaviours and opportunities. Accordingly, this study aimed to explore football talent narratives in the Italian sporting press to understand macro-systemic influences on the construction of youth players in Italy.

METHODS: A Google News search using the keywords 'football' and 'talent' was used to collect articles. Only articles written in 2024 were considered. Supposing national sporting news outlets have a greater social impact than general and local ones, 25 articles from La Gazzetta dello Sport, the most read and downloaded Italian sporting newspaper, were included in the study. Qualitative and inductive content analysis was used to analyse articles.

RESULTS: Results revealed three dimensions of talent narrations interacting to shape perceptions of youth players' pathways: (a) cultural, (b) social, and (c) temporal. The cultural dimension defined what talent looks like ('he was deselected for disciplinary reasons, as he was considered lazy and overweight'), their preferred developmental corridors ('he specialised in football at 5, and an Italian first division club selected him at 9'), and performance standards ('he was the star of the local youth tournaments'). The social dimension presented youth players' socioeconomic background ('he comes from a poor community and played on the streets, there the only thing counting is dribbling opponents') and interactions with family ('his mother drove for 4 hours a day to take him to training') and coach ('after deselection, his former coach trusted in his abilities and took him with him'). The temporal dimension acknowledged talent as in-becoming ('accumulating hours of training and playing to develop'). Each dimension is indirectly linked to the set of values promoted by Italian football (competition, youth performance, and work ethic).

Discussion: Findings presented three interacting dimensions contributing to the recognition phenomenon (youth players receiving the label of 'talent'), which does not appear as an objective, linear, and unbiased process, being instead related to youth players' conformity to the cultural values, dependent on the received developmental support, and influenced by the passage of time. This study highlighted the construction of football talent in the Italian press, contributing to understanding identification, selection, and development procedures, and presented the mechanisms behind talent recognition, describing what youth players should aim for to be considered talented in the eyes of journalism.

References

1. Baker et al., 2024

2. Vaughan et., 2022

**SPORTS PARTICIPATION AND ITS VALUES: A CASE STUDY OF AN UNIVERSITY IN THE NORTHWESTERN UNITED STATES**

TANG CJ, KEH NC, LIN CP

*NATIONAL TAIWAN NORMAL UNIVERSITY*

Introduction: Taiwan has been gradually establishing a nationwide sports culture by introducing American physical education curricula, teaching models, and emerging sports concepts, although various differing views are still being debated. Rokeach (1973) classified values into terminal values, which pertain to the purposes of life and life goals, and instrumental values, which pertain to means and behaviors. Terminal values can be further divided into personal values that fulfill individual life and survival goals and social values that fulfill group development goals. Instrumental values can be divided into competence values that emphasize personal abilities to achieve self-goals and moral values that demonstrate appropriate interpersonal behavior. Whether sports are viewed as a terminal or instrumental value can influence individuals willingness to participate, and further affect school curriculum goals and content, and impact the development of various sports. Purpose: This study aimed to investigate the participation in sports and to understand the difference between the two areas. Methods: A qualitative interview approach was used to collect data. The participants were fifteencollege students purposeful sampling from an university in the Northwestern United States.Theparticipants included 7 females and 8 males, with an average age of 27. The interview consisted of 8 open-ended questions and 20 closed-ended questions. They were interviewed during the 2024 summer, individually for 20 to 30 minutes with answers directly recorded on a laptop respectively. The interview data were analyzed through content analysis for coding, classification, and interpreta-

tion.To ensure trustworthiness, triangulation method was used. The researchers analyzed some data individually and discussed to cross check some categories for consistensy. Results: (1) All 15 participants had regular exercise habits, with a diverse range of activities. Outdoor aerobic exercises such as hiking, walking, and running were most common, followed by indoor activity such as weight training. (2) Most participants accumulated between 1 to 6 hours of exercise per week, followed by13 to 19 hours. (3) The primary reasons for exercising were to achieve physical, mental and emotional health related goals, with many participants already experiencing these benefits but hoping to gain even more physical and mental health, and social in teraction benefits. (4) The value of sports was predominantly related to physical and mental health. Participants believed that the value of exercise was primarily for "improving emotional health" and "maintaining health," rather than as a means for "losing weight" or "achieving academic and career goals." Conclusion: The personal goal values within terminal goal values of the participants in this study were the most prevalent. This findings have implications for Taiwan's physical education and sports development.

## 14:45 - 16:00

Invited Symposium

IS-AP01 Navigating the Perception of Time in Sport: Psychological and Physiological Insights

**TIME PERCEPTION AND PRE-EVENT STRATEGIES**

ELFERINK-GEMSER, M.
*UNIVERSITY OF GRONINGEN, UMCG*

An Olympic champion does not wake up one morning as a non-athlete, over breakfast deciding to become the best athlete at the world stage in a certain sport & winning the gold medal that very same evening. It's evident that a long process over the course of many years precedes being successful at the Olympics. Time perception plays a critical role in this developmental journey, influencing both athlete & coach in shaping effective long-term strategies. How well time is perceived & managed can affect not only training volume & intensity but also the timing of peaks & recovery periods. Athletes must manage not just the present moment, but their longitudinal careers. In this session, we will explore the importance of time perception for an athlete's development towards peak performance. This can relate to an Olympic champion but also extends to the broader population of recreational athletes who aim to improve themselves. When designing a training program a trainer needs to be aware of how many years, months, weeks & hours of training & recovery are needed for a certain athlete to meet the requirements of success during his or her sports career. Good time perception could be evident in structured long-term planning, such as periodization, managing avoiding injury and burnout as well as pitfalls such as misjudging pace. Several models, such as the LTAD model (Balyi, 2002) give direction to choices regarding the content of training in different phases of development but research is limited in how well trainers perform in terms of time perception. For athletes, peaking at the right moment is key. To perform optimally at the most important competition of the season, it seems paramount that good time-perception about how many months, weeks, days, and hours are available for physiological and psychological preparation leading up to the event is essential. Pre-event strategies not only involve these long-term perceptions of time for training and recovery, but also involve knowledge of the duration of the event itself so that the race or match can be planned accordingly. Several studies underscore the positive relation between pre-event planning and performance. For example, international competing athletes outscore their national level counterparts on planning their course of action (e.g., Jonker et al., 2010). However, the specific role of time-perception herein is still under investigated. From practice there are clear indications for its importance. For example, world-class athletes have shown to be able to accurately state the time how long their race lasts while in rest, sitting on a chair. Prior experience and knowledge of the likely demands of the exercise (e.g., 'endtime') have been indicated to be important in managing physical resources to get the best possible outcome (Edwards & Polman, 2013). In this session we will explore how time perception influences the athlete's development journey from years out to the start of the race, drawing on research and examples of both good practice and common pitfalls to ensure success.

**THE DYNAMIC PERCEPTION OF TIME DURING EXERCISE**

MENTING, S.
*ULSTER UNIVERSITY*

Athletes often report contrasting perceptions of time during exercise: moments when time flies (the race has barely begun and energy feels limitless) and others where time drags (fatigue builds, and every second feels longer). Despite the commonality of this experience, scientific investigation into time perception during exercise has only recently gained momentum. This is surprising given that athletic competitions are frequently decided by marginal differences, where well-timed decisions can be the key to victory. We will explore the dynamic relationship between time perception and exercise intensity, drawing from recent research on how individuals perceive time at varying levels of physical exertion. Empirical studies comparing subjective time perception in both fixed-intensity exercises and self-paced time trials (with and without competitive contexts) have revealed fascinating insights. Initial findings suggest that during maximal effort, athletes expe-

rience a slowing of perceived time, likely due to a heightened focus on internal signals associated with fatigue (Edwards & McCormick, 2017). In contrast, during self-regulated efforts, athletes respond dynamically to both internal cues and the behaviour of competitors (Edwards et al 2024). Within this context, the competitive environment act as an external distraction, potentially counteracting the exercise-induced slowing of time. Physical discomfort during high-intensity efforts appears to narrow attentional focus, placing athletes "in the moment" and making time seem to drag. Conversely, competitive environments may shift attention outward, diverting focus from the present and seemingly overriding the sensation of time slowing down. To close out, we will survey the practical applications of these findings. By leveraging the effects of external stimuli on time perception, new strategies for enhancing performance can emerge. Cognitive distractions, such as the use of music, visualization, or social comparison in competitive environments, can counteract 'associative' sensations like pain feedback during exercise. For example, listening to fast-paced music during a workout has been shown to increase motivation and reduce the perception of effort, effectively altering the athletes experience of time and making intense intervals feel shorter. Virtual reality has the potential to immerse athletes in environments where time might be artificially sped up or slowed down, allowing for unique training experiences. Other techniques, such as visual pacing systems like LED lights on athletic tracks, have also helped athletes break long-standing world records by altering perceptions of time and effort. This exploration of time perception offers a fresh perspective on performance optimization, with broad implications for training, competition strategies, and athlete development.

**POST-EXERCISE TIME PERCEPTION AND ITS IMPACT ON REFLECTION, ENJOYMENT AND TRAINING ADHERENCE**

EDWARDS, A.

*CANTERBURY CHRIST CHURCH UNIVERSITY*

Time perception extends beyond the immediate experience of exercise, influencing how athletes reflect on their sessions, how much they enjoy the activity, and their future training adherence. The perception of time during exercise can distort the athlete's memory of the session, particularly if viewed as overtly painful or unenjoyable. This is critical because post-exercise reflections can shape motivation. Using latest time perception data from populations such as professional soccer (Edwards et al. 2024), this presentation will extend findings to other sports and physical activity contexts, offering practical applications for optimising training design, session structure, and motivation strategies. Research shows that athletes' enjoyment and perception of time during exercise vary greatly, usually driven by personal motivations. This perception of time not only affects athletes' in-the-moment experience, but also their reflection on the session afterwards, influencing their overall attitude towards future training. This concept has wide-reaching implications into all sports, physical activity, and public health. In endurance sports such as running and cycling, athletes often report that high-intensity intervals feel much longer due to perceived exertion, potentially making these sessions less appealing despite their physical benefits. This presentation will suggest strategies to manipulate time perception to enhance motivation and potentially reduce the feeling of time dragging, increasing perceived enjoyment, which is critical for long-term exercise adherence. In recreational physical activity settings, such as group exercise classes or public health programmes aimed at encouraging people to be more active, organising sessions to enhance enjoyment and reduce the "dragging" perception of time could have a substantial impact on retention and motivation. For example, research has shown that structured, engaging activities like dance-based fitness classes or sports-specific drills tend to increase enjoyment and make time feel as though it passes quickly. Conversely, less interactive and monotonous workouts, like steady-state cardio without engaging stimuli, often feel longer and lead to boredom, decreasing the likelihood that participants will adhere in the long-term. This session will highlight practical ways to restructure training to take advantage of time perception dynamics. For instance, incorporating enjoyable activities—such as sport-specific activities to create a dissociative effect, where athletes become less aware of physical discomfort, making the session feel shorter and more engaging. Integrating subjective time perception into more robust training load (TL) assessments could refine how coaches balance objective and subjective measures. Adjusting models like session-RPE to account for how long athletes feel they have worked—rather than just how hard—could provide a more comprehensive understanding of their mental and physical states, leading to better-managed workloads and recovery protocols.

## Oral Presentations

### OP-PN28 Physiology of Fatigue II

**MATCHED FOR PHYSICAL ACTIVITY THERE ARE SEX DIFFERENCES IN THE HYPOTENSIVE EFFECTS OF ACUTE DIETARY CAPSAICIN**

IVES, S., GYAMPO, A.O., MATHIAS, M.N., ZALESKI, K.S., LORA, B.1, TOMASI, T., LYNCH, M., GIURIATO, G., BASSO, E., FINEGAN, E., SCHICKLER, J., FIORASO, E., VENTURELLI, M.

*SKIDMORE COLLEGE*

INTRODUCTION: Cardiovascular disease (CVD) is the leading cause of death worldwide, although there are known sex-based differences until the age of menopause in women. Interestingly, the consumption of spicy peppers and their active ingredient, capsaicin, has been suggested to reduce CVD-related mortality, but whether this effect may be due to reductions in blood pressure (BP) and the underlying mechanisms remains unknown. Thus, the study of sex differences in not only peripheral BP, but Central BP and vascular stiffness which are relatively novel independent risk factors for CVD, and

the acute effect of dietary capsaicin is warranted. As physical activity (PA) is recognized to reduce BP, it is imperative to match for this when making comparisons. Thus, we aimed to determine sex differences in the central and peripheral BP and vascular stiffness response to acute dietary capsaicin and potential differences in vasoactive biomarkers endothelin-1 (ET-1) and nitric oxide (NO) metabolites nitrite/nitrate (NOx), key regulators of vasomotor tone, vascular resistance, and thus BP.

METHODS: In a randomized placebo-controlled crossover design, 40 young males (n=22, 21±2 yrs.) and females (n=18, 19±1 yrs.) were assessed for peripheral systolic (SBP) and diastolic (DBP) BP, central systolic (cSys), diastolic (cDia) BP, augmentation index normalized to 75 beats/min (AIx@75), and pulse wave velocity (PWV), in duplicate, using an automated oscillometric sphygmomanometer under placebo and capsaicin conditions. PA was self-reported and allowed for matching of men and women to control for the influence of PA on BP. Urine samples were obtained and analyzed for ET-1 and NOx using enzyme-linked immunosorbent or Griess reagent assays, respectively. Data were analyzed using two-way ANOVA.

RESULTS: For peripheral BP, there was an interaction of sex*condition for SBP ($p=0.028$, $\eta^2p=0.201$), where capsaicin lowered SBP in women but not men. Though directionally similar, no significant effects were noted in DBP (sex*condition, $p=0.437$, $\eta^2p=0.028$). In central BP, no interaction effects were noted in central systolic (cSys, sex*condition, $p=0.126$, $\eta^2p=0.103$) and diastolic BP (cDia, sex*condition, $p=0.185$, $\eta^2p=0.078$), but again trended along the effects noted in SBP. AIx@75 was also similar (sex*condition, $p=0.135$, $\eta^2p=0.099$), but not PWV (sex*condition, $p=0.399$, $\eta^2p=0.033$). ET-1 was lower in women and tended to fall more so in women (sex*condition, $p=0.187$, $\eta^2p=0.045$), though the opposite seemed true in NOx (sex*condition, $p=0.099$, $\eta^2p=0.070$) and the ET-1:NOx ratio (sex*condition, $p=0.245$, $\eta^2p=0.035$).

CONCLUSION: Capsaicin lowered brachial SBP, where women responded favorably, with similar tendencies in cSys. While capsaicin tended to lower ET-1 in women, but not PA-matched men, and that NOx and the ET-1:NOx ratio do not exhibit this trend, suggests other mechanisms may be responsible, and warrants further study.

**A CHAMBER OF SECRETS: SEX-SPECIFIC ADAPTATION TO EXERCISE IN THE LEFT ATRIUM**

CRIDDLE, J., COLLIS, J., MARSH, C., THOMAS, H., GEORGE, K., NAYLOR, L., GREEN, D.
*UNIVERSITY OF WESTERN AUSTRALIA*

INTRODUCTION: The left atrium (LA) is responsible for modulating venous return and ventricular filling. Both pathological stimuli (e.g., hypertension, obesity, valvular disease) and endurance training (END) can influence LA structure and function. Clinically, an enlarged LA is associated with an increased risk of atrial fibrillation, including atrial dysrhythmias in some ultra-endurance athletes. Conversely, LA size is linked to higher cardiorespiratory fitness. Longitudinal studies of exercise-induced LA adaptations are limited, with existing research focused solely on END, demonstrating LA enlargement but sparse data on LA function. No studies have assessed LA adaptations to resistance training (RES) or utilized speckle-tracking echocardiography to evaluate mechanical function. Additionally, sex-specific changes to distinct exercise modalities have not been reported.

METHODS: Sixty-four participants (26 male, 38 female) were randomized in a crossover designed study involving 12-weeks of END or RES, separated by a 12-week washout. LA structure and function were assessed using 2D and speckle tracking echocardiography.

RESULTS: LAmax volume significantly increased following END (Delta 3.94±1.53mL, P=0.01) but not RES (Delta 2.68±1.54mL, P=0.07). The increase in LAmax volume following END was primarily due to a significant increase observed in males (Delta 6.19±2.27mL, P=0.007), not females (Delta 1.7±2.05, P=0.41). There was no significant change in LAmin volumes in response to training (END; Delta 1.03±0.85, P=0.23, RES; Delta -0.93±0.89, P=0.30), and no sex-dependent differences (all P>0.05). LA emptying fraction (LAEF) did not significantly change following END (Delta -1.21±1.54%, P=0.43), but significantly increased after RES (Delta 3.66±1.6%, P = 0.03), although no significant sex-dependent differences were apparent (all P>0.05). There were no significant training effects for either training type on LA reservoir, conduit, or contractile strain, nor sex-specific differences in these variables (all P>0.05).

CONCLUSION: END significantly increased LAmax volume, primarily driven by adaptations in males, whereas RES had no significant effect. Conversely, RES improved LAEF, with no sex-specific differences. Neither training type altered indices of LA strain. These findings suggest that END induces structural LA remodelling, particularly in males, while RES enhances LA emptying. Given the higher prevalence of atrial fibrillation and the larger a priori LA structure apparent in men, the END related LA enlargement we observed in males may have implications for long-term management of cardiac arrythmias, particularly in ultra-endurance athletes.

**SEX DIFFERENCES IN CYCLING EFFICIENCY, AEROBIC ENZYMES, AND GLYCOGEN STORES FOLLOWING A STRENUOUS MILITARY FIELD EXERCISE**

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INTRODUCTION: Strenuous military field exercises (MFE) causes muscle mass loss and long-lasting physical performance impairments. However, their effect on muscle efficiency during submaximal work and associated cellular muscle changes are poorly understood. Furthermore, the effects of MFE in women are not well documented. This study aimed to investi-

gate the impact of strenuous MFE on efficiency during submaximal work, muscle aerobic enzyme content, muscle glycogen content, and to identify potential sex differences in these aspects.

METHODS: Efficiency was tested on a cycle ergometer (200 W for men and 150 W for women) and CMJ on a force plate in 10 men and in 8 women before (T0), and 1 (T1), 7 (T7), and 14 (T14) days after a 10-days MFE consisting of rigorous physical activity with food and sleep restriction. Muscle biopsies from m. vastus lateralis were collected at T0, T1, and T7.

RESULTS: Countermovement jump height was decreased with 6.7±6.2% ($p \leq 0.001$) at T1 and was still decreased at T14 with 4.1±4.7% ($p=0.003$) for the sexes combined. There were no sex differences in the changes from T0

The men improved gross efficiency (GE) at T1 (0.7±0.7 pp, $p=0.019$), whereas it decreased in women (–0.9±1.0 pp, $p=0.042$). The change was different between sexes ($p=0.002$), and these group differences persisted at T7 ($p=0.022$). At T14, GE returned to pre-values in women, while it remained improved in men (0.4±0.6 pp, $p=0.038$), with no sex differences in the changes from T0.

Heart rate (HR) decreased at T1 in both men (–12.9±3.4%, $p \leq 0.001$) and women (–4.6±4.7%, $p=0.030$), with a larger reduction in men ($p \leq 0.001$). HR remained reduced in men throughout recovery but returned to pre-values at T7 in women. Blood lactate concentration did not change significantly in either sex, though women showed a larger ($p=0.037$) non-significant increase at T1 (29±44%, $p=0.198$) compared to a non-significant decrease in men (–11±31%, $p = 0.109$). There were no sex differences in changes in respiratory exchange ratio or perceived exertion during submaximal cycling.

At T7, the sexes combined reduced the content of citrate synthase (–23±28%, $p=0.005$) and tended to reduce to content of COX4 (–18±43%, $p=0.056$), with no sex differences.

The changes in muscle glycogen content were similar in Type I and II fibers for both sexes. At T1, glycogen content in the muscle fibers combined was reduced in both men and women with 8±10% ($p=0.033$) and 8±8% ($p=0.02$), respectively. At T7, the percentage change from T0 was different between sexes ($p=0.009$), where the men had increased glycogen content with 10±6% ($p \leq 0.001$), while the women returned to T0 values.

CONCLUSION: A demanding MFE resulted in improved cycling efficiency in men but impaired efficiency in women. The reasons for this sex difference remain unclear, though it is likely unrelated to changes in aerobic enzyme levels or glycogen stores, which were similar between men and women

**EFFECT OF THE MENSTRUAL CYCLE ON FAT OXIDATION DURING A ONE-HOUR AEROBIC EXERCISE AT FATMAX**

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INTRODUCTION: The potential influence of the menstrual cycle on the relative contribution of fat and carbohydrates to energy metabolism during moderate-intensity aerobic exercise remains uncertain, as previous studies have reported inconsistent findings. Overall, previous studies relied on laboratory-based exercise testing that did not reflect the training routines typically followed by women, limiting their applicability to real-world exercise conditions. To address this gap, the primary objective of this study was to examine the effect of the menstrual cycle on fat and carbohydrate oxidation rates during a one-hour cycling session at Fatmax.

METHODS: Fourteen physically active naturally menstruating women participated in a randomised crossover experimental trial consisting of one hour of cycling at their Fatmax performed in three phases of the menstrual cycle: (a) early follicular, (b) peri-ovulatory and (c) mid-luteal. These menstrual cycle phases were individually determined using a combination of methods, including a mobile application that tracked menstruation onset for four months prior, detection of luteinizing hormone surges in urine samples and monitoring of body temperature and body weight throughout an entire menstrual cycle. At each experimental session, respiratory variables were recorded with a gas analyser to calculate fat and carbohydrate oxidation rates through stoichiometry equations. Heart rate and the rating of perceived exertion were also measured at each session. Variables were analysed with one-way repeated measures ANOVA and post-hoc analysis were applied in the case of a main effect.

RESULTS: There was no main effect of menstrual cycle phase on total fat oxidised ($F = 0.764$, $p = 0.476$), total carbohydrate oxidised ($F = 1.047$, $p = 0.365$) or total energy consumed ($F = 0.123$, $p = 0.885$) during exercise. However, a significant main effect in heart rate was found ($F = 4.014$, $p = 0.010$) with higher values in the peri-ovulatory compared to the early follicular phase ($p = 0.021$). Last, menstrual cycle had a main effect on perceived exertion ($F = 5.460$, $p = 0.010$). Post-hocs revealed higher perceived exertion in mid-luteal compared to the early follicular ($p = 0.018$) and peri-ovulatory phases ($p = 0.022$).

CONCLUSION: Menstrual cycle did not affect the contribution of fat and carbohydrate as fuel nor total energy expenditure during a one-hour aerobic cycle-ergometer exercise at Fatmax. However, other variables such as heart rate and perceived exertion were affected by menstrual cycle, as heart rate was higher in peri-ovulatory vs. early follicular and rate of perceived exertion was higher in mid-luteal compared to early follicular and peri-ovulatory phases.

**SEX DIFFERENCE IN THE COMBINED EFFECTS OF MODERATE-INTENSITY AEROBIC EXERCISE AND MEDIUM-CHAIN TRIGLYCERIDES ON WORKING MEMORY**

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INTRODUCTION: Working memory (WM) is a core component of executive function (EF) and our previous study showed that compared to long-chain triglycerides (LCT) intake, a four-week medium-chain triglycerides (MCT) intake improved WM in young males (1). In addition to this observation, combining MCT with a four-week aerobic exercise (AE) intervention provided similar benefits to MCT alone in young males (1). Although females show better responses in EF improvement to regular AE (2), it remains unclear whether a combination of regular AE and MCT improves WM in females, as compared to MCT alone. Here, we aimed to investigate the combined effects of four-week MCT intake and AE training on WM in males and females and examined potential sex differences in response to the intervention.

METHODS: Thirty-six healthy young adults (21 ± 1 years) were randomly assigned to the MCT group (n = 18, 10 males, 8 females) or the MCT-AE group (n = 18, 10 males, 8 females). Participants consumed 16.3 ml of oil daily, which contained 12 g of MCT, for four-week in a single-blind manner (1,3). The MCT-AE group additionally performed moderate-intensity cycling AE (30 min/session, 3 sessions/week) at 50~70% heart rate reserve (HRR). For female participants, baseline measurements were conducted during the mid-follicular phase. Given the four-week intervention period, post-intervention measurements were scheduled to ensure they were also conducted during the mid-follicular phase. WM was assessed using the face n-back task, measuring reaction time (RT) and the number of errors (ERR) pre- and post-four-week intervention. A two-way analysis of variance (group [MCT, MCT-AE] × sex [male, female]) was conducted to analyze changes in RT and ERR from pre- to post-four-week intervention.

RESULTS: No significant main effects for the group and sex were found in either RT (group $P = 0.900$, $\eta^2 < 0.001$; sex $P = 0.885$, $\eta^2 < 0.001$) or ERR (group $P = 0.639$, $\eta^2 = 0.007$; sex $P = 0.749$, $\eta^2 = 0.003$). The group × sex interaction was also non-significant for RT ($P = 0.322$, $\eta^2 = 0.031$) and ERR ($P = 0.639$, $\eta^2 = 0.007$).

CONCLUSION: The combination of MCT and AE did not improve WM compared to MCT alone, and no sex differences in this effect were observed. These findings suggest that the four-week AE may not further enhance the cognitive benefits of MCT in both young males and females.

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## Oral Presentations

### OP-PN05 Physiology

**IMPACT OF WHOLE-BODY HOT WATER IMMERSION ON CEREBRAL HAEMODYNAMICS AND CEREBROVASCULAR REACTIVITY TO CARBON DIOXIDE**

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INTRODUCTION: Passive heating may be an alternative or adjunct to exercise to maintain cardiovascular and cerebral function and health. Hot water immersion (HWI) improves peripheral vascular function via shear-mediated mechanisms; however, it remains unclear if acute HWI can improve cerebrovascular function. This study determined the influence of HWI on cerebral haemodynamics and subsequent cerebrovascular reactivity to carbon dioxide (CVRco2) within the internal carotid artery (ICA), an index of cerebrovascular function.

METHODS: Fifteen healthy adults (six female, mean age 28 ± 8 years) completed two experimental trials separated by at least 48 hours. Females were tested in the same menstrual cycle phase for both trials. In the HWI trial, participants were immersed in 39°C water to the sternum for 60 min whilst in the CON trial they rested in 21°C air in the same semi-recumbent posture and duration as in the HWI trial. Thermal and haemodynamic variables were assessed throughout trials. CVRco2 was determined before and 45 min after the 60 min HWI and CON interventions by participants breathing four minutes of a hypercapnic gas (6% CO2, 21% O2, N2 balance) whilst ICA blood velocity and diameter were measured by duplex ultrasound.

RESULTS: At 60 min of the interventions core body temperature and heart rate were higher on HWI than CON (CON, 36.9 ± 0.3°C; HWI, 38.1 ± 0.3°C, $P < 0.001$. CON, 60 ± 10 bpm; HWI, 96 ± 13 bpm, $P < 0.001$). No differences were observed between the HWI and CON interventions for ICA diameter ($P = 0.34$), ICA blood velocity ($P = 0.97$), ICA shear rate ($P = 0.75$) and ICA blood flow (CON, 311 ± 80 ml·min-1; HWI, 338 ± 92 ml·min-1, $P = 0.39$). Compared to CON, HWI intervention reduced mean arterial blood pressure (CON, 82 ± 7 mmHg; HWI, 67 ± 8 mmHg, $P < 0.001$), and increased ICA conductance (CON, 3.9 ± 1.3 ml·min-1·mmHg-1; HWI, 5.2 ± 2.0 ml·min-1·mmHg-1, $P = 0.03$). A 45 min after the interventions no differ-

ence was detected for CVRco2 between the trials (CON, pre: 13.9 ± 9.2 to post: 11.3 ± 6.1 ml·min-1·mmHg-1; HWI, pre: 14.6 ± 7.9 to post: 10.9 ± 5.4 ml·min-1·mmHg-1; Interaction P = 0.65).

CONCLUSION: HWI reduced blood pressure and increased ICA conductance (i.e. autoregulation) to maintain blood flow to the brain. Nevertheless, despite differences in cerebral vascular tone between interventions, HWI did not influence subsequent cerebrovascular function, as assessed by cerebrovascular reactivity to carbon dioxide. These findings support hot water immersion as an intervention to reduce blood pressure, which if repeated regularly may help to maintain cardiovascular and cerebral health.

**GUT MICROBIOTA, PHYSICAL ACTIVITY, AND PHYSICAL FITNESS: EXPLORING RELATIONSHIPS IN CHILDREN AND IMPLICATIONS FOR EXERCISE NUTRITION**

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INTRODUCTION: This study aims to investigate the association between the gut microbiota and physical activity (PA) and physical fitness (PF) in children by comparing extreme levels of PA and PF, in order to provide a basis for the development of individualized exercise nutrition intervention strategies in early childhood.

METHODS: PF and PA were assessed in 6,074 children aged 6-9 years using the National Standards for Students Physical Health (2014 Revision) and the International Physical Activity Questionnaire Short Form, respectively. Children in the top 25th percentile (high) and bottom 25th percentile (low) for both PF and PA were selected and categorized into four groups: low PA-low PF, high PA-low PF, low PA-high PF, and high PA-high PF. Thirty participants were randomly selected from each group (total n = 120), and fecal samples were collected for 16S rRNA V3-V4 region gene sequencing. Gut microbiota composition and α and β diversity were analyzed for each group. Between-group differences in α diversity were assessed using the Wilcoxon rank-sum test; for β diversity, PERMANOVA was used to test the significance of between-group differences, and Principal Co-ordinates Analysis and Non-metric Multidimensional Scaling (NMDS) were used for visualization. Linear discriminant analysis effect size analysis was used to identify differentially abundant taxa. Pearson correlation and Mantel tests were used to analyze the correlation between the relative abundance of gut microbiota and exercise performance indicators.

RESULTS: At equivalent PA levels, children with high PF showed significantly greater gut microbiota richness and diversity (Chao1, Shannon indices; $p < 0.01$). The low PA-low PF group was enriched in Gammaproteobacteria (Escherichia coli), linked to dysbiosis and inflammation. The high PA-low PF group was enriched in SCFAs-producing Akkermansia and Bacteroides coprocola. The low PA-high PF group was enriched in fiber-fermenting Clostridia and Faecalibacterium. Community structure differed significantly between the low PA-low PF group and others ($p < 0.05$). Firmicutes correlated positively with weight, BMI, and sit-ups; Bacteroidetes negatively with BMI; and Proteobacteria positively with vital capacity and long jump, implicating these phyla in energy metabolism, body composition, and athletic performance.

CONCLUSION: childrens gut microbiota composition varies significantly based on the combined levels of PA and PF. Children with high PF show greater microbial diversity within similar PA levels, particularly under high PA conditions. PERMANOVA-assessed group differences (weighted vs. unweighted UniFrac NMDS) suggest the low PA-low PF group harbors unique species, potentially linked to its distinct microbial enrichment. PA and PF are associated with gut microbiota composition and potential nutrient metabolism in children. Higher PF correlates with greater gut microbiota diversity and may reflect more efficient nutrient utilization.

**PHOTOBIOMODULATION DOES NOT INCREASE MITOCHONDRIAL RESPIRATION IN SKELETAL MUSCLE OR SKIN TISSUE IN VIVO IN HUMANS**

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INTRODUCTION: Laser therapy, now more referred to as photobiomodulation (PBM), is gaining interest as a non-invasive treatment for various conditions and as a potential means to enhance health and performance. While in vitro and in vivo animal studies provide promising evidence, surprisingly little research has been conducted on the proposed capacity for PBM treatment to activate metabolism in skin and skeletal muscle tissue in vivo in humans.

METHODS: In a within-participant study design, 12 healthy, young men and women (6/6 m/f; age: 25±6 y; BMI: 23.3±2.2 kg/m2) received PBM on a randomly chosen leg, while the other leg received sham-treatment (no light emitted, CON). Three cycles of PBM were performed for 5 min 16 sec each, separated by 5 min of rest. During the rest periods the other leg received the sham treatment. In total 16.8 kJ in form of light energy was applied (3 x 5.6 kJ) in PBM using wavelengths of 660, 800, 905 and 970 nm in intermittent Continuous Wave (CW), Pulsed Wave (PW), SuperPulse (SP), and IntenseSuperPulse (ISP) mode. Skin temperature was measured before and after treatment. After the treatment, skin and muscle tissue biopsy samples were collected from both legs at the location where the PBM and sham treatments were applied. Permeabilized muscle fiber bundles were prepared from skeletal muscle tissue to measure mitochondrial respiration in an Oroboros Oxygraph-O2k. Skin tissue was minced, and respiration was analyzed in an Oroboros Oxygraph-O2k. Mitochondrial respiration data were compared between treatments (PBM vs CON) using paired samples t-tests. Skin tempera-

ture data were analyzed by a repeated measures ANOVA with time (pre/post) and treatment (PBM/CON) as a within-participants factors. Statistical significance was set at P<0.05. All data in text and figures are expressed as mean±SD.

RESULTS: PBM increased skin temperature by 8.0±1.4 °C (P<0.05), with no changes in the control leg (P>0.05). In permeabilized muscle fibers, leak mitochondrial respiration (pyruvate, malate) was not altered by PBM (25.7±6.9 vs 24.2±5.6 pmol/sec/mg dry weight in PBM vs CON, respectively; P=0.37). Furthermore, maximal complex I+II-linked respiration (pyruvate, malate, ADP, glutamate, succinate) did not differ between legs (474±114 vs 467±81 pmol/sec/mg dry weight, respectively; P=0.71). Furthermore, no differences were observed in mitochondrial sensitivity to submaximal ADP levels (apparent ADP half-time: 1310±180 vs 1229±240 µM ADP, respectively; P=0.14). In skin tissue, maximal complex I+II-linked respiration did not differ between legs (2.7±0.8 vs 2.6±0.7 pmol/sec/mg wet weight, respectively; P=0.66).

CONCLUSION: A single session of photobiomodulation does not increase mitochondrial respiration in skin or underlying muscle tissue in vivo in humans. The proposed benefits of photobiomodulation via high intensity laser therapy are not attributed to the direct activation of tissue metabolism.

**INFLUENCE OF CARBOHYDRATE OR NIACIN INGESTION ON POST-EXERCISE PLASMA BCAA AND KETONE BODY CONCENTRATIONS**

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INTRODUCTION: Skeletal muscle metabolic adaptations to endurance exercise may be enhanced by training in a fasted state, which may be partly due to differences in the circulating metabolic and hormonal environment from differences in carbohydrate and/or fat availability (1). However, it is currently unknown how much of the circulating metabolic milieu is influenced by specifically carbohydrate or fatty acid availability. The aim of the study was to assess the effect of carbohydrate or niacin ingestion during exercise on plasma metabolite concentrations to isolate the role of suppressed NEFA availability from increased insulin and carbohydrate availability.

METHODS: Fifteen active males (n=10) and females (n=5) cycled on three occasions for 1 hour at 95% of lactate threshold 1 with ingestion of either carbohydrate (CARB), niacin (NIACIN), or placebo (FAST) in a crossover design. After baseline breath and blood samples were collected, participants consumed a drink (1.6g/kg maltodextrin or placebo) and tablets (10mg/kg niacin or lactose). Following 1 hour of rest participants cycled with further carbohydrate (0.8g/kg/hr maltodextrin), niacin (10mg/kg/hr) or placebo with blood and expired breath samples collected every 15 minutes. A final blood sample was taken 2 hours after completion of exercise. Plasma was analysed for NEFA and insulin concentrations and targeted nuclear magnetic resonance spectroscopy was performed to determine plasma lipoprotein and metabolite profiles. Normality of data were checked by visual inspection of residuals. Differences between conditions were analysed by two-way ANOVA with multiple comparisons assessed by paired t-tests with Bonferroni correction.

RESULTS: Total fat oxidation during exercise was higher in FAST compared to CARB (mean difference ± 95% CI; 11±4 g, p<0.001) and NIACIN (9±5 g, p=0.001). During exercise, plasma NEFA concentrations were lower in CARB and NIACIN compared to FAST (time x condition p<0.001, all p<0.05) and plasma insulin concentrations were higher in CARB compared to FAST and NIACIN (time x condition p<0.001, all p<0.05). Time by condition interactions were seen for total plasma BCAA and total plasma ketone body concentrations (all p<0.0001). Total ketone body concentrations were higher in FAST compared to both CARB and NIACIN at 120 and 240 minutes and higher concentrations in NIACIN compared to CARB at 240 minutes (all p<0.01). In contrast, total BCAA concentrations were lower in CARB compared to FAST and NIACIN at 120 and 240 minutes (all p<0.001).

CONCLUSION: These data suggest that post-exercise BCAA concentrations are suppressed by insulin and carbohydrate availability but not by reduced fatty acid availability per se, whereas ketone body concentrations are suppressed by reduced fatty acid availability independent from insulin.

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**POST-EXERCISE COOLING REDUCES SKELETAL MUSCLE TISSUE PERFUSION AND IMPAIRS POST-PRANDIAL AMINO ACID INCORPORATION INTO MUSCLE IN ACTIVE YOUNG ADULTS**

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INTRODUCTION: Cold-water immersion is commonly applied by athletes to facilitate post-exercise muscle recovery. However, post-exercise cold-water immersion blunts the increase in muscle protein synthesis rates following protein ingestion. Whether this effect can be attributed to cold-water immersion-induced reduction in muscle microvascular perfusion and a subsequent decline in post-prandial amino acid provision to the muscle remains unknown.

METHODS: Twelve, recreationally active, young males (24±4 y) performed a single resistance exercise session followed by water immersion for 20 min with one leg immersed in cold water (8°C: COLD) and the contralateral leg in thermoneutral water (30°C: CON). After immersion, a beverage was ingested containing 20 g free amino acids, 0.25 g L-[ring-13C6]-phenylalanine, and 45 g carbohydrates. Femoral artery blood flow and microvascular perfusion of the vastus lateralis

muscle were assessed for both legs simultaneously at rest, immediately following exercise and water immersion, and at t=60 and t=180 min following amino acid ingestion using Doppler and contrast-enhanced ultrasound, respectively. A percutaneous biopsy sample from the vastus lateralis muscle was collected from both legs at t=240 min to determine amino acid tracer incorporation in muscle protein. To assess differences between the CON and COLD leg, data were analyzed by two-way repeated-measures ANOVA (time x treatment leg; with post-hoc testing in case of significant interaction) or paired-samples t-tests where appropriate. Pearson's r was calculated to determine associations. A statistical level of $P<0.05$ was accepted. All data are expressed as mean±SD.

RESULTS: Immediately following water immersion, femoral artery blood flow and microvascular blood volume were significantly lower in the COLD vs CON leg (82±39 vs 165±67 mL/min, and 1.24±0.82 vs 3.13±1.64 video intensity, respectively, both $P<0.001$). Femoral artery blood flow remained lower in the COLD vs CON leg at t=60 min (80±52 vs 126±52 mL/min, $P=0.008$), while microvascular blood volume remained lower at both t=60 and t=180 min following beverage ingestion (0.90±0.84 vs 1.53±0.98, and 2.10±2.53 vs 2.77±2.81 video intensity, respectively, both $P<0.05$). Exogenous amino acid incorporation into muscle protein was lower in the COLD vs CON leg (0.011±0.004 vs 0.016±0.005 mole percent excess, respectively, $P<0.001$). The relative difference in post-prandial amino acid incorporation into muscle protein between the COLD and CON leg was strongly associated with the relative difference in microvascular blood volume between the two legs during recovery ($r=0.65$, $P=0.022$).

CONCLUSION: Cold-water immersion during post-exercise recovery greatly reduces muscle microvascular perfusion and, consequently, lowers post-prandial amino acid incorporation into muscle. Cold-water immersion during recovery from exercise should be avoided when nutrient delivery to muscle tissue is considered a priority.

## Invited Symposium

### IS-BM04 Neural modules in the control of movement: assessing the utility of EMG recordings

**HIGH-DENSITY INTRAMUSCULAR ELECTRODE ARRAYS**

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Although the concurrent activity of multiple motor units can be recorded with grid electrodes attached to the skin over a selected muscle, these recordings are limited to superficial muscles and are easily contaminated by crosstalk. More selective recordings can be obtained with intramuscular electrodes that can be inserted into both superficial and deep muscles. Importantly, relatively recent advances in technology have included the development of intramuscular electrodes with multiple detection points, so-called high-density intramuscular electrodes. These electrodes allow the simultaneous and accurate detection of large populations of motor units providing insight into mechanisms of human movement. Remarkably, the availability of multiple intramuscular EMG channels enables highly accurate automatic decomposition into the trains of motor unit action potentials activating a muscle compared with the decomposition of single channel EMG that requires considerable interaction by the human operator. We have used this technology in multiple experiments in humans and different animal species to investigate neural connectivity among trains of motor unit action potentials, compartmentalized activation of muscles, force estimation, responses to postural changes, and changes in motor unit composition following transfer of motor axons. The talk will focus on applications in the field of motor control and touch upon technological developments.

**NEUROMUSCULAR CHARACTERISTICS OF INDIVIDUAL HAMSTRING MUSCLES**

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The anatomy, mechanical properties, and relative contributions to the net hip extensor and knee flexor torques differ across the four hamstring muscles (semitendinosus, semimembranosus, and the long and short heads of biceps femoris). Pennation angle, for example, is greatest in the long head of biceps femoris and least in semitendinosus, which maximizes force capacity and range of motion, respectively, in the two muscles. Moreover, the force produced by the long head of biceps femoris varies with changes in hip and knee angles, whereas the torque produced by semitendinosus does not. The anatomy of semitendinosus differs from the other hamstring muscles by the presence of a tendinous inscription in its middle to which the muscle fascicles in the proximal and distal compartments attach. Moreover, each compartment is innervated by a separate branch of the tibial nerve. As a result of this anatomy, the neural drive to the two compartments during submaximal isometric contractions is independent, as indicated the low correlations in the neural drive to the two compartments as measured with high-density surface EMG electrodes. Although the overall activation of biceps femoris and semitendinosus does not differ across exercises, some exercises preferentially engage one muscle over the other. For example, hip-dominant exercises primarily engage the semitendinosus. Recent advances in high-density surface EMG have been used to acquire a more detailed assessment of muscle activation patterns and neural drive to the hamstring muscles during different exercises. Integrating these advanced techniques can enhance our understanding of hamstring function, with significant implications for improving injury prevention strategies, optimizing rehabilitation protocols, and augmenting athletic performance.

**NEURAL MODULES AT THE MOTOR UNIT LEVEL**

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In the field of motor control, the term "synergy" is used to denote a motor module developed by the nervous system to manage the redundant degrees of freedom that are available to perform an intended action. Motor modules derived from covariation in the amplitudes of surface EMG recordings are known as "muscle synergies". They are presumed to reflect the concurrent activation of several muscles by the same motor command. Neural modules can also be defined at the motor unit level by using factor analysis to identify motor units with correlated modulation of discharge rates. This approach requires the use of high-density EMG technology to record the activity of many motor units in several muscles. Motor units with correlated discharge rates are presumed to share a significant proportion of synaptic input. These neural modules are referred to as "motor unit modes". In contrast to the extensive literature on muscle synergies, recent findings indicate that not all the motor units in a muscle belong to the same motor unit mode. This means that the shared synaptic input is distributed to sets of motor units within and across muscles. Moreover, the strength of the correlated discharge rate among the motor units within a mode can be changed by a brief bout of physical activity. These findings provide new opportunities to explore the plasticity of networks within the spinal cord of humans.

## Oral Presentations

### OP-AP14 Team Sports IV - Rugby and Australian Football

**CAFFEINE SUPPLEMENTATION ATTENUATES SEVERAL NEGATIVE EFFECTS OF MENTAL FATIGUE DURING SIMULATED RUGBY LEAGUE MATCH-PLAY**

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INTRODUCTION: Mental fatigue is characterised by feelings of tiredness, decreased motivation and a lack of energy, which can have adverse effects on subsequent cognitive, skilled and physical performance. Caffeine intake, in doses between 1-6 mg·kg-1, is widely known for its ergogenic properties and has been shown to enhance endurance and cognitive performance. While caffeine has been shown to enhance endurance performance under mental fatigue, its effects on rugby-specific performance remain unexplored. The purpose of the study was to describe the effects of mental fatigue on simulated rugby league performance and to determine the effects of caffeine supplementation in the presence of mental fatigue.

METHODS: Ten male university rugby players (age = 23 ± 4 y, body mass = 81.2 ± 6.8 kg, stature = 1.79 ± 0.06 m, predicted maximal oxygen uptake [VO2max] = 51.1 ± 5.5 ml.kg-1.min-1) completed four trials of the rugby league movement simulation protocol for interchanged players (RLMSP-i) in a randomised, repeated measures, double-blind design. After baseline measurements, participants completed a control, mental fatigue, caffeine (5 mg.kg-1) and a placebo trial of the RLMSP-i, with 5-8 days between trials. Mental fatigue was induced using a cognitively demanding task (30 min incongruent Stroop). Throughout all protocols, movement characteristics using a GPS device, heart rate and rating of perceived exertion were recorded. Before, at half time and immediately after the protocol, reaction time and passing accuracy were measured. Subjective task load (NASA-TLX) was reported on completion of each trial. Data are presented as means ± SD and effect sizes (ES) ± 90% confidence intervals (CI).

RESULTS: Completing a mentally demanding task increased participants' subjective rating of mental fatigue (pre = 29 ± 25 AU; post = 55 ± 20 AU) immediately before completing a simulation protocol. Impairments in sprint speed (ES = -0.18; ±0.19), sprint to contact speed (ES = -0.20; ±0.27), high-intensity running (ES = -0.30; ±0.24), high metabolic power > 20 W·kg-1 (ES =-0.50; ±0.51) and time to complete a passing accuracy task (ES = 0.54; ±0.63) were observed after mental fatigue. Caffeine supplementation (5 mg.kg-1) attenuated several adverse effects of mental fatigue, with increased sprint speed (ES = 0.40; ±0.18), high-intensity running (ES = 0.50; ±0.53), high metabolic power > 20 W·kg-1 (ES = 0.33; ±0.38) and decreased time to complete a passing accuracy test (ES =-0.70; ±0.45).

CONCLUSION: Mental fatigue affected the internal loads, external loads and skill performance during simulated rugby league match play that appear to be centrally regulated by a decreased motivation and increased perception of effort. However, a single dose of caffeine (5 mg.kg-1) taken 60 min before performance can attenuate several of these adverse effects, supporting its role as an effective countermeasure for mental fatigue-induced declines in team sport performance.

**EXPLORING THE VARIANCE IN SUBJECTIVE SYMPTOMS AND PERFORMANCE IN AUSTRALIAN FOOTBALLERS ACROSS MENSTRUAL CYCLE PHASES AND HORMONAL CONTRACEPTIVE USE**

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INTRODUCTION: Minimal evidence supports the implementation of an individualised approach to menstrual cycle management in team sports, especially one that accounts for cycle variability. This study explored strength and power performance changes across the menstrual cycle and phases of hormonal contraceptive (HC) use over two cycles.

METHODS: Fourteen professional female Australian footballers participated in a 13-week pre-season study, reporting daily symptom severity. Naturally menstruating athletes (AthletesNMC, n=7) completed countermovement jump relative peak power (CMJ RPP) and isometric belt squat relative peak force (IBSQ RPF) tests during menstruation (days 2–6 after bleeding onset), ovulation (within 48 hours of a positive ovulation test), and the luteal phase (7–9 days post-ovulation). Athletes using HC (AthletesHC, n=7) were tested during bleeding and across three arbitrary phases. Results are reported as 95% CI [upper limit, lower limit]

RESULTS: Two athletes (IUD users) did not experience regular bleeding. Ovulation was confirmed in at least one cycle for all (14 ± 1.73 days) and across two cycles for three athletes. Two AthletesNMC were found to have progesterone levels (<16mmol/L) in the mid-luteal phase in one cycle but were (>16mmol/L) in the following cycle. Average bleed duration and cycle length were 4.5 ± 1.38 and 28.68 ± 5.06 days, respectively. Abdominal cramps were the most reported symptom (count=78). Daily symptom severity (SS) scores were significantly higher in HC users (p=0.004), with greater variability (SD = 4.33) compared to AthletesNMC (SD = 3.10). Peak SS occurred at different times (AthletesNMC: Day 2, 4.1 ± 8.4 AU; AthletesHC: Day 29, 3 ± 6 AU).Peak Power (CMJ RPP) (W/kg) results across the three phases in cycle 1 were 47.11 [45.16–49.07], 42.26 [38.75–45.76], and 44.79 [41.53–48.05], respectively. In cycle 2, these values were 43.50 [40.50–46.50], 41.34 [37.14–45.54], and 42.84 [40.14–45.54], respectively. A general decline in peak power is observed from cycle 1 to cycle 2 across phases, though the magnitude of change varies. Peak Force (ISBQ RPF) (N/kg) results in cycle 1 were 38.80 [33.60–43.99], 38.30 [32.61–43.98], and 36.18 [31.62–40.73], while in cycle 2, values were 39.29 [35.60–42.98], 44.70 [35.03–54.37], and 42.11 [36.40–47.82]. Peak force showed a more mixed trend, with values generally increasing in cycle 2, suggesting greater variability in force production across cycles.

CONCLUSION: This study demonstrates the variability in strength and power performance measures across menstrual cycle phases and hormonal contraceptive use in elite female athletes. Moreover, this study showed variance in performance between consecutive cycles and daily symptom severity between athletes naturally menstruating compared with those on hormonal contraception. Practitioners working with female athletes should consider individualised approaches when working with female athletes.

**DOES APPROACH DISTANCE MATTER? EXAMINING ITS EFFECTS ON SINGLE LEG VERTICAL JUMP EFFICIENCY AND PERFORMANCE OUTCOMES**

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INTRODUCTION: Running vertical jump is a fundamental movement pattern in various sports, particularly those requiring explosive takeoff, such as basketball layups, handball shooting and high jumping [1]. The effectiveness of approach distance in optimizing takeoff performance is influenced by multiple biomechanical factors, including takeoff technique, lower limb power and the conversion of horizontal velocity into vertical impulse. Moreover, variations in jumping mechanics between elite and general athletes may lead to distinct neuromuscular strategies. Therefore, this study aims to investigate the influence of different approach distances on lower-limb explosive force production and muscle activation during single-leg vertical jump, providing insight into the optimal approach strategy for maximizing performance.

METHODS: This study recruited 24 healthy male athletes, divided into elite group and general group (12 participants each). Participants performed single-leg vertical jumps with approach distances of 1 m, 3 m, and 5 m. The study analyzed lower limb joint angles, muscle activation, initial eccentric rate of force development (IRFD), speed strength index (SSI), reactive strength index (RSI), and reactive strength ratio (RSR). Two-way ANOVA, mixed design was conducted to compare lower extremities parameters across distances and groups.

RESULTS: The results indicated no significant difference in jump height across different approach distances. However, RFD, SSI, RSI and RSR were significantly higher in the 3 m and 5 m approaches compared to the 1 m approach (p = 000). Additionally, in the 3 m and 5 m approaches, the elite group exhibited significantly greater quadriceps activation and shorter contact time compared to the general group. The elite group also demonstrated less hip flexion (p = 000) and ankle dorsiflexion during takeoff (p = 000).

CONCLUSION: The findings suggest that approach distance does not significantly affect jump height, but takeoff velocity varies with approach distance. Notably, the 3 m and 5 m approaches resulted in significantly shorter contact times compared to the 1 m approach, facilitating greater explosive force output and more efficient energy utilization. Furthermore, the elite group demonstrated quadriceps activation, which enhanced the stretch-shortening cycle (SSC) effect. In contrast, the general group compensated for technical deficiencies with greater hip flexion and ankle dorsiflexion, potentially reducing energy transfer efficiency and jump performance. These results suggest that elite athletes may generate higher horizontal velocity in longer approach distances, affecting vertical energy conversion. Ultimately, lower-limb strength and SSC optimization remain crucial determinants of jump performance across different approach distances.

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**NMES CONDITIONING CONTRACTIONS IN COMBINATION WITH RESISTANCE TRAINING TO PROMOTE NEUROMUSCULAR AND FUNCTIONAL IMPROVEMENTS IN OLDER ADULTS**

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INTRODUCTION: Older adults experience physiological modifications in various aspects such as body composition, levels of strength, muscle mass quantity and quality, and bone density1. Taken together these factors may lead to physical limitations, decreased quality of life, increased risk of developing non-communicable diseases and potentially hospitalization2. To counter these modifications resistance training (RT) has proven to be a feasible and effective intervention that can also benefit older adults3. In this regard, Neuromuscular Electrical Stimulation (NMES) can be used to promote muscular reconditioning4.

METHODS: This study investigated the effects of 18 sessions of two different training methods. The experimental group (EXP) of 10 older adults (>65y) performed isometric RT with an NMES conditioning stimulus on the dominant (D) knee extensors. The control group (CTRL) of 12 active older adults (>65y) performed dynamic body weight and free-weight RT. Maximum voluntary contraction (MVC), peak power (P) of lower limbs, and physical capacities assessed with 5 Sit to Stand (5STS), Time Up and Go (TUG) and 6 Minutes Walking Test (6MWT) were assessed.

RESULTS: At the end of the intervention, the EXP group improved in MVC and power output in both legs (MVCD +30.4%, MVCnD +13.5%, $p<0.05$; PD +8.1%, PnD +7.1%, $p<0.05$). Also, both groups improved performance in 5STS, TUG, and 6 MWT (5STS EXP: -15.8%, 5STS CTRL: -15.1%, $p<0.001$; TUG EXP: -9.9%, TUG CTRL: -9.3%, $p<0.001$; and 6MWT EXP: +9.5%, 6MWT CTRL: +5.9%, $p<0.00$).

CONCLUSION: Isometric training with NMES conditioning can be a useful strategy to enhance physical and functional parameters in older adults. This approach could be useful in situations where traditional RT cannot be performed.

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**NON-TRADITIONAL METHODS OF SUPERVISING RESISTANCE TRAINING ARE AS EFFECTIVE AS TRADITIONAL SUPERVISION AT IMPROVING PHYSICAL PERFORMANCE IN OLDER ADULTS.**

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INTRODUCTION: Resistance training (RT) for older adults traditionally involves face-to-face supervision, but lack of time and requirements to travel are prevalent barriers to accessing RT among older adults. Non-traditional methods of supervising RT may alleviate these barriers and facilitate older adults' access to RT.

The aim of this study was to investigate the effect of RT supervision method on physical performance in older adults.

METHODS: Sixty-four community-dwelling, healthy older adults (OA) (66.4 ± 4.5 years; 66% female) were randomly assigned to a non-exercise control group (CON), or to 1 of 3 RT groups: traditionally supervised (TRAD) – 2 weekly supervised RT sessions in a community-centre; semi-supervised (SEMI) - 1 weekly supervised RT session in a community-centre and 1 weekly unsupervised RT session at home; and video-call supervised (VID) - 2 weekly RT sessions at home, supervised via video-call. Each participant was given 4kg, 8kg, and 12kg kettlebells and trained for 12 weeks, with training volume and intensity matched across groups. Physical performance was assessed pre- and post-intervention via Timed Up-and-Go (TUG), 30s Chair Stand (30CS), and Isometric Midthigh Pull peak force (IMTPPF). A two-way repeated measures ANOVA was used to determine the effects of training and supervision method on physical performance.

RESULTS: TUG improved in all training groups with no between-training group difference (TRAD: 7.36 ± 1.31s vs 6.58 ± 1.02s, $p < 0.001$, partial-eta squared = 0.18); SEMI: 7.90 ± 1.04s vs 6.70 ± 0.73s, $p < 0.001$, partial-eta squared = 0.29; VID: 7.11 ± 1.05s vs 6.69 ± 0.88s, $p = 0.048$, partial-eta squared = 0.06); there was no change in CON ($p = 0.795$). Similarly, 30CS (number of stands) improved in all training groups with no between-training group differences (TRAD: 19.05 ± 3.30 vs 24.40 ± 4.07, $p < 0.001$, partial-eta squared = 0.44; SEMI: 19.93 ± 3.63 vs 25.00 ± 3.95, $p < 0.001$, partial-eta squared = 0.34; VID: 20.37 ± 5.60 vs 22.90 ± 4.33; $p = 0.002$, partial-eta squared = 0.14); there was a decrease in stands in CON

(20.33 ± 4.08 vs 18.27 ± 4.65; p = 0.02, partial-eta squared = 0.08). There was no change in IMTPPF in any group (p = 0.076, partial-eta squared = 0.05).

CONCLUSION: Twelve weeks of supervised RT induced improvements in physical function (TUG and 30CS) in OA which were independent of the method of supervision used. Strength (IMTPPF) did not improve, which may be a function of the relatively low intensity of the RT prescribed in this study. Non-traditional methods of supervising RT may reduce barriers to participation while retaining effectiveness of a training intervention.

**NEVER TOO OLD, NEVER TOO LATE: EFFECTS OF 12 WEEKS OF SUPERVISED RESISTANCE TRAINING ON FRAILTY AND MUSCLE POWER IN FRAIL INSTITUTIONALIZED CENTENARIANS**

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INTRODUCTION: Although exercise interventions have shown benefits in the oldest-old population [1,2], their potential for improving frailty and muscle power, both predictors of healthy ageing, has not yet been explored in institutionalized centenarians. Hence, this study aimed to determine whether a resistance training intervention can improve frailty and muscle power in frail institutionalized centenarians.

METHODS: Twelve frail centenarians living in nursing homes (age 101.36 ± 2.09 years; 83.33% women) were randomly assigned to either an exercise (EX; n = 6) or a control (CT; n = 6) group. The EX group conducted supervised resistance training twice weekly for 12 weeks, while the CT group received usual care. Each resistance training session included 8 exercises with 1-3 sets of 8-10 repetitions, conducting the concentric phase as fast as possible at 50-70% of the estimated one-repetition maximum. The Frailty Trait Scale short form (FTS5), Fried's Frailty Phenotype (FP), and 30-s sit-to-stand (STS) muscle power test were assessed at baseline and after 12 weeks. Baseline values for both groups were compared using the Mann-Whitney test. Analysis of covariance (ANCOVA) with Bonferroni adjustment was used to determine within- and between-group differences in the effects of the intervention on the assessed outcomes. The significance level was set at $p<0.05$. The effect size (ES) was calculated using Hedge's g, and the percentage of change (Δ) was calculated as ((mean post–mean pre)/mean pre) × 100.

RESULTS: No significant differences between groups were observed at baseline in FTS5, FP and relative and allometric STS muscle power ($p>0.07$). After intervention, the EX group significantly improved FTS5 (Δ-9.8%; $p<0.01$; ES=0.59), FP (Δ-21.7%; $p<0.01$; ES=1.11) and relative (Δ+82.2%; $p<0.01$; ES=0.79) and allometric (Δ+79.9%; $p<0.01$; ES=0.76) STS muscle power. The CT group exhibited no significant changes in any outcome after 12 weeks ($p>0.11$; ES=0.75 to 0.13). ANCOVA revealed significant differences between the changes in the EX and CT groups, respectively, for allometric (+14.51 vs. -3.87 W·m-2; $p<0.01$) and relative (+0.68 vs. -0.22 W·kg-1; $p<0.01$) STS muscle power, and FP (-0.83 vs. +0.33 points; $p<0.01$); while a no significant between-group difference was found for FTS5 (-3.33 vs. +0.33 points; $p=0.15$). No side effects were detected.

CONCLUSION: Supervised resistance training effectively and safely reduced frailty and improved muscle power among frail institutionalized centenarians. These results underscore that no one is too old or unfit to benefit from exercise-based interventions.

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**PROTEIN ENHANCES MUSCLE STRENGTH FOLLOWING PROGRESSIVE RESISTANCE TRAINING: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Progressive resistance training combined with adequate protein intake is recognized as a key strategy to combat the age-related decline in muscle strength in older adults. Despite substantial research in this area, the extent to which protein enhances strength gains from resistance exercise training remains unclear. This study aims to evaluate the additional effects of a protein intervention during progressive resistance training on skeletal muscle strength, and to determine whether this effect differs by habitual protein intake levels in frail community-dwelling older adults.

METHODS: This 12-week randomized controlled trial included 295 frail community-dwelling older adults (≥65 years) into 12 training intensity groups (25–80% of one-repetition maximum). Under one-to-one supervision, participants performed twice weekly full body resistance training until volitional muscular failure. In addition, participants were allocated to either a protein intervention or no protein intervention. The protein intervention comprised dietary counselling and free daily availability of 20g whey protein products to achieve a total daily protein intake of 1.2-1.5 g/kg bodyweight. The outcome was lower-extremity muscle strength leg press. Linear Mixed Models were performed using SPSS with time and time x intervention interaction.

RESULTS: Participants with a mean age of 74 (SD=6), 69% female and 64% overweight or obese had a baseline protein intake of 1.1±0.3g/kg/day. The participants in the protein training group significantly increased their protein intake (β±SE) compared to the training only group with +0.4±0.1g/kg/d (p<0.001). For all participants, muscle strength significantly improved with +25±1 kg (p<0.001) after 12 weeks. Muscle strength significantly increased more in the protein training group than in the training only group (+5 kg, p=0.032). For participants with a baseline protein intake of <0.8, 0.8–1.0, 1.0–1.2, and >1.2 g/kg/day, the protein training group demonstrated muscle strength improvements of +14±5 kg (p=0.014), +5±4 (p=0.259), +7±5 (p=0.134) and -2±4 (p=0.583), respectively compared to the training only group.

CONCLUSION: A protein intervention combined with progressive resistance training is effective in enhancing muscle strength in frail community-dwelling older adults, particularly when habitual protein intake is low.

**THE BENEFICIAL EFFECT OF 12 WEEKS OF RESISTANCE TRAINING ON BALANCE CONTROL OF MILD COGNITIVELY IMPAIRED OLDER ADULTS**

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INTRODUCTION: The interplay between motor functions and cognitive abilities is a critical focus in aging research. Studies consistently show a strong relationship between motor and cognitive functions, which becomes particularly important as individuals age. Deficits in one area can impact the other, underscoring the complex dynamics between motor and cognitive interactions. For instance, reduced balance and poor movement control have been linked to a higher risk Mild Cognitive Impairment (MCI) and Alzheimers disease. Our study is based on the hypothesis that strength training reduces the dual-task effect on both balance control and cognitive function.

METHODS: A total of 53 participants completed the intervention (mean age: 69 ± 6.2 years). Based on the MoCA test results, participants were divided into two groups: those with a high risk of MCI (hrMCI, MoCA score 25 or below) and those with low risk of MCI (lrMCI, MoCA score 26 or above). Static posturography was evaluated using a force plate (KISTLER, Slimline System 9286). Postural sway velocity of the center of pressure (Vcop) was assessed across two positions—Dual Stance (DS) and Tandem Romberg Stance (TR). Cognitive domains were tested with Automated Neuropsychological Assessment Metrics (ANAM) battery. Participants completed two-choice reaction time, mathematical processing, and memory search cognitive tests. Participants in the experimental group took part in a 12-week progressive resistance exercise (RT) program, while participants in the control group did not receive any treatment. Training sessions were held twice a week, each session lasting 1 hour. The effect of 12 weeks of resistance training on cognitive function and balance control was assessed using a three-factor ANOVA, where "Time" was a repeated measure, and "Group" and "MCI Risk" were between-group factors.

RESULTS: The 12-week RT intervention yielded some balance improvements in the experimental hrMCI group as observed by the marginal three factor interaction (F=3.151, p=0.082, ηp2 =0.062). Exploratory analysis of this interaction showed significant reduction of Vcop in hrMCI group while performing the ST-TR-EO condition in both the ML [Vcop pre 16.1(5.96) mm/s – Vcop post 12.34(4.98) mm/s (p=0.03)] and AP [Vcop pre 16.44 (6.69) mm/s – Vcop post 14.68 (6.08) mm/s (p=0.023)] directions. Regarding between-subject effects, no significant differences were found between the experimental and control groups for any of the cognitive tests (p = 0.124).

CONCLUSION: Our study partially supported the hypothesis that strength training can improve balance control. While balance control indicators significantly improved after the training, cognitive performance did not change, indicating that the RT induced more pronounced beneficial effects on balance control than on cognitive performance.

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## Oral Presentations

### OP-BM16 Sports Biomechanics

**MUSCLE FORCE DYNAMICS ACROSS INCREASING SQUAT INTENSITY CONDITIONS IN ELITE POWERLIFTERS**

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INTRODUCTION: Since the rise of powerlifting, consisting of the squat, bench press, and deadlift, calls for biomechanically informed coaching strategies have become increasingly important to maximise performance and enhance technique. Understanding the muscle forces at work can play a key part in this endeavour and musculoskeletal modelling provides a

non-invasive and valid means for estimating in-vivo muscle forces [1]. So far, only a small number of musculoskeletal modelling studies focussed on analysing muscle forces during squats in elite athletes [2]. The aim of this study was to investigate the effects of increasing intensity in the squat on muscle forces in elite powerlifters.

METHODS: 3D movement data and ground reaction forces were recorded from 29 top-ranked powerlifters (age: 26.1±5.4 years; 1-repetition-maximum: 2.4±0.4 x body mass) performing squats at 70%, 75%, 80%, 85% and 90% of their 1-repetition-maximum. Personalized musculoskeletal models based on the "Catelli"-model [3] were used to estimate muscle forces in OpenSim [1]. Maximum isometric muscle forces of the models were adjusted based on the muscle volumes obtained from magnetic resonance imaging of six athletes [4]. Statistical Parametric Mapping was used to compare muscle forces waveforms throughout the squat across various intensity conditions.

RESULTS: While muscle forces increased significantly at higher intensities, the extent of this increase varied between the muscles examined. The gluteus maximus showed the greatest increase in muscle forces (eccentric: +25.1%±8.6; concentric: +24.6%±7.2) and the vasti muscles exhibited the highest absolute muscle forces (eccentric: 13.2±2.4 x body weight; concentric: 12.3±2.5 x body weight) but did not show a significant increase in the deepest position of the squat with increasing intensities. Furthermore, the ratio between the muscle forces of single-joint and multi-joint hip extensors was inversely correlated with the performance level of the athletes.

CONCLUSION: According to our results the increase in muscle forces was not uniform between the muscles tested. Consequently, the gluteus maximus could be identified as the muscle increasingly involved at high intensities, while the vasti muscles contributed to the squat with the highest muscle forces. The higher the athletes performance level, the more likely they were to rely on multi-joint hip joint extensors. Athletes should therefore favour a hip dominant squatting style. By tailoring training programmes and fine-tuning squat techniques based on these biomechanical findings, lifters can maximise their performance.

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**EFFECTS OF RANGE OF MOTION VARIATIONS ON MUSCLE EXCITATION DURING TWO UPPER BODY RESISTANCE EXERCISES**

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INTRODUCTION: Recent research has highlighted partial range-of-motion (ROM) exercises as potentially equal or superior to full-ROM training for promoting hypertrophy and strength adaptations [1,2]. However, possible differences in muscle excitation between full and partial ROM—and thus potential mechanisms underlying these adaptations—remain largely unexplored, particularly for upper-body exercises. Therefore, this study investigated the effects of ROM variations during two resistance exercises, bench press (BP) and the prone barbell row (PBR), on muscle excitation.

METHODS: Nineteen resistance-trained male participants (24.3±3.1 years) performed 10-repetition-maximum (10RM) sets of the BP and PBR in three ROM conditions: full ROM, upper-half ROM, and lower-half ROM. Surface electromyography (sEMG) was recorded from primary muscles (BP: pectoralis major [clavicular, sternocostal], triceps brachii [long, lateral], anterior deltoid; PBR: latissimus dorsi, trapezius transversus, rear deltoid, biceps brachii). BP repetitions were standardized by controlling movement velocity (2s up, 2s down for full ROM; 1s up, 1s down for partial ROMs), whereas the row was standardized by matching total time under tension (2s up, 2s down) across all ROMs. Mean and peak sEMG amplitudes were analyzed across repetitions. A repeated measures ANOVA (one factor, levels: full ROM, upper-half ROM, lower-half ROM) assessed possible differences in performance and muscle activity. Bonferroni post-hoc tests followed significant main effects. The alpha level was set to $p \leq 0.05$.

RESULTS: In the BP, significant differences ($p<0.01$) in mean sEMG were found across all tested muscles for the three ROM conditions. The upper-half ROM showed the highest mean excitation in the triceps, while both partial-ROM conditions showed greater mean excitation in the pectoralis major and anterior deltoid compared to the full ROM. For the PBR exercise, the latissimus dorsi exhibited significantly greater mean excitation during the upper-half ROM compared to lower-half and full ROM ($p<0.01$), whereas the trapezius transversus showed lower peak excitation in the upper-half ROM ($p<0.05$).

CONCLUSION: In summary, these findings highlight that partial-ROM strategies can alter muscle excitation in both pushing and pulling exercises. Moreover, the method of standardization (i.e., movement velocity versus total time under tension) may influence the observed activation patterns. However, these results are based on the acute relationship between muscle excitation and ROM and do not provide direct insights into long-term adaptations [3,4]. Future research should investigate how these excitation patterns translate to changes in muscle hypertrophy and strength over time.

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**IS MUSCLE ACTIVATION REGULATED ACCORDING TO ITS MECHANICAL ACTION? THE OPTIMAL ACTIVATION ANGLE OF HIP MUSCLES IS NOT NECESSARILY ALIGNED WITH THE PROJECTED MOMENT ARM VECTORS IN THE TRANSVERSE PLANE**

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INTRODUCTION: The nervous system controls the activation of hip muscles according to the magnitude and direction of the muscle forces required during various movements (1). The mechanical action of each muscle is traditionally estimated as the projected moment arm vector (2). However, it remains unclear whether neuromuscular activation is appropriately regulated according to its mechanical action. To investigate this, we developed a novel method to quantify the direction in which a muscle exhibits the highest level of neuromuscular activation among multiple external force directions (the optimal activation angle). This study aimed to determine the optimal activation angles of hip muscles and evaluate their deviations from the projected moment arm vector in the transverse plane.

METHODS: Eight male participants performed maximum voluntary isometric contractions (MVICs) for 3 s in eight directions (hip adduction, flexion, abduction, extension, and in between them [every 45°]) at the hip flexed by 0° and the knee flexed by 90°. Surface electromyograms (EMG) were recorded from the major 14 hip muscles. A root mean square (RMS) of EMG during MVICs (1 s) and corresponding direction of exeternal force were plotted in a polar coordinate system, with the RMS as the radius and direction of exeternal force as the angle from the polar axis. For each muscle, the centroid of the eight MVICs was calculated in the polar coordinates. The optimal activation angle for each muscle was defined as the angle of the line connecting the centroid and the pole from the polar axis. The projected moment arm vector was calculated using the musculoskeletal simulation model (OpenSim) for each muscle. The Wilcoxon signed-rank test was used to compare the optimal activation angle with the projected moment arm vector.

RESULTS: The optimal activation angles deviated from the projected moment arm vector in the sartorius, adductor longus and magnus, gracilis, biceps femoris long head, upper and lower parts of gluteus maximus, and anterior part of gluteus medius (12.0-63.5° [all $p < 0.05$]). However, the optimal activation angles of the other six muscles did not deviate from the projected moment arm vector.

CONCLUSION: Our findings showed that the optimal activation angles of several hip muscles deviated from their projected moment arm vector, with the lower part of gluteus maximus exhibiting deviations over 60°. These results suggest that certain hip muscles prioritize other functions (e.g., joint stabilization) rather than their mechanical actions. Training exercises that considering the optimal activation angle of the target muscles may be more effective than traditional exercises based on their mechanical actions.

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**A WEIGHTLIFTING BELT INCREASES SQUAT PERFORMANCE AND SUBJECTIVELY PERCEIVED BUT NOT OBJECTIVELY MEASURED POSTURAL STABILITY**

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INTRODUCTION: Weightlifting belts are subjectively perceived to enhance stability and improve athletic performance. However, the mechanisms behind performance enhancement are poorly researched. This study thus aims to determine whether athletic performance and postural stability are objectively increased by wearing a weightlifting belt and whether the effects are affected by sex or experience with belt application.

METHODS: Belt experienced (n=15) and unexperienced (n=14) men (height 182±7cm; weight 88±10kg), and experienced (n=11) and unexperienced (n=9) women (height 168±6cm; weight 66±6kg) participated in two measurement sessions one week apart. In each session, two sets of squats to exhaustion with the beltless 6-repetition maximum weight (6RM) were performed while standing on force plates, wearing (B) or not wearing (noB) the belt in a randomized order, which was reversed in the second measurement session. The number of repetitions, movement duration, postural sway and subjectively perceived stability were compared between conditions.

RESULTS: With belt application, the number of repetitions increased regardless of sex or belt experience (B 8.1±1.7; noB 6.5±1.3, $p<0.001$), while the duration of the concentric phase of squats decreased (B 1.99±0.2s; noB 2.09±0.2s, $p<0.001$). Wearing the belt subjectively increased postural stability but did not do so objectively. The normalized path length, adjusted for movement duration, was significantly increased in experienced individuals, indicating reduced postural stability with belt application ($p<0.05$).

CONCLUSION: As hypothesized, the belt application led to increased movement velocity, the completion of more repetitions, and increased subjectively perceived trunk stability and sense of security. These effects were observed regardless of sex. However, in contrast to our hypothesis, neither static nor dynamic postural stability improved by wearing the belt and experience with belt application was not necessary to benefit from its positive effect on performance.

Thus, if athletes or coaches aim to acutely improve performance e.g. at competition, it is advisable to wear a belt during squatting. However, in agreement with other publications, it may not be advisable to constantly wear a weightlifting belt during training, as this could result in negative and unwanted side effects, and affect muscular adaptation and injury risk. The higher movement velocity with belt-wearing observed by us and others, may increase the stress acting on joints. In

addition, the subjective perception of improved stability and sense of security, while objectively measured postural stability decreases at the same time, could potentially mislead the athlete to perform a less controlled movement, thereby increasing the risk of injury.

**BIOMECHANICAL CORRELATION ANALYSIS USING INDEPENDENT WIRELESS SYSTEMS IN YOUTH FOOTBALL PLAYERS**

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INTRODUCTION: Youth football is a globally popular sport but carries significant injury risks, particularly for younger athletes [1]. Injury prevention relies on monitoring movement patterns during functional tasks, traditionally achieved using lab-based motion capture systems [2]. However, these systems are resource-intensive and unsuitable for on-field use. Wireless sensor systems, such as the DAid® smart sock, provide portable and real-time solutions for measuring specific biomechanical variables [3]. Despite their potential, widespread adoption is hindered by challenges such as calibration, data synchronization, and compatibility between independent sensor systems [4]. Additionally, using multiple sensor systems to measure specific biomechanical variables is often complex and time-consuming [5]. Therefore, it is crucial to explore correlations between different systems to identify a unified and convenient solution that ensures reliable and practical data collection.

METHODS: Thirty-two youth football players (16 males, 16 females, aged 14–15) participated. Participants performed "Single Leg Squat" tests while data was collected using the DAid® smart textile socks (center of pressure (COP)), the NOTCH® inertial sensor system (thigh and lower leg angles), and the PLUX® Wireless Biosignals (muscleBAN kit) (muscle electrical activity). Correlations were calculated using Spearman's rank correlation analysis.

RESULTS: Significant correlations demonstrated the utility of wireless systems. Hip adduction correlated with medial plantar pressure (COP1X: $r = 0.785$, $p < .001$), and hip internal rotation with anterior plantar pressure (COPY1: $r = 0.585$, $p < .01$). Knee flexion correlated with GM muscle activity ($r = 0.66$, $p < .001$). Negative correlations included medial plantar pressure (COP2W) and GMx muscle activity ($r = -0.592$, $p < .001$). Gender-specific analysis showed males had stronger associations between hip adduction and COP1X, while females exhibited stronger relationships between knee flexion and plantar pressure parameters.

CONCLUSION: Wireless systems, such as the DAid® smart sock, show great potential for assessing lower limb biomechanics in youth football players by using one sensor system at the time, providing a portable on-field monitoring solution. Gender-specific differences underscore the need for individualized assessments, supporting injury prevention and performance optimization.

## Oral Presentations

### OP-PN06 Nutrition III - Amino Acids and Protein I

**THE EFFECT OF HMB SUPPLEMENTATION AND HIGH-INTENSITY FUNCTIONAL TRAINING STIMULI ON RESTING AND POST-EXERCISE BLOOD HEMATOLOGICAL AND ACID-BASE BALANCE INDICES IN TRAINED AND UNTRAINED MALES**

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INTRODUCTION: The study aimed to verify the effect of HMB (90 mgHMB/kgFat-free mass[FFM]) supplementation alone (SUP) and in combination with high-intensity functional training (HIFT) on resting (REST) and post-exercise (POST-EX) blood hematological and acid-base balance indices in trained (TR) and untrained (UTR) adult males.

METHODS: The randomized double-blind placebo(PLA)-controlled parallel study was performed in 30 TR (28.6±9.4 yrs) and 30 UTR (33.9±8.0 yrs) males. After the baseline (BAS) visit, participants were randomized into HMB (TR_HMB, n = 15; UTR_HMB, n=15) or PLA (TR_PLA, n=15; UTR _PLA, n=15) supplementation. There were two 3-week periods: 1) SUP – ingestion of either HMB or PLA and performing usual training cycle (TR) or no training (UTR), and 2) SUP+FGB – ingestion of either HMB or PLA and implementing the additional exercise stimuli (TR and UTR; two Fight Gone Bad workouts per week). Blood samples were taken at REST and POST-EX (3 min after the incremental cycling test to exhaustion [ICT]). Hematological evaluation was performed using the hematology analyzer Mythic®18 (Orphée, Switzerland) and gasometric/acid-base balance evaluation using a blood gas analyzer (ABL90 FLEX, Radiometer, Denmark). The data were analyzed using RM ANOVA with training status and type of supplement as qualitative factors.

RESULTS: There were no significant effects of training status x supplement type interactions across study visits for REST and POST-EX white blood cell and subset counts and percentage, red blood cell counts, concentration of hemoglobin, or other hematological indices. Similarly, no such effects were observed for blood pH, base excess [BE], anion gap [AG], or concentration of H+ and bicarbonate (HCO3-). Still, regardless of the type of supplement (HMB/PLA) or training status (TR/UTR), POST-EX pH (7.161±0.064 vs 7.184±0.062; p=0.005) and HCO3- concentration (15.6±2.1 vs 16.3±2.1 mmol/L; p=0.001) were significantly lower at SUP+FGB compared to BAS; while POST-EX H+ concentration (69.7±10.6 vs 66.1±9.5 mmol/L;

p=0.006), absolute BE (-9.6±3.8 vs -8.5±4.1 mmol/L; p=0.015) and AG (22.5±3.5 vs 21.5±3.1; p=0.012) were significantly higher at SUP+FGB compared to BAS. There were no significant effects of training status x supplement type interaction across study visits for REST and POST-EX concentrations of lactate, glucose, Na+, K+, Ca2+, and Cl-. There was a significant effect of training status x supplement type interaction for REST blood osmolality (OSM; p=0.028). Being TR and ingesting HMB was related to lower OSM.

CONCLUSION: No association was found between HMB supplementation alone and combined with HIFT stimulation on REST and POST-EX blood hematological and acid-base balance indices in trained and untrained males. Furthermore, the observed POST-EX changes in acid-base balance at SUP+FGB treatment may result from a higher intensity during ICT efforts rather than the implemented HIFT stimulation.

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**HABITUAL DIETARY COLLAGEN INTAKE IS LOWER IN WOMEN AND OLDER IRISH ADULTS COMPARED TO YOUNGER MEN**

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INTRODUCTION: There has been growing interest in the effects of dietary collagen intake, with and without exercise, on joint pain, exercise recovery, body composition, sleep quality, and muscle and tendon function (1,2). However, the quantity of collagen intake in the diet of European adults is unknown. The aim of this study was to investigate collagen intake in the habitual diets of Irish adults, and whether it differed by sex and/or age.

METHODS: We conducted secondary analysis of the Irish National Adult Nutrition Survey, which assessed typical dietary intake using a four-day semi-weighed food diary in 1,500 adults, aged 18-90 years. Participants were categorised into young (18-39 years, n=630), middle-aged (40-64 years, n=644), and older (≥65 years, n=226) adults. Collagen composition of food items was determined by applying a percentage collagen value from analytical sources, allowing computation of collagen mean daily intake (MDI), collagen MDI relative to body mass, and collagen/total protein MDI. Age and sex differences in intakes were analyzed using ANCOVA, with physical activity as a covariate due to its positive association with total protein intake in European adults (3).

RESULTS: Collagen MDI for the entire population was 3.2±2.0 g·day-1, representing just 3.6±1.9% total protein intake. Men had higher absolute and relative collagen MDI than women, regardless of age (4.0±2.1 g·day-1 vs. 2.3±1.4 g·day-1, p<0.001), and the collagen MDI as a proportion of total protein MDI was also higher in men (4.0±1.9%) than in women (3.4±1.8%, p<0.001). Furthermore, older adults had lower absolute collagen MDI than middle-aged adults (2.9±1.8 g·day-1 vs. 3.3±2.0g·day-1, p=0.021).

CONCLUSION: Collagen intake in the Irish adult population was low relative to total protein intake and considerably lower than the 15-30 g doses of collagen necessary to enhance collagen synthesis in intervention studies (4). Women and older adults had particularly low intakes, suggesting they may benefit most from dietary strategies or supplementation to optimise the health and performance of collagen-rich tissues, although achieving effective doses through food alone may be challenging.

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**NO DIFFERENCE IN EXERCISE-INDUCED MUSCLE DAMAGE AFTER CONSUMING COW'S MILK OR A SOYA DRINK: A RANDOMISED CONTROLLED TRIAL**

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INTRODUCTION: Cow's milk is rich in protein and considered a cheap, accessible food-first option for augmenting skeletal muscle protein synthesis. Several studies have also suggested that consuming cow's milk after exercise can attenuate symptoms of exercise-induced muscle damage (EIMD), such as delayed-onset of muscle soreness (DOMS) and decrements in muscle function, likely due to the stimulatory effects of dietary protein on skeletal muscle remodelling. However, a growing number of individuals avoid consuming cow's milk for ethical, health, or sustainability reasons. Soya drinks have a comparable macronutrient composition and therefore may be a promising plant-based alternative to cow's milk. However, it remains unclear whether soya drinks have comparable effects on symptoms of EIMD to cow's milk. Thus, this study aimed to examine whether protein-equivalent doses of soya drink or cow's milk similarly affected EIMD symptoms after strenuous exercise.

METHODS: In a randomised, double-blind, parallel groups design, 23 strength-trained individuals (16 M, 7 F; age 24±3 y; height 1.8±0.1 m; mass 77.3±13.3 kg) consumed cow's milk (n=11) or a soya drink (n=12) after 100 drop jumps from a 60 cm platform. Doses (0.25g/kg/body mass of protein) were consumed immediately post-exercise and 30 mins prior to sleep on two consecutive days (4 total). Pre- (PRE), 24 h-post- (24H), and 48 h-post-exercise (48H), knee extensor maximum isometric voluntary force (MIVF), torque (MIVT), and rate of force development (RFD); countermovement jump height (CMJ); modified reactive strength index (RSIMOD); DOMS (0-200 mm VAS); and pressure pain threshold of the rectus femoris (PPTRF) and vastus lateralis (PPTVL) were measured. Mixed-model ANOVAs assessed group x time interactions (Bonferroni-adjusted for post-hoc tests). Data are presented as Δ percentage change from PRE, and mean±SD.

RESULTS: MIVF, MIVT and RFD decreased post-exercise (P<0.001) but were not different between SOY and MILK (P≥0.193), decreasing by ≤19% and ≤25% at 24H, and remaining ≤16% and ≤15% below baseline at 48H, respectively. MIVF was reduced from PRE (803±226 N, 792±209 N) at both 24H (665±200 N, 793±667 N) and 48H (724±231 N, 678±223 N), in SOY and MILK, respectively. Similarly, CMJ and RSIMOD decreased in both groups at both post-exercise time-points (≥13%), but this was not different between groups (P≥0.284). DOMS, PPTVL, and PPTRF increased post-exercise, but this was not different between groups (P≥0.185). At 24H, DOMS increased from PRE (7±9 mm, 9±13 mm) by 158% and 163% (59±42 mm, 88±37 mm), and 150% and 159% at 48H (49±47, 78±44 mm), in SOY and MILK, respectively.

CONCLUSION: Protein-matched doses of cow's milk and soya drink did not differentially modulate muscle function or DOMS after strenuous exercise, suggesting that soya drinks and cow's milk have comparable effects on symptoms of EIMD.

**INGESTION OF 20 G WHEY OR CANOLA PROTEIN DOES NOT FURTHER INCREASE MUSCLE PROTEIN SYNTHESIS RATES DURING RECOVERY FROM RESISTANCE EXERCISE IN HEALTHY, YOUNG FEMALES**

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INTRODUCTION: Protein ingestion during recovery from exercise can further increase muscle protein synthesis rates. The capacity of a protein source to stimulate muscle protein synthesis is largely determined by its digestion and amino acid absorption kinetics, and amino acid composition. Plant-derived proteins are generally believed to have lesser anabolic properties when compared to animal-derived proteins. Canola, a rapeseed-derived protein, has a well-balanced amino acid profile and may, therefore, be effective in stimulating muscle protein synthesis during recovery from exercise. Here, we assessed post-prandial plasma amino acid profiles and muscle protein synthesis rates following the ingestion of 20 g canola protein, 20 g whey protein, or a non-caloric placebo during recovery from a single bout of resistance exercise in healthy, young females. Given the paucity of data in women, we specifically included healthy, young females.

METHODS: In this randomized, parallel group, double-blind placebo-controlled design, 36 healthy young females (23±4 y, BMI: 22.7±2.2 kg/m2) performed 8 sets of lower-body resistance exercise at 80% of their predetermined 1-repetition maximum after which they ingested a 300 mL beverage providing either 20 g canola protein isolate, 20 g whey protein isolate, or a non-caloric placebo. Primed continuous L-[ring-13C6]-phenylalanine infusions were applied with frequent sampling of blood and muscle tissue to assess post-prandial plasma amino acid profiles and both basal and 5-hour post-exercise muscle protein synthesis rates. Post-exercise muscle protein synthesis rates were compared between groups as primary outcome, using one-way ANOVA; time-dependent variables were analyzed using a repeated measures ANOVA with time as a within- and treatment (canola, whey, placebo) as between-subject factor. Data are presented as means±SD.

RESULTS: Plasma essential amino acid concentrations strongly increased following ingestion of both canola and whey protein when compared with the placebo treatment (Peak: 1249±173, 2113±354, and 780±60 μmol/L respectively; P<0.001) with greater post-prandial plasma essential amino acid availability following whey vs canola protein ingestion (158±50 vs 90±23 mmol·5 h/L; P<0.001). Muscle protein synthesis rates significantly increased from 0.042±0.016 to 0.067±0.015 %/h during recovery from exercise across all treatment groups (Time: P<0.001). No differences in post-exercise muscle protein synthesis rates (0.071±0.015, 0.069±0.016, 0.061±0.013 %/h, P=0.200) were observed following the ingestion of canola protein isolate, whey protein isolate, and placebo, respectively.

CONCLUSION: A single session of resistance exercise strongly increases muscle protein synthesis rates in young females. Ingestion of 20 g canola or whey protein does not further augment muscle protein synthesis rates during the early stages of post-exercise recovery in healthy, young females.

**FOREARM FOUR-POOL MODELLING: A NOVEL APPROACH TO QUANTIFYING SKELETAL MUSCLE AMINO ACID FLUXES**

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INTRODUCTION: Current methods to study the role of amino acid (AA) availability in the regulation of skeletal muscle mass are limited. Available methods often capture merely part of muscle AA metabolism, and tend to rely on assumptions e.g. that AA uptake (measured indirectly as plasma AA disappearance) equals muscle protein synthesis (MPS; measured via direct incorporation). Our aim was to establish an innovative model to comprehensively assess forearm muscle protein metabolism in a four-pool kinetics manner, by combining the arterialised venous-deep venous forearm model with stable isotope tracer infusion and m. brachioradialis biopsy sampling under rested and insulin-stimulated conditions.

METHODS: Nineteen healthy participants (4/15 F/M, 22±1 yrs, BMI 23.1±0.5 kg·m-2) took part in an experimental test day during which they were intravenously infused with L-[ring-2H5]phenylalanine. Repeated arterialized venous-deep venous forearm balance measurements and m. brachioradialis biopsies were collected in the fasted state and during a 2.5 h hyperinsulinaemic (50 mU·m-2·min-1)-hyperaminoacidaemic (0.11 g·kg-1·h-1)-euglycaemic (5.0 mmol·L-1) clamp. This enabled quantification of two-pool kinetics (i.e. AA net balance (NB), rate of disappearance (Rd, i.e. AA uptake) and appearance (Ra, i.e. AA efflux)), three-pool kinetics (i.e. two-pool expanded by intracellular fluxes to and from the intracellular AA pool), and four-pool kinetics (i.e. including mixed muscle fractional synthesis rate) of forearm muscle tissue.

RESULTS: The clamp increased arterialised insulin (9±1 vs 153±8 mU·L-1; fasted vs clamp), phenylalanine (39±1 vs 68±3 µmol·L-1), and leucine (124±5 vs 214±7 µmol·L-1) concentrations (all P<0.05). As a result, two-pool kinetics revealed an increase in phenylalanine NB (i.e. -23±3 vs 10±3 nmol·min-1·100 mL forearm volume-1, fasted vs clamp, P<0.05), which was driven by an increase in Rd (i.e. 18±3 vs 46±6 nmol·min-1·100 mL forearm volume-1, P<0.05) whilst Ra was unaffected (P>0.05). Intracellular pool phenylalanine concentrations increased from 0.251±0.011 to 0.295±0.012 nmoles·mg-1 during the 2.5h clamp, while L-[ring-2H5]phenylalanine enrichment increased from 0.029±0.001 to 0.044±0.001 MPE. Three-pool AA fluxes were overall increased by the clamp, with increases in arterialised AA supply, uptake, incorporation into protein, efflux and arteriovenous shunting all observed (P<0.05), while AA appearance from breakdown was not affected (P>0.05). Forearm mixed muscle FSR during the 2.5h clamp was 0.053±0.003%·h-1, corroborating and extending on the three-pool kinetics demonstrating a shift towards forearm anabolism.

CONCLUSION: This newly established forearm model is suitable to measure four-pool AA kinetics under fasted and insulin- and amino acid-stimulated conditions, thereby enabling comprehensive quantification of arterialised delivery, uptake, intramuscular utilization (i.e. protein synthesis and breakdown), and efflux of AAs.

## Oral Presentations

### OP-PN29 Cardiovascular Physiology II

**CARDIOPULMONARY RESPONSES TO HIGH-INTENSITY ECCENTRIC CYCLING: COMPARISON WITH ISOENERGETIC CONCENTRIC CYCLING**

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INTRODUCTION: Eccentric cycling allows for a greater mechanical power output at a lower oxygen consumption (VO2) than concentric cycling. Prior research on low-intensity eccentric cycling (<300W) reported higher cardiac output (Q̇c) and heart rate (HR) than concentric cycling at matched VO2 (~150 mL or 6%). However, physiological responses to higher-power eccentric cycling remain underexplored. This study expands on previous findings by investigating cardiopulmonary responses to high-intensity eccentric cycling (up to ~1000W) compared to isoenergetic concentric exercise.

METHODS: Seven participants (2F, 5M; age: 31.4±7.7 years; VO2max: 56.8±4.6 mL·min-1·kg-1), who completed a 12-week progressive eccentric training protocol (1 session/week) completed incremental cycling tests in both eccentric and concentric modes. Each test comprised four 5-minute stages, with eccentric power at 25%, 50%, 75%, and 100% of maximal power (Pmax) attained at training's end. Concentric power was adjusted to match eccentric V̇O2 assuming a net mechanical efficiency of 24%. When V̇O2 equivalence was not achieved, a fifth concentric exercise stage was added. Q̇c, HR (impedance cardiography) and V̇O2 (metabolic cart) were continuously recorded and averaged over the last 60 seconds of each stage, while blood pressure (BP) was measured after each stage.

RESULTS: In the last stage, eccentric Pmax was 4.2 times higher than its concentric counterpart (756±110 vs. 181±50.2 W) despite a similar V̇O2 (2.38±0.67 vs. 2.50±0.65 L·min-1; 56.8±19.2 vs. 59.9±21.6% of concentric VO2max). Arteriovenous oxygen difference (a-v̇O2) was lower in eccentric mode (124±25.7 vs 159±36.8 mLO2·L-1, p<0.05), suggesting reduced peripheral oxygen uptake despite matched metabolic demand. Ventilatory responses also differed, with eccentric cycling eliciting higher breathing frequency (46.6±6.95 vs 32.9±5.18 cycles·min-1, p<0.05) and lower tidal volume (1.75±0.57 vs 2.02±0.48 L, p<0.05). Eccentric cycling resulted in a significantly higher cardiac output (19.5±5.9 vs 16.2±5.21 L·min-1, p<0.05) and heart rate (173±24.5 vs 148±22 bpm, p<0.05) despite lower systolic (142±14.8 vs 166±18.7 mmHg, p<0.05) and diastolic (69.1±4.49 vs 85.4±7.30 mmHg, p<0.05) blood pressures. Systemic vascular resistance decreased significantly during eccentric cycling (5.08±1.12 vs. 7.35±1.65 mmHg·L-1·min-1, p<0.05), indicating peripheral circulatory adjustments despite greater mechanical load.

CONCLUSION: High-intensity eccentric cycling allows for >4x greater mechanical work at similar V̇O2, eliciting distinct cardiopulmonary responses characterized by higher Q̇c and HR, reduced peripheral oxygen uptake, and lower vascular resistance. These findings highlight its potential as a high-output yet metabolically efficient training modality, particularly for populations with reduced cardiovascular capacity.

**CARDIORESPIRATORY RESPONSES AND TOLERANCE TO ECCENTRIC VERSUS CONCENTRIC CYCLING PERFORMED AT THE SAME RELATIVE INTENSITY**

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INTRODUCTION: Eccentric cycling (ECC) results in lower cardiorespiratory responses with lower heart rate (HR) and oxygen uptake (VO2) in comparison to conventional concentric cycling (CON) when they are performed at the same mechanical power output. However, higher HR has been documented in ECC vs CON when performed at the same VO2 [1,2]. Therefore, it remains unclear whether any difference in cardiorespiratory responses exists between ECC and CON performed at the same mode-specific relative intensity. Thus, the present study compares cardiorespiratory responses and exercise tolerance between ECC and CON conducted at the same mode-specific relative intensity.

METHODS: Eleven healthy men (31 ± 7 yr, BMI 25.2 ± 3.2 kg/m2) participated in six sessions separated by at least 72 hours. The first two sessions were used to familiarize them with ECC. In the next two visits, the participants completed a CON and an ECC ramp incremental test until exhaustion (30W/min slope, starting from 100W at a pedal cadence of 50-60 rpm) to determine mode-specific maximal power output (Pmax) in each cycling mode. The fifth and sixth sessions consisted of CON or ECC constant-load trials performed at 100% of the mode-specific Pmax. The CON and ECC constant-load trials were performed until exhaustion and the total trial duration (i.e., tolerance) was recorded. Cardiorespiratory responses were continuously recorded during the trials by indirect calorimetry and telemetry, with mean values used for analysis. Paired Student's t-tests compared variables between cycling modes (mean ± SD, significance at $p<0.05$).

RESULTS: Mean power output was higher ($p<0.001$) during ECC (386 ± 55 W) than CON (287 ± 49 W) without difference ($p=0.381$) in pedal cadence (56 ± 5 rpm). Tolerance was greater ($p<0.01$) for ECC (7.9 ± 5.1 min) than CON (2.1 ± 0.5 min). Mean VO2 (1.74 ± 0.31 vs 2.13 ± 0.39 L/min), pulmonary ventilation (42.22 ± 9.94 vs 53.14 ± 13.72 L/min) and tidal volume (1.67 ± 0.40 vs 2.23 ± 0.37 L) were lower ($p<0.05$) during ECC than CON, but respiratory frequency was not different ($p=0.071$) between ECC (31 ± 9 cycles/min) and CON (27 ± 7 cycles/min). However, no significant differences ($p=0.290$) in mean HR were evident between ECC (139 ± 15 bpm) and CON (134 ± 16 bpm).

CONCLUSION: The results show unique characteristics of ECC enabling higher mechanical power output with lower pulmonary ventilation and VO2 responses but similar HR to CON despite similar mode-specific relative intensity. Therefore, prescribing ECC at the same mode-specific relative intensity to CON increases mechanical load to lower limb muscles while reducing breathing load and metabolic demand, without imposing additional cardiac burden. This could be a useful strategy for exercise interventions to improve health and fitness.

**THE EFFECT OF RAMP SLOPE ON THE PREDICTION OF W′ FROM A SINGLE RAMP TEST**

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INTRODUCTION: Ramp incremental (RI) exercise tests have been proposed to determine critical power (CP) and the work capacity above CP (W′), as a more feasible alternative to the traditional methodology, which requires multiple exhaustive constant work rate (CWR) tests. W′ estimated from a RI test is defined as the total work done above CP during such test (W′R). This study assessed the influence of ramp slope on the magnitude of the estimated W′, and the agreement between W′ derived from the traditional method and W′R.

METHODS: 13 healthy men (23 ± 3 yr, 56.2 ± 7.5 mL·min-1·kg-1) performed a maximal RI test with a standard slope (30 W·min-1) on an electromagnetically braked cycle ergometer, followed by a series of CWR trials to determine CP and W′. Subsequently, they performed two maximal RI tests with slow and fast slopes (10 and 50 W·min-1). Each RI test was immediately succeeded by a CWR bout above CP to compute the additional amount of work that could be delivered above CP (W′extra). CP and W′ were estimated using the two-parameter model equations, selecting the model with the lowest total error on an individual basis. Total work done above CP during the different RI tests (W′R10, W′R30 and W′R50) were compared with the conventionally determined W′. Pulmonary gas exchange was measured during all tests on a breath-by-breath basis to ensure the attainment of maximal oxygen consumption (V̇O2max) at task failure. Differences in performance parameters and W′ estimates across the different tests were assessed using Repeated Measures ANOVA with pairwise comparisons (LSD adjustment).

RESULTS: Time to exhaustion (TTE) became longer with decreasing ramp slope (1615 ± 262 s > 661 ± 91 s > 430 ± 26 s, $p < 0.001$). Conversely, POpeak was the lowest in the slow and the highest in the fast protocol (319 ± 44 W < 378 ± 48 W < 405 ± 52 W, $p < 0.001$). V̇O2max did not differ across the three RI tests ($p = 0.15$). CP and W′ were respectively 251 ± 44 W and 19.1 ± 3.4 kJ. We found significantly lower values for W′R10 (14.4 ± 6.2 kJ, Δ = 4.7 ± 5.1 kJ, $p = 0.006$), W′R30 (16.4 ± 2.5 kJ, Δ = 2.7 ± 3.6 kJ, $p = 0.018$) and W′R50 (14.6 ± 3.5 kJ, Δ = 4.5 ± 3.3 kJ, $p < 0.001$) compared to the conventionally determined W′. W′extra was the highest in the fast protocol (3.1 ± 1.5 kJ) compared to the normal (1.6 ± 1.5 kJ, $p = 0.013$) and slow protocol (1.7 ± 1.4 kJ, $p = 0.007$), whereas there was no difference between the normal and slow test in W′extra ($p = 0.899$). For all three RI protocols, the sum of W′R and W′extra did not differ from each other, nor from W′ ($p = 0.098$).

CONCLUSION: A standard ramp slope of 30 W·min-1 showed the lowest underestimation of W′, indicating that a full depletion of W′ is obstructed during particularly slow or fast ramp protocols. However, performing an additional work bout above CP, immediately after the RI test, led to higher estimates of W′ that were closer to the conventionally determined W′.

**THE EFFECT OF INTERMITTENT VS. CONSTANT HIGH INTENSITY AEROBIC EFFORTS WITH EQUAL TOTAL WORK ON VO2 KINETICS, FATIGUE AND PERFORMANCE**

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INTRODUCTION: Exercise-induced fatigue (EIF), a reduction in muscle force or power output following prolonged or high-intensity exercise, is a key factor in endurance sports. Oxygen uptake (VO2) kinetics reflect the metabolic response of working muscles, and are related to EIF, exercise tolerance and performance. To date, these relationships have been studied only regarding what the exercise bout itself provoked; the effect of different fatiguing efforts on VO2 kinetics, EIF and performance in a consecutive effort, mimicking conditions in training and racing, has not been studied. We studied the effect of two fatiguing protocols on VO2 kinetics and EIF during a subsequent severe-intensity effort.

METHODS: Twelve male endurance athletes participated in a random-order cross-over study, involving five visits (V1-V5). At V1, participants performed a graded cardiopulmonary exercise test to exhaustion, to assess the gas exchange threshold (GET), the respiratory compensation point (RCP) and VO2max, so as to individualize workloads in subsequent tests; and familiarization with time to exhaustion (TTE) and sprint performance (ST) tests. During each of visits V2-V5, participants completed one of two equal work fatiguing protocols (FPs): heavy constant exercise (CONT) at an intensity corresponding to 90% of RCP; or severe intermittent exercise (INT) at 120% of RCP with recovery periods at 50% of RCP. Each FP was performed on two different consecutive visits, in random order. VO2 kinetics were assessed pre- and post- FPs (i.e. fresh and fatigued, respectively).

RESULTS: No significant differences were found in VO2 kinetics measured in a subsequent effort after CONT and INT (tau=35.3+/-8 vs. 33.5+/-5 sec, amplitude=2471+/-697 vs. 2590+/-546 mL/min). Additionally, TTE duration (413+/-153 vs. 359+/-124 sec) and ST peak power output (1106+/-230 vs. 1091+/-229 W) did not differ significantly. However, when comparing pre- to post- FP values, a significant increase in VO2 amplitude was observed only post-INT (2404+/-639 vs. 2590+/-546 mL/min, p=0.012). During FPs - cumulative O2 uptake was greater in CONT than INT (40.8+/-7.7 vs. 39.2+/-8.8 L, p=0.04), and excess post-exercise O2 consumption was significantly greater after INT compared to CONT (2.39+/-0.48 vs. 2.06+/-0.27 L, p=0.04).

CONCLUSION: When total work is equal, different high-intensity aerobic fatiguing efforts (continuous vs. intermittent) have a similar effect on VO2 kinetics, EIF, and performance during a subsequent effort.

**CHARACTERISTICS AND ANALYSIS OF THE DURABILITY OF HIGH-LEVEL FEMALE ROWERS**

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INTRODUCTION: Besides VO2max, threshold power or velocity, and exercise economy, durability has been considered the fourth dimension in evaluating endurance performance in sports such as road cycling and marathon running in recent years. However, there have been no reports or research on durability in rowing, which is also an endurance sport. Therefore, this research aims to explore the durability characteristics of high-performance Chinese female rowers during anaerobic threshold intensity continuous training.

METHODS: Thirteen female rowers (age = 26.3 ± 3.2 years, height = 182.6 ± 4.4 cm, weight = 77.8 ± 4.0 kg) from the Chinese National Rowing Team completed several 30-minute rowing ergometer training sessions (100% AT = anaerobic threshold), 2 km maximal tests on the rowing ergometer, and multi-step (3 × 8 min) tests on the rowing ergometer during winter training in 2024 (from October 2023 to March 2024). Real-time heart rate and power were recorded every 3 minutes during the 30-minute rowing ergometer training, along with average power (P30) and lactic acid (L30) afterward. The time (T2km) to finish the 2 km rowing test on the ergometer and anaerobic threshold power (P4) obtained from the multi-step test were also recorded. The interval between each training session and test should be more than 48 hours, and both training and tests should be completed within one week. According to this requirement, data from 23 instances per person were selected for this research. Based on their 2 km maximal test performance on the rowing ergometer, the data were divided into three groups: low performance (LP, n = 8, $t \geq 410s$), medium performance (MP, n = 6, $405s \leq t < 410s$), and high performance (HP, n = 9, $t < 405s$). The time course of the ratio of interval vs. external (In/Ex) training load during the 30-minute rowing ergometer training was plotted, and the magnitude of In/Ex (denoted as ΔIn/Ex) was determined by the difference between the 6th and 27th minutes.

RESULTS: T2km values were 414.8 ± 4.1s (LP), 407.1 ± 1.3s (MP), and 401.9 ± 2.1s (HP), with significant differences ($p < 0.01$) between each group. P4 values were 229.4 ± 18.2 W (LP), 248.3 ± 14.2 W (MP), and 252.1 ± 11.3 W (HP), with significant differences ($p < 0.01$) between HP, MP, and LP. ΔIn/Ex values were 0.078 ± 0.022 (LP), 0.068 ± 0.021 (MP), and 0.054 ± 0.018 (HP), showing a gradual decrease in opposition to their performance levels, with significant differences between HP and LP ($p < 0.05$). There was a low correlation between P4 and ΔIn/Ex ($r = -0.205$, $p > 0.05$) but moderate correlation between T2km and ΔIn/Ex ($r = 0.566$, $p > 0.002$).

CONCLUSION: There was a decoupling in continuous training at anaerobic threshold intensity in high-performance elite rowers, which can be described as durability. This index is related to performance level but not to traditional physiological indicators such as anaerobic threshold power.

# Oral Presentations

## OP-AP44 Sports Equipment

### VALIDITY OF THE TYME WEAR STRAP MEASURING RESPIRATORY FREQUENCY DURING CYCLING EXERCISE

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INTRODUCTION: Respiratory frequency (fR) is an objective marker of physical effort and is very sensitive to changes in exercise tolerance, especially during high-intensity exercise (1). An abundance of technological solutions is currently available to meet the increasing demand for breathing monitoring during training and competitions, with strain sensors representing a promising solution to estimate fR via chest-wall movements (2). However, robust methodological approaches are required to validate commercial breathing sensors before encouraging their widespread use. Thus, the current study aims to validate a commercial breathing device with a thorough cycling protocol designed to describe its accuracy and precision during both progressive and abrupt changes in fR.

METHODS: Ten competitive cyclists (M/F: 8/2; stature: 173 ± 10 cm; body mass: 64 ± 8 kg) performed a single-visit validation protocol wearing the Tyme Wear (TW) strap (Tyme Wear Inc, Boston, MA, USA). The protocol was composed of: i) a 10-min warm-up (80 W M, 60 W F); ii) a ramp incremental test until exhaustion (25 W/min M, 20 W/min F); iii) a self-paced 8-min intermittent protocol (20:40 s); and iv) a 5-min time trial. The performance of the TW device was compared against that of a reference metabolic cart (Quark PFT, Cosmed, Rome, Italy). Both reference and TW breathing waveforms were recorded at 25 Hz and processed with custom-based algorithms to extract fR. Mean absolute error (MAE), mean absolute percentage error (MAPE), mean of difference (MOD), and limits of agreement (LoAs) were computed to verify the accuracy and precision of the TW strap during the cycling protocol. The validation analysis was conducted breath-by-breath and on 30-s windows.

RESULTS: The fR time course measured with the TW strap fairly resembled that measured with the reference system throughout the cycling protocol. The breath-by-breath comparison showed an average MAE value of 1.56 breaths·min-1 and an average MAPE value of 3.76 %. The 30-s comparison showed average MAE e MAPE values of 0.60 breaths·min-1 and 2.00 % respectively. In addition, a good agreement was found between the TW strap and the reference system for both breath-by-breath (MOD ± LoAs: -0.03 ± 5.71 breaths·min-1) and 30-s (MOD ± LoAs: -0.13 ± 3.34 breaths·min-1) values.

CONCLUSION: The present findings suggest that the TW strap is a suitable device to measure fR in cycling. The good performance and wearability of this commercial device may facilitate the daily measurement of fR in cycling and potentially in other endurance sports.

(1) A. Nicolò, C. Massaroni, L. Passfield, Front. Physiol. 8 (2017) 922.

(2) C. Massaroni, A. Nicolò, D. Lo Presti, M. Sacchetti, S. Silvestri, E. Schena, Sensors 19 (2019) 908.

### EXPLORING WEARABLE TECHNOLOGY IN SKIING: USER FEEDBACK ON THE CONNECTED BOOT'S USABILITY AND PERFORMANCE BENEFITS

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INTRODUCTION: The integration of wearable technology in sports has advanced rapidly, enabling athletes and recreational users alike to gain personalized insights into their performance. In skiing, where skill development and technique are essential for safety and enjoyment, tools that provide real-time feedback have the potential to transform the user experience. The Connected Boot sensor system, which consists of two inertial measurement units (IMUs) mounted at the upper posterior cuff of the ski boot, offers an innovative approach to assessing skiing style by capturing objective sensor data through a calculated ski quality score [1]. This study aims to evaluate the usability, learning curve when using the app, and perceived effectiveness of the Connected Boot among recreational skiers. By analyzing user feedback and engagement, this research seeks to assess the devices potential as a tool for enhancing skiing style.

METHODS: Data were collected during the 2022/23 season from a sample of 89 recreational skiers (23 female 66 male; age: avg 46.3, sd = 14.8). Participants were equipped with IMUs to collect sensor data that was used to calculate turn size, turn speed, edge angle velocity, edging of the ski boot and other metrics. The participants installed a specially developed mobile application to process and visualize this objective sensor data and to calculate a ski quality score. In addition, the app was used to collect subjective questionnaire data at the beginning and end of the study to determine the acceptance of the Connected Boot sensor system.

RESULTS: Survey results indicate a generally positive reception of the Connected Boot across multiple dimensions. Most participants found it easy to use (71%) and beneficial for improving skiing style (81%). Statements regarding ease of learning received particularly strong support, e.g., over half of respondents strongly agreed that both familiarizing themselves with the Connected Boot (54%) and learning to use it (48%) were easy. The high level of agreement on usability (72%) highlights effective design and alignment with user needs. However, a small proportion of negative responses regarding usefulness of the provided information about the individual skiing style (18%), learning of how to use the Connected Boot

and ease of use (15% each) could indicate that some users find the Connected Boot less intuitive. Moreover, it suggests that individual differences, such as skill level or technological familiarity, may influence user experience.

CONCLUSION: The Connected Boot is promising when it comes to improving the skiing experience through feedback and ease of use, as shown by the high agreement in the areas of ease of use and perceived benefits. Nevertheless, to improve the product's appeal and satisfaction, further refinements might focus on increasing user enjoyment and addressing specific pain points highlighted by the minority of users who reported lower satisfaction.

[1] Snyder et al., Sensors, 2021

**VALIDATION OF SMART SWIM GOGGLES HEART RATE MEASUREMENT FOR SWIM TRAINING MONITORING**

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INTRODUCTION: Accurately measuring training intensity in swimming is challenging due to a lack of validated measurement devices. Smart swim goggles (FORM goggles, Vancouver, Canada) that harbour a temple-mounted optical heart-rate (HR) sensor enable real-time feedback of HR during training. These HR data facilitate the calculation of HR-based training loads (TL) such as Banister training impulse (bTRIMP) and cumulative TRIMP (cTRIMP) (1). However, the HR measurement from these goggles has yet to be validated. The purpose of this study was to assess the validity of the FORM goggles HR measurements for use in swim training monitoring.

METHODS: We applied a criterion validation approach in which the FORM goggles HR measurements were compared to those from a gold-standard electrocardiogram chest-strap (Garmin HRM-Swim). Twenty-five experienced recreational swimmers (proficient in freestyle, backstroke, and breaststroke) completed one of two workouts, with two participants completing both. The workouts differed in intensity and distance. Comparisons were made at four levels: individual heartbeat, interval, main-set, and workout. At each level, the average (HRmean), maximum (HRmax), and minimum (HRmin) HR were assessed using Lin's concordance correlation, Bland-Altman, and regression. The analysis of cTRIMP and bTRIMP was performed at the interval and workout levels, respectively. Statistics are presented as ranges across all levels.

RESULTS: HRmean from the FORM goggles and Garmin HRM-Swim were similar in both workouts, with respective mean±SD values of 131.1±16.4 bpm and 131.1±17.3 bpm (Workout 1), and 142.3±17.0 bpm and 141.8±17.7 bpm (Workout 2). HRmean, HRmax, and HRmin correlation ranged from 0.90-1.0, 0.87-0.92, and 0.59-0.90, respectively, while the TRIMPs correlation was 1.0. The fixed bias (limits of agreement) ranged from -0.34 to 0.11 (3.6-9.5) bpm, -0.11 to 2.6 (8.9-12.0) bpm, and -0.6 to 1.2 (10.1-26.9) bpm for HRmean, HRmax, and HRmin, respectively, and from -0.38 to -0.20 (4.3-4.6) arbitrary units (a.u.) for the TRIMPs. Proportional bias was observed for HRmean (individual heartbeat, interval, and workout levels), and for HRmax (interval level). Regression intercepts from the differences between devices showed no statistically significant difference from zero: HRmean (-0.20 to -0.05 bpm), HRmax (-0.25 to 2.1 bpm), HRmin (-0.66 to 0.89 bpm), and TRIMPs (-0.43 to -0.29 a.u.).

CONCLUSION: This study revealed strong agreement between the FORM goggles and Garmin HRM-Swim for HR measurements, particularly for HRmean and TRIMP values. Given that HRmean serves as the primary input for HR-based TL metrics, the goggles provide valid data for monitoring swim training. Larger discrepancies between devices were noted for HRmin and HRmax. Further research should explore the impact of these observed discrepancies on adhering to HR intensity zones during training when utilizing real-time HR feedback.

1. García-Ramos et al., Eur J Sport Sci., 2015.

**SMART SWIM GOGGLES WITH REAL-TIME VISUAL FEEDBACK IMPROVE ADHERENCE TO TRAINING INSTRUCTIONS IN RECREATIONAL SWIMMERS: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Swimmers commonly face challenges in adhering to prescribed workout metrics, such as intensity and duration, which can hinder fitness and performance improvements. Wearable technology providing real-time feedback has the potential to enhance adherence by offering swimmers immediate performance insights. This study examined the effects of real-time feedback on compliance with prescribed training metrics in recreational swimmers during a 12-week unsupervised intervention.

METHODS: Fifty-seven recreational swimmers were randomly assigned to two groups: feedback (FB) and non-feedback (NFB). Both groups were prescribed 35 structured workouts over 12 weeks. The FB group used FORM Goggles, which provided real-time visual feedback on performance metrics, including swimming pace, heart rate, and time splits. The NFB group used printed workout instructions and relied on either a pool clock or waterproof sports watches to track time and splits. Key compliance metrics analyzed included workout length count, workout effort, incomplete workouts, interval effort, interval rest time, and interval stroke type. Statistical analyses were conducted to compare compliance between the FB and NFB groups. RESULTS: The FB group demonstrated significantly greater compliance with workout length counts compared to the NFB group ($p < 0.001$). Mean deviations from prescribed lengths were consistently lower in the FB group across various contexts (FB: 0.5–0.1 lengths vs. NFB: 3.5–2.4 lengths), showing large effect sizes (rate ratio > 3.00). No significant differences were observed between groups for other compliance metrics.

CONCLUSION: Real-time visual feedback significantly improved compliance with prescribed workout length counts. These findings suggest that wearable feedback technology can improve adherence to structured swim training, making it a valuable resource for recreational swimmers seeking to optimize their workouts.

**VIRTUAL REALITY AS A TOOL FOR ASSESSING RESPONSE TIME IN ELITE VOLLEYBALL: GENDER AND LIMB DOMINANCE INSIGHTS**

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INTRODUCTION: Virtual Reality (VR) technology has seen widespread adoption in recent years, with an increasing number of individuals integrating it into their daily routines. VR systems immerse users in a three-dimensional computer-generated environment, making assessments reproducible and simulating gestures very similar to those of real life. Research highlights the potential of VR in sports, indicating that these systems can improve perceptual-cognitive and motor skills. The aim of this study was to employ VR to assess response times (RT) to visual stimuli in elite male and female volleyball players, with the intent of identifying differences between sexes and potential asymmetries between dominant and non-dominant upper limbs.

METHODS: Forty elite volleyball players of the Lega Pallavolo Serie A (Age= 24.2±5.6 years; Male: n = 20; Female: n = 20) were recruited for the study. VR-CNS Sprint Software was used to assess RT in response to visual targets appearing randomly in the field of view. The assessments were always conducted using a standard panel with targets positioned within the visual field. The panel consisted of 16 targets arranged in 4 rows and 4 columns. Participants wore hand controllers and were instructed to touch the target that turned green in less time as possible (hit). An interval of rest was randomly repeated between hits, and the assessment included a total of 96 hits, with each target being activated six times (16 targets x 6 = 96 hits).

RESULTS: Results indicated that while males had slightly faster average RT (M = 453.7±45.2 ms) than females (F= 481.8±59.3 ms), the differences were not statistically significant (p = 0.100). Similarly, no significant differences in RT were observed between dominant (461.3±54.1 ms) and non-dominant limbs (474.2±55.2 ms, p = 0.296).

CONCLUSION: This study, utilizing VR technology as a standardized and individualized tool for assessing response time in elite volleyball players, suggests that gender differences could be mitigated at the highest levels of training and that limb dominance has no significant impact in a bilateral sport. Future research could explore the use of VR not only for evaluation but also as a training tool to enhance response time in athletes.

## Oral Presentations

### OP-SH10 Physical Activity Promotion in Children

**ASSOCIATION BETWEEN PHYSICAL EXERCISE AND PROSPECTIVE MEMORY IN SCHOOLCHILDREN: SINGLE SESSION EFFECTS AND CROSS-SECTIONAL RELATIONS**

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Introduction

Prospective memory is a cognitive ability required to remember to perform an intended task without an explicit reminder. Research showed that this ability is linked to other higher-order cognitive functions, such as working memory or attentional processes (Ball et al., 2022). Physical exercise is known to be related to executive function and further, research found that a single session of endurance exercise can enhance performance in such abilities (Ludyga et al., 2016). Due to an overlap in underlying neural structures in executive function and prospective memory, it's likely that acute effects of exercise will also influence the latter (Loprinzi et al., 2018). This study aimed to investigate a possible link between prospective memory, executive function and physical activity and further, evaluate the potential of one single exercise session on prospective memory performance.

Methods

98 schoolchildren completed a prospective memory task embedded in a 1-Back and Flanker paradigm. The Flanker task served as a distractor after prospective cues were introduced and participants had to remember that prospective trials embedded in a subsequent 1-Back task required a different response. Participants were then randomly assigned to either an experimental group (25-minute endurance exercise) or a control group (25-min stretching). After the intervention, the cognitive assessment was repeated. Physical activity was recorded over seven consecutive days using accelerometers and the 7-day physical activity recall questionnaire.

Results

With regard to the chronic exercise paradigm, partial correlations that controlled for age and sex showed that higher MVPA was associated with higher accuracy on the prospective memory task. VPA was positively associated with executive function performance. In contrast, linear mixed models showed no effect of a single exercise session on prospective memory and executive function.

Discussion

The association of physical exercise and prospective memory differed based on the exercise paradigm. Children with higher physical activity levels showed better prospective memory performance. However, engagement in a single exercise session does not necessarily lead to an improvement in prospective memory. This provides an indication that prospective memory seems to be more sensitive to long-term changes in regular physical activity and exercise levels.

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**SINGLE AND COMBINED EFFECTS OF ACTIVE BREAKS AND STANDING DESK: COMPARISON OF STATISTICAL ANALYSIS METHODS FOR RANDOMIZED TRIAL PRE-POST DESIGNS**

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INTRODUCTION: Active breaks and standing desks are innovative strategies to promote physical activity in schools setting. The Yes, We Can! study assessed the effectiveness of these interventions, both individually and combined, on physical health and cognitive performance in secondary school students (aged 15–17). A cluster-randomized controlled trial with pre- and post-intervention assessments over 12 weeks was conducted. However, this study design poses analytical challenges: while ANCOVA and repeated measures ANOVA are commonly used to compare effects between groups over time, there is ongoing debate regarding the most appropriate methodology. This study aims to identify the most effective statistical model for accurately estimating the impact of active breaks and standing desks on health and cognitive abilities, providing evidence to support future school-based physical activity interventions.

METHODS: In Italy, 86% of boys and 92% of girls aged 11 to 17 fail to meet recommended physical activity levels. Therefore, our study involved students from second-year classes of linguistic and human sciences high schools.

Four classes (n=100) were randomly assigned to one of four groups: control (CT, n=20), active breaks (ACT, n=26), standing desks (STD, n=26), and a combination of both interventions (ACT+STD, n=28). Health-related fitness parameters—including muscular strength, endurance, flexibility, aerobic fitness, and blood pressure—were assessed, along with cognitive performance measures such as short-term memory, working memory, visual attention, and processing speed.

For statistical analysis, we compared repeated measures ANOVA (RM ANOVA), which accounts for repeated measurements over time, with ANCOVA, which controls for baseline covariates.

RESULTS: We analyzed three key variables: Systolic Blood Pressure (SBP), the Six-Minute Walking Test (6MWT), and the Digit Span Test (DS), representing physiological parameters, physical abilities, and cognitive performance, respectively.

The comparison between ANCOVA and RM ANOVA revealed differences in estimated coefficients and information criteria, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC). ANCOVA showed lower AIC and BIC values across all cases, indicating a higher model precision. RM ANOVA estimated a greater number of parameters but with lower statistical efficiency.

The results indicate significant improvements in several analyzed parameters, primarily in the ACT group.

CONCLUSION: ANCOVA proved to be the most effective methodological choice for evaluating the effects of active breaks and standing desks, ensuring greater precision and statistical power. This study confirms the effectiveness of active breaks as a valuable intervention for improving students physical health and cognitive performance, supporting the integration of active strategies into school settings.

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**EFFECTS OF PHYSICAL ACTIVITY INTERVENTIONS ON PHYSICAL LITERACY OF PRESCHOOL CHILDREN AGED 3-6 YEARS: A SYSTEMATIC REVIEW WITH META-ANALYSIS**

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INTRODUCTION: Physical literacy (PL) in early childhood is crucial for lifelong physical activity and health of individuals (Lugossy et al., 2021). Physical, cognitive, affective/psychological, and social aspects are considered the four main domains of PL (Keegan et al., 2019). However, previous systematic reviews have focused on the impact of physical activity-related interventions on health indicators, implying that little is known about the reasons for the heterogeneity in effectiveness given potential differences in intervention design. This systematic review with meta-analysis aims to describe and assess the impact of physical activity-related interventions on physical literacy among typically developing preschool children aged 3-6 years.

METHODS: 10 databases (e.g., Web of Science, Scopus) were systematically searched for peer-reviewed English-language intervention studies. Eligibility criteria aligned with PICOS principles. Two reviewers independently screened records, extracted data, and assessed risk of bias using the Effective Public Health Practice Project (EPHPP) tool. Meta-analysis was conducted using random-effects models to calculate standardized mean differences (SMD).

RESULTS: Out of 42,134 records, 205 studies (N=30,775 children) met inclusion criteria, with 160 being included in meta-analysis (Cohens Kappa: 0.69-0.89). Studies were mainly from North America and Europe (66.3%). Most studies used structured approaches (86.3%). Risk of bias assessment classified 35.6% of studies as having strong, 35.6% moderate, and 28.8% weak quality. Meta-analysis revealed small-to-moderate total effects across PL domains: physical (N=469, d=0.50), cognitive (N=152, d=0.35), affective (N=46, d=0.33), and social (N=34, d=0.04). Subgroup analysis showed that interventions facilitated by external teachers/coaches/researchers were more effective than those facilitated by preschool teachers in all four domains of PL. Combined interventions did not show better outcomes than single interventions.

CONCLUSION: Physical activity related interventions demonstrate positive effects on various PL domains in preschoolers, while affective and social domains remain understudied. This review provides evidence for the importance of PL-focused interventions in early childhood. Further evidence-based research is needed to optimize intervention design and implementation to maximize PL development across all domains.

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**EFFECTS OF DANCE ON FUNDAMENTAL MOVEMENT SKILLS IN YOUNG CHILDREN**

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INTRODUCTION: Fundamental movement skills (FMS) are an important indicator of health and well-being in young children. Locomotor and object control skills play a crucial role in their future growth and well-being. It has been suggested that dance could improve young children's FMS, thereby promoting motor development. Therefore, this study aims to investigate the impact of dance practice on FMS in young childre

METHODS: The study involved 62 five-year-old Japanese children from a kindergarten without physical education classes. Participants were divided into two groups: the Dance Group (DG) and the Control Group (CG). For five months, the DG participated in dance-based physical education classes three times a week, while the CG did not receive any structured physical activity intervention. FMS was assessed before and after the intervention, measuring locomotor and object control skills, including the 25-meter run (m/s), standing long jump (cm), and softball throw (m).

RESULTS: Indicated a statistically significant interaction between "time" and "group" for the standing long jump [$F(2,405) = 19.43$, $p < 0.001$, $\eta^2 = 0.42$]. The post-hoc test revealed that the DG showed a significant improvement in its average score after the intervention, whereas the CG experienced a decline.

For the 25m run, the DG demonstrated a statistically significant improvement in the post-test compared to the pre-test($Z = -4.422$, $p < .001$), whereas the CG showed no significant change($Z = -0.009$, $p = 0.993$). Additionally, the DG group outperformed the CG in the post-test($Z = -3.006$, $p = 0.003$), despite no initial differences between the two groups in the pre-test($Z = -0.490$, $p = 0.634$). In the softball throw, both groups showed some improvement in the post-test compared to the pre-test; however, these improvements were not statistically significant for either group.

CONCLUSION: Overall, the findings suggest that dance training positively influenced FMS, particularly in sprinting and jumping ability, likely through improvements in lower-body strength and body coordination[1]. Dance requires precise control of posture, rhythm, and dynamic movements (lunges and strides, running and jumping movements), which could have enhanced body coordination , speed and explosive power. This increased efficiency in movement execution may have led to better sprinting mechanics and improved jumping ability, as seen in the significant improvements in the 25m run and standing long jump. Future research should incorporating exercises that specifically target upper-body strength could help maximize the benefits of dance training for overall physical development of young children.

This study suggests that dance intervention improved FMS in young children and have a positive impact on their development.

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**MORE MOVEMENT, BETTER SLEEP? THE EFFECTS OF TEN DAYS AT A DIABETES SUMMER CAMP ON ACTIVITY, SEDENTARY BEHAVIOR AND SLEEP PATTERNS**

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INTRODUCTION: Managing type 1 diabetes in children and adolescents is challenging for both patients and families. Regular physical activity improves glycemic control and overall well-being, but maintaining adequate levels can be diffi-

cult. A structured environment, such as a summer camp, may help increase activity while also influencing sleep and sedentary behavior. This study aimed to assess physical activity, sleep, and sedentary behavior in children and adolescents with type 1 diabetes before and during a diabetes summer camp.

METHODS: This study investigated physical activity, including steps taken and time spent in light, moderate, and vigorous activity, sleep quality and quantity, and sedentary behavior in 23 children and adolescents (13.3 ± 2.1 years) before and during a diabetes summer camp. These variables were assessed using two types of Fitbit devices (Fitbit® Inc., San Francisco, California, USA), the Fitbit Inspire HR for adolescents and the Fitbit ACE for children. The devices were worn on the non-dominant wrist over two periods: 7-10 days prior to the camp and 10 days during the camp, monitoring continuously day and night both activity and sleep. The Student's t-test and Wilcoxon rank-sum test were conducted to assess differences between the two periods, based on the data distribution.

RESULTS: The results showed that the number of steps taken was significantly higher during the camp (18901.9 ± 3330.6) compared to the pre-camp period (8772.1 ± 2823.8; $p < .001$). Similarly, time spent in light physical activity increased from 258.3 ± 52.7 min/day before the camp to 436.3 ± 61.9 min/day during the camp ($p < .001$). Moderate physical activity also increased significantly, from 28.5 ± 16.4 min/day before the camp to 71.0 ± 43.7 min/day during the camp ($p < .001$). Vigorous physical activity showed a smaller but significant increase, from 24.7 ± 18.1 min/day pre-camp to 39.3 ± 36.2 min/day during the camp ($p = .016$). In contrast, sedentary time was significantly lower during the summer camp (505.5 ± 75.2 min/day) compared to the pre-camp period (717.0 ± 80.6 min/day; $p < .001$). Regarding sleep, the average duration of nighttime awakenings was significantly higher before the camp (46.1 ± 17.0 minutes) compared to the camp period (39.7 ± 13.6 minutes; $p = .005$), while total sleep duration decreased from 408.9 ± 61.3 min/day before the camp to 365.2 ± 49.8 min/day during the camp ($p < .001$).

CONCLUSION: A summer camp significantly increased physical activity and reduced sedentary time in children and adolescents with type 1 diabetes. Although total sleep duration decreased, fewer nighttime awakenings suggest improved sleep continuity. These findings highlight the positive impact of structured environments on both activity levels and sleep quality.

## Oral Presentations

### OP-SH21 Female Sport and Physical Activity

**FEMALE ATHLETES' KNOWLEDGE OF BIOPSYCHOSOCIAL PUBERTY-RELATED TOPICS IN SPORTS DURING ADOLESCENCE: WHAT IS MISSING?**

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Background: Puberty is a key factor in the decline of girls' sports participation during adolescence. Knowledge, preparation, and social support can make the biopsychosocial (BPS) puberty-related changes more manageable. Yet, research on knowledge about BPS puberty-related topics in the sport context of female athletes is limited.

Aim: Thus, the main aims of the study were to (a) examine female athletes' perceived knowledge and knowledge needs regarding BPS puberty-related topics in sports during adolescence and to (b) examine how perceived knowledge and knowledge needs, respectively, were interconnected across BPS domains. Additionally, as a secondary aim, the study sought to (c) explore potential differences between athletes participating in team versus individual sports regarding perceived knowledge, knowledge needs, and interconnections across BPS domains.

Method: Swedish and Norwegian female athletes from ten sport disciplines (football, horseback riding, handball, swimming, gymnastics, floorball, athletics, cycling, and cross-country and alpine skiing) were invited to fill out an anonymous online survey with questions focusing on perceived knowledge and knowledge needs regarding BPS puberty-related topics, such as individual differences and social comparisons, during adolescence. Both perceived knowledge and knowledge needs were measured using a 7-Point Likert Scale.

Results: A total of 1323 female athletes (n=657 (49.7%), athletes from team sports; n=656 (49.6%) from individual sports) responded to the online survey. Findings revealed low perceived knowledge as well as knowledge needs regarding BPS puberty-related topics among female athletes. The Mann-Whitney U test was used, revealing that athletes in team sports perceived their knowledge to be slightly higher regarding individual differences, social cohesion, social comparison, acceptance within the group, and recovery, compared to athletes in individual sports. Athletes in team sports reported higher knowledge needs regarding social comparisons, sports nutrition and recovery, while athletes in individual sports reported higher knowledge needs regarding changes in sex hormones, individual differences, and changes in body composition. A network analysis identified clusters of biological, psychosocial, and behavioral topics in both perceived knowledge and knowledge needs, indicating that knowledge regarding BPS puberty-related topics is concentrated within subdomains.

Conclusion: Our findings underscore the urgent need of and the considerable opportunity for a more holistic understanding of BPS puberty in the sport context of female athletes. Future educational programs should therefore be holistic and interdisciplinary in scope.

**DEVELOPMENT OF THE FIDES ADP "GIRLS ARE NOT SMALL BOYS" DIGITAL EDUCATIONAL INTERVENTION**

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INTRODUCTION: Girls who participate in exercise and sports face unique challenges regarding acceptance of pubertal weight gain and hormonal fluctuations in a way that most boys and young men do not. Lack of female-specific knowledge within the sporting environment may be preventing girls from reaping the full benefits it has to offer. Therefore, the aim of this study was to develop a cost-effective, sustainable educational program for girls in organized sport, their parents and coaches.

METHODS: We developed the study methods and the digital educational program in different steps 1) Content validity of the female-specific topics of the intervention was established by a) literature reviews performed by the research group including specialists within subdisciplines ranging from pedagogy, psychology, sociology, and film science to physiology, and sport medicine; and b) an online survey examining female athletes' perceived knowledge needs regarding biopsychosocial puberty-related topics during adolescence including 1323 female athletes aged 16-24, from different sport disciplines; and c) the film scripts were read aloud in a pilot group of six 13–16-year-old girls who provided immediate feedback. 2) On-line surveys aimed to estimate changes in well-being, sporting experiences and parental, peers, and coaching support were constructed and pilot tested. 3) The construction, production, and delivery form of the intervention was developed in collaboration with a film crew and a technical specialist.

RESULTS: The intervention development resulted in 12 films à 5-7 minutes with a mix of experts and female athletes delivering the female-specific topics: 1) Misconceptions About Female Athletes, 2) Understanding Your Whole Self, 3) How Do We See Ourselves?, 4) and 5) Physical Development During Puberty Part 1 and Part 2, 6) Self-Image During Puberty, 7) You, Your Training Partners, and the Sense of Belonging, 8) Get to Know Your Menstrual Cycle, 9) Physical and Mental Recovery, 10) Nutrition for Health, Exercise, and Recovery, 11) The Relationship Between You, Your Coaches, and Parents, 12) Putting it all together. The protocol development resulted in a case-control design including a 6-week control period followed by a 6-week intervention period with assessment of main variables (well-being and sporting experiences) every second week, and selected variables (e.g., perceived social support) at baseline, pre-, and post-intervention. The delivery of the intervention and the distribution of surveys were most effectively administered using the m-Path app.

CONCLUSION: This paper describes the development of a cost-effective, sustainable digital educational intervention for girls in organized sport, their parents and coaches. The study suggests that a digital intervention is best co-developed in an interdisciplinary environment, at the interface between different areas including technical specialists and in collaboration with the intended population.

**SUPPORTING FEMALE PARTICIPATION IN SPORT AND ACTIVE RECREATION DURING PERIODS**

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INTRODUCTION: Periods are a normal part of female reproductive function. However, there remains a lack of understanding and research on how periods influence participation in sport and active recreation, and what strategies can be used to support participation during periods.

METHODS: A mixed-method survey of 325 menstruating females was conducted to explore how periods influence participation in sport and active recreation. Descriptive analysis and relative risk (RR) were used to analyze quantitative data, and thematic analysis was used for qualitative data analysis. A working group of sport and recreation representatives (n=8) reviewed the survey data to inform evidence-based strategies to support participation during periods.

RESULTS: Over half reported having missed training for sport (57%) or active recreation (55%) due to their period but only 14% missed competitive sport events. The main reasons for missing sport/active recreation training were symptoms (96/91%), and concerns about leaking (35/49%) and reduced performance (16/15%). Period-related training modifications were more common in active recreation (74%) than in sport (40%). Females with menorrhagia (heavy menstrual bleeding) were more likely to have missed training for sport (74% vs 52%, RR 1.4), active recreation (71% vs 51%, RR 1.4) and sport events (26% vs 11%, RR 2.4); and perceived periods as a greater barrier to participation than females without menorrhagia (sport: 50% vs 29%, RR 1.7; active recreation: 58% vs 34%, RR 1.7). Adolescent females (15–18 years) perceived periods as a greater barrier to sport participation than older females (>18 years; 65% vs 30%, RR 2.2). Thematic analysis identified that the barriers to participation included physical (inadequate facilities, sport uniforms), social (stigma/embarrassment, unsupportive cultures, communication with coaches), policy (inadequate education and awareness, medical support), and individual psychological considerations (fear of underperformance, body image issues). The working group identified 15 potential strategies to support participation during periods, with a guide for sport and active recreation organisations to create supportive environments voted as the most feasible strategy for short-term implementation.

CONCLUSIONS:

Periods are often perceived as a barrier to sport and active recreation participation and can influence attendance and participation of females at training. Females with menorrhagia experience greater barriers and challenges to participation during periods. Understanding the attitudes and preferences of women and girls is essential for co-developing strategies that support participation. A guide for sport and active recreation organisations could address some of the identified barriers, but will require co-design, piloting, and evaluation to ensure effectiveness in supporting participation during periods.

**HOW CAN WE CONTRIBUTE TO DESTIGMATIZE THE MENSTRUAL CYCLE IN SPORTS?**

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INTRODUCTION: Training, sports performance and general well-being is perceived to be affected by the menstrual cycle (MC) among female elite athletes [1]. The often limited communication in the athlete-coach relationship, partly due to knowledge, interpersonal and structural barriers [2], poses a persistent difficulty in finding optimal strategies for dealing with sport and MC. The aim of this study was to identify taboo de-activators regarding the MC in the context of sports and to investigate whether and to what degree communication could contribute to de-stigmatization.

METHODS: 28 adult amateur athletes (15 males, 13 females; aged 20-35 years) took part in an interactive workshop, consisting of a lecture addressing the current scientific literature regarding the interaction between sport and the MC and small group discussions, according to the World Café method, a qualitative research technique distinguished by its innovative approach to participatory action research (PAR; [3]). Three rounds of conversations on three separate tables with up to 10 randomly assigned participants (organized in mixed-gender groups) addressed the following topics: Perception of MC as a taboo subject in sports; Importance & learnings of the workshop; Self-experienced effects of MC on performance. Table conversations were recorded and transcribed anonymously. A qualitative content analysis [4] was conducted with data being facilitated using MAXQDA 24 software.

RESULTS: The investigated male amateur athletes described an existing lack of knowledge and the fear of crossing their opposites' personal boundaries as hindering factors in initiating a conversation about the MC. Therefore, they phrased their communication role primarily as listeners. Several female participants expressed emotionality as correlated to the topic of the MC and referred to the positive aspect of talking to other women about the MC, as knowledge and empathy are assumed to be given, whereas in mixed-gender conversation the perception of a gap of neutral wording was mentioned. However, female amateur athletes described the degree of intimacy towards their contact person and not their gender as decisive. Respondents further reported that an enhanced number of female elite athletes to talk about the MC in public and corresponding media coverage could contribute to destigmatize the MC in sports.

Discussion: According to previous studies, knowledge and strong interpersonal relationships help to overcome the taboo in communication about the MC [1]. The results of the present study further suggest a potential in the de-emotionalization of communication, focusing on wording, in athletic communities.

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## Oral Presentations

### OP-SH20 Psychology II - Mixed Session I

**THE ROLE OF CARDIORESPIRATORY FITNESS AND BRAIN HEALTH IN AGE-RELATED COGNITIVE DECLINE: INSIGHTS FROM TIP-OF-THE-TONGUE STATES**

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INTRODUCTION: As global populations live longer, understanding the factors that contribute to cognitive decline in healthy ageing is increasingly important. Even in the absence of neuropathology, ageing is associated with wide-ranging cognitive difficulties, yet the rate and severity of decline vary across individuals. This variability may be explained by an interplay between brain-based and lifestyle factors, such as cardiorespiratory fitness. While research has examined these factors in isolation, here, we integrate their joint contributions to neurocognitive ageing. We employed commonality analysis that combined multimodal neuroimaging and fitness-based measures to explain variability in tip-of-the-tongue states—a prototypical cognitive problem in ageing which involves a temporary failure in producing a known word.

METHODS: The study involved 78 neurologically healthy older adults (mean age = 65.53 [4.94], range 60–81, 39 female) who underwent structural, functional, and perfusion MRI alongside a maximal, treadmill-based cardiorespiratory fitness

test that was used to quantify VO2Peak. Structural (T1-weighted anatomical) and perfusion (pseudo-continuous arterial spin labelling) imaging were used to estimate global grey matter density and cerebral blood flow, respectively, while functional imaging captured blood-oxygen-level dependent (BOLD) signal during a cognitive task designed to elicit tip-of-the-tongue states.

RESULTS

Replicating prior work, we first confirmed that there was a positive association between age and tip-of-the-tongue rates ($r = .288$, $p = .014$). Examining the functional MRI in isolation, we found that tip-of-the-tongue states recruited a broad language network within the brain, namely precuneus, bilateral angular gyri, and superior and middle frontal gyri. Next, using commonality analysis—a statistical technique that partitions variance in an outcome variable to identify unique and shared contributions of multiple predictors—we examined how age-related tip-of-the-tongue states were jointly explained by cardiorespiratory fitness together with brain structure, function, and perfusion. We found that tip-of-the-tongue occurrences were best predicted by a shared effect of age, fitness, and the functional recruitment of language-related brain regions ($t = 1.842$, $p = .002$).

CONCLUSION

These findings suggest that brain health and fitness work together to shape individual differences in age-related cognitive decline. Our results align with classic models of neurocognitive ageing, such as compensation, maintenance, and reserve by demonstrating that brain function is modified by both age and fitness levels. This interdisciplinary evidence underscores the importance of lifestyle factors, particularly aerobic fitness, in mitigating cognitive decline. By integrating neuroscience and exercise physiology, we highlight the potential for targeted fitness interventions to promote cognitive resilience in ageing populations.

**EXERCISE INTENSITY AGREEMENT, NEEDS FULLFILMENT, BEHAVIORAL REGULATION, AND EXERCISE-BEHAVIOR OUTCOMES: A DOUBLE SERIAL MEDIATION ANALYSIS**

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Introduction: Vicennial efforts to promote physical activity have fallen short of their intention and societal needs. The contemporary lifestyle millions adopt daily is often detached from several health-prone practices, as is often the case of physical activity, resulting in increasingly dire consequences on Human health. Grounded on the emerging trend of exploring behavior and decision-making through dual process theories, investigating potential mechanisms that can articulate implicit and explicit variables relevant to exercise adherence seems paramount. As such, this study aimed to test a hypothesized model where the exercise intensity agreement to individual preference/tolerance is proposed to be a facilitator of exercise behavior and related variables (intention to continue exercising and exercise habit). This exploration sustains that this would occur indirectly, through the improvement of the bright and dark sides of motivation as proposed by Self-Determination Theory (SDT), and directly, as theoretically proposed by previous related studies.

Methods: A total of 369 participants (Mage = 43.6 years ± 12.96; 214 females) from 26 health clubs fulfilled a psychometric battery for psychological (preference/tolerance agreement, basic psychological needs satisfaction/frustration, and behavioral regulations) and behavior-related variables (intention to continue to be physically active, exercise habit, and exercise frequency by attendance). Descriptive and correlational analysis, followed by double serial mediation procedures using model 18 of the PROCESS macro v.4.2, were utilized to test the direct and indirect effects of the hypothesized models.

Results: The analyses showed positive associations between intensity preference and tolerance agreement with basic psychological needs satisfaction, behavioral autonomous regulations, intention to continue exercising, and exercise habit. Negative associations were found with basic psychological needs frustration, and behavioral controlled regulations. Mediation analyses revealed direct effects of both preference ($\beta = 0.49$ [0.36, 0.62]) and tolerance agreement ($\beta = 0.41$ [0.28, 0.55]) on the intention to continue exercising. Indirect effects emerged mainly from the path with both BPN satisfaction and behavior-autonomous regulations in all models.

Conclusion: The results suggest that aligning exercise programs with individual intensity preference and tolerance may facilitate intention. Moreover, it can act as a BPN satisfaction facilitator, which has been extensively reported as being positively associated with improved behavioral regulation, an increase in exercise habit, and higher exercise frequency. When articulating these results with current evidence, increasing support emerges for the need to understand the individual relation with exercise intensity and respective implications manifesting on implicit and explicit variables across Human behavioral theories.

**INTERPERSONAL VIOLENCE IN MEXICAN ATHLETES**

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This study examined differences in violence experienced by athletes from teammates and coaches. The sample consisted of 2,633 Mexican athletes ($M = 21.17$, $SD = 5.03$), with 53.4% men and 46.6% women, and an average of 7.80 years of experience in their discipline ($SD = 5.80$).

The instrument used was the Violence Towards Athletes Questionnaire (VTAQ; Parent et al., 2019). The overall results show significant differences in psychological violence (M = -0.31, SD = .43, T = - 3.72, p < .001) and physical violence (M = -0.16, SD = .37, T = -2.20, p < .05). No significant differences were found in sexual violence scores (M = 0.001, SD = .25, T = 0.24, p = .81).

Regarding gender differences, women reported significantly higher levels of psychological violence from teammates than men (T = -3.87, p < .001), with women scoring higher (M = 1.20, SD = .45) than men (M = 1.14, SD = .41). Likewise, physical violence by the coach showed significant differences (T = 2.88, p < .01), being higher in men (M = 1.11, SD = .42) than in women (M = 1.07, SD = .32).

These results suggest that athletes are more frequently subjected to psychological violence (e.g., threats, ridicule) by teammates (mainly women) than by coaches. Additionally, they have also been victims of physical violence (e.g., hitting, pushing), predominantly by their coaches (mainly men), with the difference being minor in both cases.

These findings highlight the need for prevention and intervention strategies targeting both athletes and coaches.

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**A 1-YEAR OF LOW-INTENSITY EXERCISE TRAINING IN HYPOXIA ON MENTAL HEALTH IN THE ELDERLY**

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INTRODUCTION: Exercise training in hypoxia has been shown to cause greater improvements of fat reduction (Wiesner et al. 2010), insulin sensitivity (Haufe et al. 2008) and muscle strength (Park et al. 2019) compared with the same training in normoxia. Although majority of previous studies utilized short- or middle- term (< 24 wk) of moderate-intensity exercise training, long-term effects (> 24 wk) of low-intensity exercise in hypoxia in the elderly remains unclear. Especially, how the long-term exercise training in hypoxia affects mental health has not been fully elucidated. The purpose of the present study was to determine the effect of 1 year of low-intensity exercise training in hypoxia on mental health, sleep quality and cognitive function in the elderly.

METHODS: Twenty-two elderly (mean ± SD; 72.8 ± 6.1 yrs) were recruited. They were divided into either "group with exercise training in hypoxia (HYP, n=15)" or "group without exercise training (CON, n = 7)". HYP performed low-intensity exercise session for 60 min under moderate hypoxia (FiO2; 16.4 %), while CON did not join the exercise training session and maintained normal lifestyle. The exercise training was conducted twice per week for 1 year. Before and after the intervention period, all subjects answered questionnaires to assess depression status (Geriatric depression scale15 [GDS15], The depression anxiety stress scales [DASS21]), health related quality of life (SF8), cognitive function (Mini-mental state examination [MMSE]) and sleep quality (Pittsburgh sleep quality index [PSQI]). Physical fitness levels were also evaluated before and after the intervention period.

RESULTS: In HYP, average SpO2 during training session was constant during the intervention period (1st month: 92.6 ± 1.7%, 12fth month: 94.6 ± 2.2%). The pulse rate during training session was around 90 bpm (1st month: 88 ± 10 bpm, 12fth month: 90 ± 10 bpm). The score of GDS15 presented significant interaction (group × period, p = 0.035), and it was significantly lowered after the intervention period only in the HYP (p = 0.021). The score of MMSE presented significant main effect of period (p = 0.002), but no significant interaction or main effect of group was found. The score of PSQI did not change significantly in both groups. In HYP, systolic blood pressure was decreased significantly after the intervention period (pre: 129 ± 17 mmHg, post: 120 ± 11 mmHg. p = 0.015). For physical fitness levels, number of sit-ups, (pre: 10.6 ± 6.5, post: 12.9 ± 7.1, p=0.025), and time for 10m obstacle walk (pre: 6.1 ± 1.2 s , post: 5.4 ± 1.5 s , p=0.02) were significantly improved.

CONCLUSION: A 1 year of low-intensity exercise training under moderate hypoxic environment decreased depression score with improved physical fitness levels and systolic blood pressure in the elderly.

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**FACTORS INFLUENCING PERFORMANCE IN SQUARE-STEPPING EXERCISE AMONG HEALTHY OLDER ADULTS**

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*UNIVERSITY OF OXFORD*

INTRODUCTION: The Square-Stepping Exercise (SSE) is a structured program that integrates both physical and cognitive demands, designed to enhance balance, memory, and fall prevention, particularly among older adults. However, the extent to which SSE relies on physical and/or cognitive abilities remains unclear. This study aims to explore the relationship between these factors in a sample of healthy elderly adults.

Method: A total of 135 healthy older adults from the local community were recruited and completed a series of assessments, including questionnaires (Geriatric Depression Scale, Mini Mental State Examination, Montreal Cognitive Assessment), memory tests (Forward and Backward Digit Span), and fitness tests (30-Second Sit-to-Stand, Chair Sit-and-Reach, One-Leg Stand, 8-Foot Up-and-Go, Timed Up-and-Go, Functional Reach), along with the SSE. Stepwise ordinal logistic regression was conducted to examine the relationship between these variables and SSE performance, which was defined by the level participants could imitate following the instructors demonstration once or twice.

RESULTS: We developed three separate models focusing on demographic, mental state, and lower-limb fitness variables. The analysis showed that age, education level (demographic model), Backward Digit Span (mental state model), and performance on the TUG test (lower-limb fitness model) were significantly linked to SSE performance. After combining these factors into a final model, Backward Digit Span emerged as the only variable significantly associated with SSE performance.

Discussion

In conclusion, this study identified working memory as the strongest predictor of SSE performance among older adults, underscoring the key role that cognitive abilities play in SSE. We propose that, given the significant involvement of cognitive abilities over physical fitness components in SSE, incorporating this exercise into physical activity interventions has the potential to enhance both cognitive and physical abilities in older adults while promoting increased physical activity.

## Oral Presentations

### OP-MH41 Interventions I

**TWO YEARS FOLLOW-UP OF THE REMOTE HIGH-INTENSITY AEROBIC INTERVAL TRAINING EFFECTS ON PHYSICAL FITNESS OF BREAST CANCER SURVIVORS**

KLAVINA, A., LIEPINA, S., BERNANS, E., VISKINTE, M.
*RIGA STRADINS UNIVERSITY*

INTRODUCTION: Exercise interventions during neoadjuvant chemotherapy treatment (NACT) for patients with BC have been studied extensively during last decade demonstrating beneficial effects related to reducing treatment-associated side effects. High intensity interval training (HIIT) interventions have demonstrated clinically meaningful benefits for physical health and quality of life in BC patients in a relatively short time during therapy, while long-term effects remain unclear (Mijwel et al., 2019). This study aimed to investigate the effects of remote aerobic HIIT intervention during neoadjuvant chemotherapy treatment (NACT) on physical health outcomes 18-24 months following end of intervention in breast cancer (BC) survivors

METHODS: The HIIT intervention study was two arm randomized control trial (RCT) implementing remotely supervised 4x4 min HIIT at an intensity of 85-95% of peak heart rate for 6 months during NACT during 2022-2023 (Cancerbeat 1 study, Klavina et al., 2024). Incremental exercise test (VO2peak) and physical performance (6MWT and sit-to-stand test including 5 sec (5xSTS) 30 sec (30STS) assessment) was measured pre-post NACT and at 18-24 months follow-up (2024, Cancerbeat 2 study). The data were analyzed for 24 participants (HIIT= 13, CG = 11) who agreed to participate in follow-up study.

RESULTS: HIIT demonstrated significant effects for 6MWT (ES = .27, p = .012), Sit-to-stand scores (5 x) sec (ES = .233, p = .023), VO2peak outcomes (ES = .186, p = .045) and time to exhaustion (TTE) (ES = .25, p = .012) compared to CG. Both groups, HIIT and CG, significantly improved in 6MWT at 18-24 months follow-up compared to pre- and post-NACT ($p < .05$). Significant positive correlations were found between TTE scores and 6MWT (r = .564, p = .045) and minute ventilation (VE) outcomes (r = .645, p = .017) in HIIT group at follow-up. In CG the TTE was significantly correlated with VO2peak (r =.966, p <.001).

CONCLUSION: Participants in the HIIT group 18-24 months after intervention were demonstrating significant differences in aerobic endurance and leg muscle strength outcomes compared to CG. The CG presented physical health outcomes close to the pre-treatment follow-up. The remote 4x4 min HIIT intervention during the 6 months of NACT may lead to long-term benefits of physical health related outcomes. Future studies should emphasize the benefits of physical activity in long-term health maintenance by exploring individualized exercise prescriptions that align with the specific needs and post-treatment goals of each BC survivor.

References:

Klavina A, Ceseiko R, Campa M, et al. The effect of high-intensity interval training on quality of life and incidence of chemotherapy side effects in women with breast cancer. Integr Cancer Ther. 2024;23:15347354241297385. doi:10.1177/15347354241297385

Mijwel S, Jervaeus A, Bolam KA, et al. High-intensity exercise during chemotherapy induces beneficial effects 12 months into breast cancer survivorship. J Cancer Surviv. 2019;13(2):244-256. doi:

**A CO-DESIGNED INTERVENTION (ACTIVE-FAB) TO REDUCE SEDENTARY BEHAVIOUR AND INCREASE PHYSICAL ACTIVITY IN ADULTS WITH FABRY DISEASE**

BAILEY, D., GOSLING, S., HUGHES, D., KILBRIDE, C., MANSFIELD, L.

*BRUNEL UNIVERSITY LONDON*

INTRODUCTION: Fabry disease is a rare inherited metabolic disorder caused by a genetic fault in the alpha-galactosidase A enzyme. Breakdown of glycolipids in the lysosomes of cells is impaired, leading to excess storage of globotriaosylceramide that results in multi-organ disease (most notably affecting the brain, heart and kidneys). Mental health and quality of life is often severely impacted in Fabry disease, yet treatment is pharmacological and predominantly focuses on physical symptoms. Reducing sedentary behaviour and increasing physical activity are associated with improved mental health and quality of life in the general population. The aim of this study was to co-design a sedentary behaviour and physical activity intervention tailored for adults with Fabry disease.

METHODS: Barriers and facilitators linked to sedentary behaviour and physical activity were identified through focus groups with adults with Fabry disease (N=13), family members (N=8), and staff of the Society for Mucopolysaccharide Diseases (N=6). This was in addition to semi-structured interviews with 10 healthcare professionals (physicians, clinical nurse specialists, and a physiotherapist). Participatory workshops were then undertaken (N=12 adults with Fabry disease), informed by focus group and interview data, to test concepts and define the intervention content. The design process and intervention components were further refined through patient and public involvement. Data analysis used the Framework Method with inductive and deductive coding.

RESULTS: Barriers to reducing sedentary behaviour (e.g. habit, previous negative experiences, work environment) and increasing physical activity (e.g. comorbidities, perceived inability to be active, lack of understanding around Fabry disease in the community) were identified. Themes generated from the focus groups, interviews, and workshops led to a multi-component intervention, 'ACTIVE-FAB', that includes: (1) initial consultation with a physiotherapist to discuss sedentary behaviour, physical activity levels and set goals, (2) progress consultations with a physiotherapist focusing on intervention engagement and reviewing goals, (3) online education covering the importance of limiting sedentary behaviour and engaging in physical activity, and information to support engaging in adaptable physical activities, (4) a smartwatch that tracks sedentary behaviour and physical activity, and (5) online peer support.

CONCLUSION: This study has led to the co-design of a multi-component intervention to reduce sedentary behaviour and increase physical activity in adults with Fabry disease. The feasibility, acceptability and potential effectiveness of ACTIVE-FAB is being evaluated in a randomised controlled feasibility trial. This intervention could provide an effective adjunct to pharmacological treatment and improve management of Fabry disease in the future.

**EFFECT OF TWO DIFFERENT DIETARY-NUTRITIONAL THERAPIES COMBINED WITH ADAPTED PHYSICAL ACTIVITY ON HEALTH-RELATED QUALITY OF LIFE IN CHRONIC KIDNEY DISEASE: A PILOT STUDY**

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*UNIVERSITY OF ROME FORO ITALICO*

INTRODUCTION: Chronic kidney disease (CKD) is associated with several comorbidities, including uremic sarcopenia (US), which negatively influences patients' health-related quality of life. Dietary-nutritional therapy (DNT) and adapted physical activity (APA) are effective nonpharmacological strategies to counteract the CKD progression and its complications. Among dietary approaches, low-protein diets (LPD) (0.6-0.8 g/kg body weight/day) with controlled intake of phosphorus, sodium, and potassium and adequate energy intake can help mitigate the metabolic imbalances that contribute to US. An alternative DNT, such as the plant-dominant LPD (PLADO), with ≥50% plant-based protein intake, may further slow the CKD progression through modulation of the gut microbiota and reduction of uremic toxins. However, the combined effects of PLADO and APA on the prevention of US remain unclear. This pilot study analyses the impact of a 12-week online APA protocol combined with PLADO or LPD on muscle mass, physical capacity and quality of life in CKD patients.

METHODS: 15 CKD patients, aged 59.8±9.8 years, were randomized into 2 groups: A) Online APA protocol (3 sessions per week, lasting 1 hour each) combined with PLADO; B) Online APA protocol combined with LPD. Physical capacity (6-minute walking test), muscle strength (Handgrip), body composition (bioelectric impedance analysis), quadriceps femoris muscle thickness, and laboratory parameters were evaluated at baseline (T0) and after 12 weeks (T1). SF-36 was administered to assess patients' general health.

RESULTS: At T1 Group A and Group B increased the distance in the 6-minute walking test (p=.001; p=.034). Handgrip strength significantly improved in Group A for the left limb (p=.014), showing a positive trend in the right limb as well. In addition, there was a significant reduction in body mass index (BMI) in Group A (p=.022). While quadriceps femoris muscle thickness increased significantly in Group B (p=.050). No significant differences in free oxygen radical defense (FORD) and free oxygen radicals test (FORT) values were observed in both groups. Positive trend was reported in general health perception in both groups, and the item health change increased significantly in Group A (p=.050).

CONCLUSION: Both PLADO and LPD, combined with APA, seems to positively affect muscle function and body composition of CKD patients. The results suggest that combining dietary interventions with structured exercise may improve health-related quality of life in CKD. Further investigations into long-term outcomes and larger sample are required.

**12-WEEK EXERCISE INTERVENTION TO IMPROVE PHYSICAL AND MENTAL HEALTH IN POST-SURGERY COLORECTAL CANCER PATIENTS**

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*UNIVERSITY OF SURREY*

INTRODUCTION: Colorectal cancer is the third most common cancer worldwide1. Surgery is the main method of treatment in this tumour type, but many patients still experience surgery and cancer related complications such as fatigue, pain, bowel dysfunction and reduced quality of life2. There is increasing evidence that shows that increased physical activity is beneficial to improve disease prognosis3 but there is still a need for more applied evidence assessing the effectiveness of exercise interventions in a referral setting.

METHODS: All patients undergoing curative colorectal resections without metastases were eligible to take part. 24 patients (14 male, 66.7±11.6y, BMI:27.06±4.1 kg/m2 and 10 female, 60.3±11.5y, BMI:24.62±6.5 kg/m2) have currently finished the intervention. The intervention consisted of a 12-week individualised, progressive resistance training plan with one supervised and two self-managed sessions per week. At baseline and after 4, 8 and 12 week we assessed physiological and health parameter (e.g. W:H, blood pressure, grip strength), fitness outcomes (6min bike test (6mBD), strength assessments) and questionnaires to determine physical activity (DASI) and functional assessment (FACIT-G/F).

RESULTS: Adherence to the exercise sessions was good at 82% of all sessions completed. Comparing results pre and post intervention, 6mBD improved (2.5±0.5 vs 2.7±0.5 km, p=0.03), as did DASI predicated VO2peak (25.18±6.63 vs 30.01±5.15 mL/kg/min, p=0.03) and physical activity levels (DASI 36.2±15.4 vs 47.5±12.0, p=0.03). Of the strength measures attained only left-hand grip strength changed over the 12-week intervention (27.2±9.5 vs 29.5±9.9 kg, p=0.003). Functional Assessment of Chronic Illness Therapy scores did not reveal any changes because of the intervention (FACIT-F: 37.3±5.5 vs 40.7±8.0, p=0.29 and FACIT-G: 87.8±9.8 vs 90.2±15.1, p=0.66).

CONCLUSION: Twelve weeks of individualised semi-supervised exercise was shown to be effective in improving overall physical activity and exercise capacity in a cohort of post-surgery colorectal cancer patients. Functional capacity remained unchanged following the intervention, which may, to some extent, be attributed to the patients overall good health. Ongoing analysis is required to further elucidate the specific responses to the exercise interventions based on gender, surgery type and cancer stage.

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2Baum, P., Diers, J. Et al. (2019). Mortality and complications following visceral surgery: a nationwide analysis based on the diagnostic categories used in German hospital invoicing data. Deutsches Ärzteblatt International, 116(44), 739.

3Walter, V., Jansen, L. Et al.( 2017). Physical activity and survival of colorectal cancer patients: Population-based study from Germany. International journal of cancer, 140(9), 1985-1997.

**A MULTIDISCIPLINARY APPROACH TO IMPROVING FUNCTIONAL ABILITIES IN A CHILD WITH DCD: A CASE REPORT**

AFRICA, E., RAINSFORD, I., VAN BAALEN, G., CLOTHIER, J.
*STELLENBOSCH UNIVERSITY*

INTRODUCTION: Developmental Coordination Disorder (DCD), diagnosed around 5-6 years of age, significantly impacts gross motor development, affecting 5-6% of school-aged children globally and up to 15% in some South African regions, with a higher prevalence in boys (2-3:1 ratio). Children with DCD struggle in daily activities and academics due to motor skill difficulties, influenced by factors like poor postural control and proprioception1. While physical activity is crucial, their engagement is often lower than peers, necessitating tailored strategies, including impairment-oriented programmes, perceptual-motor therapy, and kinaesthetic training, to optimize outcomes in fundamental movement skills, muscle development, and overall quality of life. This report represents a 12-year-old girl diagnosed with DCD to showcase the positive effects of a multi-disciplinary intervention on her everyday motor abilities. To the authors' knowledge, this is the first case-report of this nature.

METHODS: An InBody evaluation was used to accurately measure the client's body composition, with emphasis on the segmental lean analysis results. The Quick Neurological Screening Test, 3rd Edition Revised (QNST-3R) was used by a Kinderkineticist (Paediatric Movement Therapist) to test for the client's fundamental and gross motor abilities. In addition, various functional assessments were performed by a Biokineticist (Clinical Exercise Therapist).

RESULTS: The pre-and-post-test results showed the lean analysis percentage of the right and left arm changed from 108 and 106,5 to 112,4 and 109,6 respectively. The total score of the QNST changed from 38 during the pre- to 21 during the post-test. In terms of functional assessments, the largest improvements were seen in seated hip flexion [left & right] (pre: 10.3° & 14.3°; post: 19.8° & 22.1°), and external rotation [left] (pre: 13°; post: 19.5°).

CONCLUSION: The InBody segmental lean analysis results showed an increase in both the client's arms and core, although a slight decrease was recorded in both legs. The positive change observed in QNST-3R scores is clinically relevant and positive results were recorded in all the functional assessments done. The results suggest that a close collaborative approach to movement interventions might have a larger beneficial effect of enhancing the motor abilities, daily functioning, and quality of life in children with DCD and that this approach is more beneficial than a single disciplinary treatment approach. This approach may reduce long-term societal burdens, such as academic struggles, limited physical activity,

and related health issues. Research in this area raises awareness and highlights the importance of early intervention for better outcomes.

## 16:30 - 17:30

### Conventional Print Poster Presentations

#### CP-AP01 Training and Testing I - Mixed

**CAN WE COMPARE JUMP HEIGHT MEASUREMENTS ACROSS DIFFERENT FORCE PLATFORM SYSTEMS?**

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*THE NORWEGIAN SCHOOL OF SPORT SCIENCES*

INTRODUCTION: Maximal vertical jump height is a key performance metric in research and athlete testing. Force platforms are the most common measurement tool, but systems vary across and within laboratories and sports clubs. Different force platform systems give rise to hardware and calculation (software) differences, which may impact data comparability. While prior research has examined force platform differences for some hardware solutions, to our knowledge, no studies have quantified discrepancies across multiple hardware and software solutions for several jump modalities. This study aimed to compare jump height measurements across four portable force platform systems for countermovement jumps (CMJs), squat jumps (SJs), and drop jumps (DJs).

METHODS: Twenty-seven participants (26.2 ± 3.8 yrs, 1.76 ± 0.08 m, 73.2 ± 11.2 kg) were included in this study. Four portable force platform systems were tested: Kistler, ForceDecks, MuscleLab, and HurLabs. Each force platform was placed on top of an in-ground reference force platform (AMTI) to concurrently measure ground reaction forces (GRFs) during SJs (n=678), CMJs (n=667), and DJs (n=998). 3D motion capture was collected for 14 of the participants (1426 jumps) as a secondary reference. Jump height was estimated using two analytical approaches. In the Hardware analysis, GRF data from each force platform (reference and portable) were processed using the same standardized algorithm. In the Software analysis, jump height was computed from the portable system using each system´s built-in (proprietary) software, comparing it to the standardized algorithm. System differences were assessed using Bland-Altman comparisons, and typical error of estimate was evaluated. A one-way ANOVA detected significant differences between force platform systems across all jump modalities for both analyses, followed by a Tukey-Kramer post hoc test.

RESULTS: Across all jump types, systematic differences in jump height between portable systems and the reference system ranged from -2.9% to 3.8% for the Hardware analysis, with a typical error of 1.1% to 5.0%. The Software analysis showed larger systematic differences (-11.6% to 11.1%) and greater typical error (3.2% to 22.3%). Similar trends appeared when using kinematics as reference. The Tukey-Kramer post hoc test found significant differences ($p < 0.05$) across all force platforms and jump modalities in both analyses.

CONCLUSION: Jump height measurements varied significantly across different force platform systems, even when using identical jump protocols and calculation methods. Different force platform systems should be used interchangeably in this way with caution. Proprietary software calculations should not be assumed valid, and different software cannot be used interchangeably for jump height measures if accuracy below 2 ± 2 cm is important. The results of this study are useful to understand and interpret jump height measured from different commercial force platform suppliers.

**ESTIMATION OF ENERGY EXPENDITURE IN TEAM GAME SPORTS VIA LOCAL POSITION SYSTEMS AND METABOLIC POWER MODEL VERSUS INERTIA MEASUREMENT UNITS**

HUANG, I., BONT, P., FIOLO, N., WAGNER, H., FUCHS, P.X.
*NATIONAL TAIWAN NORMAL UNIVERSITY*

INTRODUCTION: Monitoring loads and energy costs (EC) is important, but obtaining EC via spiroergometry (gold standard) during competitions is not feasible, especially not in contact game sports. A unique method (metabolic power model) addressed this problem by estimating EC based on players' acceleration derived from a local position system (LPS) [1]. Since the method's accuracy has been debated despite model updates [2], inertia measurement units (IMU; often incorporated in LPS) may be an alternative or addition to estimate EC more accurately. The study aimed to compare EC estimations derived from spiroergometry, LPS, and IMU during a validated game sports test.

METHODS: Eleven professional female handball players completed a validated, team handball game-based performance test [3]. Data were collected via a portable spiroergometry system (K5 Cosmed) and an LPS with integrated IMU (Catapult ClearSky T6). Indirect calorimetry derived ECSpiro from spiroergometry data, and the updated metabolic power model estimated ECLPS based on position data (10 Hz). IMU data (100 Hz) were used to calculate horizontal, vertical, and total PlayerLoad [4]. Differences between ECs were examined via repeated-measures ANOVA ($p\eta 2$). Pearson correlation coefficients (r) expressed the relationship between time- and body mass-normalized spiroergometry, LPS, and PlayerLoad data. Stepwise regression analysis (R2) explored the predictability of ECSpiro via metabolic power model and PlayerLoad. Significance level was set at $p<.05$.

RESULTS: ECSpiro (727±87 J/kg/min) differed from ECLPS (266±28 J/kg/min) ($p\eta2$=.98, p<.001) and did not significantly correlate with ECLPS (r=.56, p=.07). ECSpiro correlated with horizontal (r=.68, p<.05) but not with vertical (r=.47, p=.15) and total (r=.57, p=.07) PlayerLoad. A final regression model included only horizontal PlayerLoad (R2=.46, p<.05).

CONCLUSION: The large difference and insufficient correlation between ECSpiro and ECLPS advised against using ECLPS as the only estimate. PlayerLoad metrics demonstrated stronger correlations, suggesting greater potential for EC estimations than the metabolic power model. Combining ECLPS with PlayerLoad did not improve regression predictions due to strong co-linearity.

Regression analysis was statistically underpowered due to the limited sample size including only elite athletes to capture realistic dynamics. Nevertheless, the findings highlighted the significant discrepancy between ECSpiro and ECLPS, suggesting ECLPS unsuitable as a direct proxy for EC but not undermining its value for intra- and inter-subject comparisons.

References

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**SLEEP ARCHITECTURE IS ALTERED WITH TRAVEL AND MATCHES IN PROFESSIONAL RUGBY UNION PLAYERS**

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*UNIVERSITY OF WESTERN AUSTRALIA*

INTRODUCTION: Field-based research highlights the susceptibility of elite team-sport athletes to irregular sleep patterns, particularly during competition due to travel and matches. Currently, field-based data is derived from wrist-worn activity monitors (tracking sleep-wake patterns) and subjective assessments, however, they cannot measure sleep architecture (i.e., sleep-staging). While polysomnography is the gold standard for sleep assessment, its use in ecological settings remains impractical. Advancements in wireless home-based polysomnography and commercial sleep technology now enable the measurement of sleep architecture outside of laboratory environments. Given that each sleep stage plays a role on next-day function and performance, assessing sleep architecture could offer valuable insights into the consequences of travel and matches during competition. Therefore, the aim of this study was to examine the effects of travel and matches by comparing the sleep quantity, quality, and architecture of professional male rugby players during a home and away match fixture.

METHODS: Twenty-six players, contracted for the Super Rugby season, were recruited for a prospective observational study. The experiment was conducted during the first two rounds of the competition to compare sleep (quantity, quality and architecture) across two conditions: a home (no travel; HOME) and an away (eastbound travel across three time zones; AWAY) match fixture, separated by eight days. Sleep data was collected using home-based polysomnography over three nights per condition: two nights preceding the match (MD-2), match night (MD), and the following night (MD+1). Sleep quantity (sleep duration), quality (sleep efficiency), and architecture (sleep onset/offset, latency, wake after sleep onset, awakenings, and sleep stages) were monitored. Sleep stages (light, deep and rapid eye movement [REM] sleep) were evaluated as proportion (%) and duration (min).

RESULTS: Twenty athletes participated in the study (age: 27.5±4.1 years; height: 185.4±7.1 cm; body weight: 99.6±12.3 kg; positions: 9 forwards and 11 backs), with sleep data collected from 69 out of the 120 nights. Compared to HOME, AWAY increased sleep onset latency (+12±23 min; p<0.01) and altered sleep architecture (light: -6.2±7.1%; p<0.01). Regardless of condition, MD incurred delayed bedtime (+71±135 min; p<0.001), reduced sleep duration (-94±120 min; p<0.05) and altered sleep architecture (deep: +9.8±10.0%; REM: -6.9±8.3%; both p<0.05) compared to MD-2. On MD+1, sleep duration (+96±147 min; p<0.01), and time in light and REM sleep all rebounded (light: +52±44 min; REM: +39±52 min; both p<0.05) in both conditions.

CONCLUSION: Professional male rugby union players experience alterations in sleep quantity, quality, and architecture on nights surrounding both home and away matches, with variability among players. Teams should arrange in-season training and flight schedules to ensure adequate sleep opportunity to optimise recovery.

**LOAD-VELOCITY PROFILING AS A PREDICTOR OF 50 M SPRINT PERFORMANCE IN 11-YEAR-OLD SWIMMERS: INSIGHTS ACROSS ALL FOUR STROKES**

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INTRODUCTION: Load-velocity profiling has been shown to predict sprint performance in elite swimmers [1], yet its potential in adolescent swimmers remains unexplored. Identifying performance-related characteristics at an early stage could provide valuable insights for talent identification and training optimisation. This study examines the relationships between load-velocity profiles and 50 m sprint performance in 11-year-old swimmers across all four swimming strokes.

METHODS: A repeated cross-sectional design was employed with 147 11-year-old swimmers (44 boys, age 11.2±0.5y, height 152.4±6.9cm, weight 43.6±7.6kg, and 103 girls, age 11.2±0.5y, height 153.1±7.0cm, weight 42.2±6.8kg). Sprint performance was recorded with an automated race analysis system (AIMsys, Lund, Sweden), to obtain 50 m velocity (V50)

and time (T50) in a 25 m pool. Load-velocity data was collected using a robotic resistance device (1080 Motion, Lidingö, Sweden), where swimmers performed three maximal semi-tethered 25 m sprints with increasing resistance (~1, 2, 3 kg). A 5 m segment (10-15 m) was analysed for mean velocity, and load-velocity profiles were modelled using linear regression to determine theoretical maximum velocity (V0), theoretical maximum load (L0), and relative L0 (rL0, normalized to body mass). Pearson's (parametric) and Spearman's (non-parametric) correlation coefficients examined relationships between V0, L0, rL0 and T50, V50.

RESULTS: V0 showed very large correlations with both T50 and V50 across all strokes. In front crawl, correlations were -0.796, p<0.001 for T50 and 0.819, p<0.001 for V50. In backstroke, correlations were -0.724, p<0.001 for T50 and 0.784, p<0.001 for V50. Breaststroke showed correlations of -0.629, p<0.001 for T50 and 0.772, p<0.001 for V50. In butterfly, correlations were -0.758, p<0.001 for T50 and 0.795, p<0.001 for V50. Large correlations were found for L0 and rL0 with both T50 and V50 in front crawl and backstroke: T50 (front crawl L0 -0.556, p<0.001 and rL0 -0.503, p<0.001, backstroke L0 -0.534, p<0.001 and rL0 -0.524, p<0.001). V50 (front crawl L0 0.564, p<0.001 and rL0 0.537, p<0.001, backstroke L0 0.613, p<0.001 and rL0 0.619, p<0.001). Breaststroke showed small correlations between L0 and both T50 (-0.171, p<0.05) and V50 (0.204, p<0.05). Butterfly L0 showed moderate correlations with both T50 (-0.318, p<0.001) and V50 (0.314, p<0.001).

CONCLUSION: V0 strongly predicts 50 m sprint performance across all strokes in 11-year-old swimmers. L0 and rL0 are strong performance indicators in front crawl and backstroke, but less relevant in breaststroke and butterfly. Thus, load-velocity profiling is a valuable tool for assessing sprint performance in 11-year-old swimmers, particularly in front crawl and backstroke. Future research should investigate training interventions targeting load-velocity parameters to optimise adolescent sprint performance.

[1]Olstad, B. H. et al (2024). Journal of Sports Sciences, 42(16).

**SEX DIFFERENCES IN THE SLEEP DEPRIVATION EFFECT ON MUSCULAR STRENGTH, POWER AND ENDURANCE PERFORMANCE IN RESISTANCE-TRAINED PARTICIPANTS**

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*UNIVERSIDAD DE ALCALÁ*

INTRODUCTION: Nightly rest is essential for preserving both physical and mental health. Despite its importance, nearly 45% of adults in Western countries do not achieve the recommended 7 to 9 hours of sleep per night. This is of special interest in athletes who have a higher predisposition to experiment with poor sleep or sleep deprivation, which cause a reduction in exercise performance. However, the effect of sleep deprivation on exercise performance is mainly obtained from evidence in men. Thus, this study aimed to examine sex differences in the impact of total and partial sleep deprivation on muscular strength, power, and endurance performance in resistance-trained participants.

METHODS: Twenty-four resistance-trained participants (age: 22.1±3.3 years; sex (F/M): 12/12; training experience: 3.4±2.4 years) took part in a randomized, cross–over and counterbalanced trial with four sleep conditions: 8h normal sleep at home (SH) and the remaining three at the laboratory: normal sleep 8h (SL), early sleep deprivation 4h (pSD) and sleep deprivation 0h (SD). After each experimental condition, participants performed a muscular strength and power, and muscular endurance tests in the bench press and back squat exercises using a linear transductor. The muscular strength and power test was performed at 25%, 50%, 75%, 90% and 100% of 1RM loads, while the muscular endurance test was assessed for both exercises at 65% 1RM, performing one set until task failure. Velocity and power production were obtained in all tests. Dietary and physical activity habits were replicated 24 hours before the trials.

RESULTS: In the muscular strength and power test at 50%1RM, a condition effect was found in both bench press and back squat exercises for Vmean, Vpeak and Time to Vpeak (P<0.048, ηp2>0.10). These effects were only found in male participants when comparing in both exercises SH and SL to pSD in Vmean (11-12%, P<0.048), Vpeak (7-10%, P<0.049) and time to reach Vpeak (-7–15%, P<0.049), and SL to SD in back squat exercise for Vmean (10%, P=0.048), Vpeak (7%, P=0.008) and time to reach Vpeak (-11%, P=0.050). In muscular endurance test, condition effect was found in the back squat exercise for Vmean, Vmax, Time to Vpeak, Wmean, Wpeak, and time to Wpeak (P<0.01, ηp2<1.61), differences that were only found in female participants when comparing SH and SL to PSD and SD in Vmean (10–12%, P<0.025), Vpeak (9–12%, P<0.02), Time to Vpeak (-13–15%, P<0.05), Wmean (10–11%, P<0.05), Wpeak (11–14%, P<0.04) and time to Wpeak (-14–16%, P<0.05).

CONCLUSION: In conclusion, performance reduction in muscular strength, power and endurance performance caused by total and partial sleep deprivation occur differently according to sex. While male participants experienced a reduction in muscular strength and power performance, particularly at moderate loads (50%1RM), in females the reduction in performance occurred in muscular endurance test.

**THE REMOTE EFFECTS OF FOAM ROLLING: EVIDENCE OF MYOFASCIAL CHAINS?**

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INTRODUCTION: Foam rolling (FR) is widely used to enhance joint range of motion (ROM). However, limited evidence is available regarding the remote effects of FR. Thus, this study aims to examine the acute local and remote effects of FR,

with this being performed on the right knee flexors (RKF) and relevant outcomes being also measured in the cervical spine.

METHODS: Eighteen participants (26.3±4.87 years, 169±9.63 cm, 66.4±14.5 kg) were recruited. Each participant underwent two conditions in a randomized order: a control (CC) and a FR intervention. In the FR session, participants performed 4 sets of 30 rolls (15 in each direction) with a 30 seconds rest between sets in the RKF using a GRID surface roller. Outcome measures were skin temperature (TsK), tissue hardness (TH) and ROM. Data were assessed upon arrival (T0) and immediately after the sessions (T1). The environmental temperature was standardized at 24° C. Before starting the first session, anthropometric measures were taken. Participants then underwent a 15-minute acclimatization period lying on a medical bed in a prone position. Afterward, TsK and TH were measured in the RKF (both the biceps femoris [BF] and semitendinosus [ST]) and the cervical region (to the right and left of C7) using an infrared thermal camera and a portable TH meter, respectively. Then, active hip flexion and cervical (flexion, extension, rotation and inclination movements) ROM were measured using a Gyko inertial sensor system. In the CC session no intervention was applied, and participants were asked to lie on a medical bed in a prone position for 4 minutes. Immediately after each session, all measurements were re-evaluated (T1) and compared to the T0.

RESULTS: Our results showed that hip flexion ($p<0.001$), cervical flexion and extension ($p<0.001$), right and left rotation ($p<0.001$), as well as right ($p<0.001$) and left ($p=0.003$) inclination ROM, significantly increased only for the FR intervention. Conversely, TH significantly decreased in BF, ST ($p=<0.001$) and right cervical region ($p=0.030$) but not in left cervical region ($p=0.287$) for FR. Lastly, RKF TsK significantly decreased ($p=0.019$) for CC, while no effect was observed ($p=0.242$) for FR, with no changes in cervical TsK.

CONCLUSION: The FR intervention acutely improved local (right hip flexion) and remote (cervical) ROM. A reduction of tissue hardness was associated with the ROM increase both locally and in a remote region, with no variations in skin temperature. Our results suggest that the remote ROM improvement may be attributed to strain transfer along a myofascial meridian rather than a warm-up effect.

**EFFECT OF HAMSTRING ECCENTRIC PRECONDITIONING ON MUSCLE DAMAGE INDUCED BY A STRENUOUS REPEATED-SPRINT TASK IN MALES AND FEMALES**

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INTRODUCTION: Repeated sprints are crucial regarding physical performance in many sports but result in reversible hamstrings muscle damage (HsMD) (1). In females, the hamstring-to-quadriceps ratio decreases at high knee angular velocities (2), which could lead to greater HsMD following sprinting. Eccentric preconditioning is reported to reduce muscle damage in response to subsequent exercise - a phenomenon known as the repeated bout effect. Thus, this study aimed to investigate whether performing a hamstring-specific eccentric exercise a few days before a repeated-sprint task could attenuate HsMD to a greater extent for females than males.

METHODS: Participants were randomly assigned to either a preconditioning (PC; n=21; 11 females; age=20.1±2.1) or a control group (CT; n=22; 11 females; age=20.6±3.1) and underwent 3 visits scheduled according to the menstrual cycle. The first visit included a familiarisation with the procedures but only the PC group performed a preconditioning exercise (4x10 eccentric hamstring contractions). Fourteen days later, participants performed a repeated sprint task (3 sets of 5x30m) (1). To assess the acute and delayed effects of HsMD, participants were tested before (PRE), immediately after (POST) and two days (2D) after the strenuous sprinting task. Indirect markers of HsMD included muscle soreness (MS; assessed via visual analogue scale), muscle swelling (decreased echo-intensity; EI), maximal voluntary isometric torque (MVT) and low-frequency fatigue (myostimulation trains: 10-50Hz; T10 to T50). Linear mixed models were performed fitted with time, group and sex as independent factors and participant as random intercept.

RESULTS: No significant differences were found between PC and CT groups over time for any of the measures. Regardless of group, MVT decreased by -13.4±8.9% ($p<.001$) at POST and -4.4±9.1% ($p<.01$) at 2D, respectively. Evoked responses to T10, T20 and T30 decreased at POST (-9.6%±23.6%, -15.0±19.6%, -7.6±12.8%; $p<.05$) but returned to baseline at 2D, in all groups. A time x sex interaction effect was found for EI and MS. Only females showed significant loss of EI (i.e. increased muscle swelling) at 2D (-5.8±5.0%; $p<.001$). Moreover, females showed increased MS at POST and 2D (+2.9±2.4 and +3.6±2.8, respectively; $p<.05$), whereas MS increased only at 2D for males (+2.2±1.5; $p<.05$).

CONCLUSION: Our results do not support a repeated bout effect from hamstring-specific eccentric preconditioning against future HsMD induced by repeated sprinting. Nevertheless, only females showed indirect signs of hamstring swelling at 2D (associated with increased MS), which reinforces their higher sensitivity to HsMD (3). These findings highlight the necessity for sex-specific strategies to prevent HsMD. For females, longitudinal eccentric training may serve as an effective approach to mitigate HsMD following running-based activities.

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**STRENGTH VARIABILITY AND UPPER BODY COMPOSITION: A COMPARATIVE ANALYSIS ACROSS EXERCISES**

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INTRODUCTION: Assessing body composition, particularly muscle morphology, can help coaches predict strength outcomes in athletes and evaluate their training status [1]. The relationship between muscle strength and muscle morphology is less studied in the upper body. Thus, the purpose of this study was to measure the 10-repetition maximum (10RM) strength performance during the bench press (BP) and the horizontal row (HR), and determine a correlation between muscle mass, muscle stiffness and anthropometrics.

METHODS: Twenty-one resistance-trained males visited the laboratory for three sessions, during which the cross-sectional area (CSA) of the pectoralis major and triceps brachii, as well as muscle thickness (MT) of the biceps brachii and trapezius transversus, were assessed using 2D ultrasound imaging. Muscle stiffness was evaluated using shear wave elastography (SWE) at multiple sites. Upper-body anthropometrics, including biacromial distance, chest girth, upper arm length, and arm span width, were measured at key anatomical landmarks. Participants further performed the 10RM tests for the BP and HR. Data normality was tested with the Shapiro-Wilk test, using Pearson's correlation for normal and Spearman's correlation for non-normal distributed data.

RESULTS: Strong correlations were observed between pectoralis major CSA (i.e., medial and lateral point) and BP 10RM strength ($r = 0.80 – 0.82$, $p < 0.001$), while proximal triceps CSA showed a moderate correlation ($\rho = 0.49$, $p = 0.027$), with no significant relationship for distal CSA. For HR 10RM strength, no correlations were found with trapezius MT (i.e., area, medial and thickest point), but moderate to strong correlations were identified with biceps brachii MT at the proximal ($r = 0.61$, $p = 0.006$) and distal ($r = 0.56$, $p = 0.013$) sites. BP 10RM correlated significantly with chest girth ($r = 0.57$, $p = 0.007$) and biacromial distance ($r = 0.59$, $p = 0.005$), while HR 10RM correlated with chest girth ($r = 0.61$, $p = 0.006$), upper arm length ($r = 0.52$, $p = 0.022$), and span width ($r = 0.51$, $p = 0.025$). Regarding stiffness, strength and morphology, no correlation was found for any of these outcomes.

CONCLUSION: These findings emphasize pectoral muscle mass as a key contributor to BP strength [2] and biceps brachii to HR strength. SWE muscle stiffness in the upper body at rest showed no link to strength performance, suggesting stiffness may not be critical for strength adaptations. This was also confirmed in interventional studies, whereas resistance training did not consistently result in stiffness increases in the muscle [3]. Upper-body width may predict BP strength, while arm length and chest girth may serve as HR strength indicators.

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**ARE BODY COMPOSITION ESTIMATES AFFECTED BY THE MENSTRUAL CYCLE IN FEMALES WITH OR WITHOUT HORMONAL CONTRACEPTION? - A CASE-CONTROL STUDY**

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INTRODUCTION: The menstrual cycle (MC) is characterized by rapid changes in female sexual hormone concentrations, resulting in subsequent water retention alterations, which may affect the estimates of body composition (BC) parameters [1]. Thus, MC phase-dependent variations in BC measurements might be expected in females for bioelectrical impedance analysis (BIA) or air-displacement plethysmography (ADP), but not for skin-fold calipometry (CAL).

This study aimed to evaluate the accuracy of BC estimates during a regular MC by means of BIA, ADP, and CAL in females with or without hormonal contraception, with males serving as a control group [2], and to examine the impact of hormone-induced water retention on these measurements.

METHODS: In a case-control design, BC was determined using BIA, ADP and CAL in 54 participants (age 18-33; BMI 17.0-27.8) divided into females using hormonal contraceptives (HC) (n=19), eumenorrheic females using non-hormonal contraceptives (no-HC) (n=17) and males (n=18). In a repeated measure design with four cycle-related time points (t1-t4) a complete MC was covered (t1: start of menstruation, t2: late follicular, t3: ovulation, t4: mid-luteal).

Fat mass (FM), fat-free mass (FFM) and bodyfat (BF%), as well as total body water and extracellular water served as BIA outcomes for statistical analyses. Body weight, body volume, BF%, FM and FFM served as dependent ADP parameters and BF% served as the CAL dependent variable for latter statistical analyses.

RESULTS: There were only small intraindividual BC variations during the MC (CV% 0.5-5.2) and neither significant time effects within any group (p=0.065-0.939) nor significant time*group interactions (p=0.151-0.956) for all measuring devices in any BC parameter.

CONCLUSION: Hormone-induced water retention during the MC did not affect BC estimates of ADP, BIA and CAL or were too small to influence the estimates of the devices neither in females with HC nor in females with no-HC. Thus, female athletes do not have to consider their menstrual phase when assessing their BC in their athlete monitoring.

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## Conventional Print Poster Presentations

### CP-AP02 Statistics and Analyses I - Team Sports

**PERFORMANCE INDICATORS OF BALL HANDLER'S DECISION-MAKING IN BASKETBALL**

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INTRODUCTION: In the team sport of basketball, passing decisions significantly influence cumulative scoring and achieving victory. Ball handlers determine their following action based on the positions of teammates and defenders. The outcomes of these decisions are often reflected in the defenders performance. Performance indicators in the notational analysis of sports usually refer to successful actions or outcomes. This study aims to investigate ball handlers decision-making performance indicators through notational analysis.

METHODS: Six group-stage matches from the FIBA 3x3 U23 World Cup womens division, featuring the top six and bottom six teams, were analyzed. The Simi Scout notational analysis software was used to record the outcomes of defensive actions following ball handlers decision-making (steals, effective defensive positioning, or defensive failure). Intra-observer reliability was tested using Cohen's Kappa. Statistical analyses were performed using Jamovi 2.3.28.0. One-tailed independent samples t-tests were conducted to compare the quantity and proportion of defensive outcomes between the top and bottom six teams.

RESULTS: Intra-observer reliability was found to range from 0.798 to 0.978. Regarding the number of defensive outcomes, the top six teams demonstrated a significantly higher number of defensive failures by opponents than the bottom six teams ($p = 0.028$). However, no significant differences were observed in the other two defensive outcomes. Regarding proportions, the top six teams exhibited a significantly higher proportion of defensive failures by opponents ($p = 0.043$) and a significantly lower proportion of steals by opponents ($p = 0.026$) compared to the bottom six teams.

CONCLUSION: Using basketball's defensive outcomes as performance indicators of ball handlers decision-making, it was found that ball handlers from top-performing teams generated more open opportunities due to defensive failures and experienced fewer turnovers from steals. Opponents defensive actions can also be used as performance indicators of ball handlers decision-making. Beyond team-based comparisons, this method could also assess changes in athletes decision-making abilities before and after training.

**THE REINVENTION OF BEACH VOLLEYBALL - PREVALENCE AND EFFECTIVITY OF THE SWEDISH JUMPSET**

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INTRODUCTION: In the last years, the Swedish world class Team Ahmann / Hellvig (AH) reinvented beach volleyball by introducing the so-called "Swedish Jumpset". On the second ball contact, they create two Second Ball Options (SBO) either a) by attacking the second ball or b) by faking an attack on the second ball and playing a fast jumpset to the teammate. This style causes massive temporal pressure on the opponent block player in moving to the correct blocking position. This study focusses on seven research questions including i) how of-ten and in which situations do AH create SBO, ii) which factors influence the decision second ball attack vs. jumpset, iii) is setting quality reduced in SBO?, iv) is block quality reduced in SBO, v) how do AH attack in SBO, vi) how effective is attack in SBO, vii) are opponents able to adapt to this playing style?

METHODS: In order to answer these research question, we analyzed 34 matches on world tour 2021-2023 (19 won, 15 lost). The sample includes pairs of matches against the same team (ear-ly match, second match around one year later). Notational analysis based on video re-cordings uses a compressive observational system including performance variables as-sociated with SBO, such as position of contacts, quality of reception, setting, block and at-tack as well as direction of the attack and temporal variables.

RESULTS: Results show a surprisingly high ratio of situations with SBO (50,5%). Against power serve on Ahman, SBO rate is decreased (50.7% vs. 59.3%) Both players chose the attack-ing option on contact 2 more often (66%) than playing a jump set (34%). There are nor hints towards setting problems when using jump set. Block quality against attack on con-tact 2 is quite low (only 35% in time). On optimal receptions, kill rate ion SBO is increased by ~12% compared to non SBO situations. Opponents were less successful in blocking against AH in the second match.

CONCLUSION: AH used the "Swedish Jumpset" very often. By doing this, they reduced bock quality without introducing inaccurate setting. This leads to an increased attacking success com-pared to non SBO situations. Most opponents were no able to create countermeasures in the second match. Attacking success suggest that AH, were only able to establish them-selves under the world top teams, because the take use of this tactical-technical mean.

**ANALYSIS OF PHYSICAL AND PERFORMANCE METRICS IN CZECH WOMENS LACROSSE TEAMS IN PREPARATION FOR THE 2028 OLYMPICS**

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*CASRI*

INTRODUCTION: With lacrosses return to the Olympics in 2028, this study aims to examine the physical and performance characteristics of elite Czech womens lacrosse players and compare them with previously published results for their NCAA Division I and III counterparts in the US. The goal is to identify areas for improvement and align with the performance standards set by advanced lacrosse programs such as those in the United States.

METHODS: The study included Czech national team players (N=24) and club players (N=41), measuring metrics such as body weight, height, skeletal muscle percentage, body fat percentage, and performance tests including shooting speed. Performance evaluations also involved countermovement jumps without added weight and with 20 kg and 40 kg weights, as well as static jumps with a 40 kg load. Our findings were compared with existing NCAA data to identify training gaps and standardize training practices.

RESULTS: There were significant physical and performance disparities between Czech players and their NCAA counterparts. Specifically, the shooting speed for Czech national players was recorded at 87.84 km/h (±12.63 km/h), considerably lower than the 129.02 km/h (±16.42 km/h) observed for NCAA Division I athletes. Additionally, the countermovement jump for Czech players was 29.1 cm (±4.2 cm) compared to 44 cm (±6.2 cm) for NCAA Division I. Somatic differences were also notable with Czech players averaging a height of 169.3 cm (±6.2 cm), weight of 67.42 kg (±11.1 kg), and body fat percentage of 23.2% (±5.3%), which contrasts with their NCAA Division I and III counterparts. These findings underscore the need for targeted training improvements to reach competitive standards set by top-tier U.S. programs.

CONCLUSION: The findings indicate significant disparities in physical characteristics and performance outputs between Czech womens lacrosse players and their NCAA counterparts. This knowledge is crucial for optimizing the preparation of Czech players for the 2028 Olympics

**THE ROLE OF EXTERNAL POWER IN ASSESSING NEUROMUSCULAR LOAD IN PROFESSIONAL RUGBY MATCHES**

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INTRODUCTION: The precise measurement of mechanical load in rugby is crucial for optimising player performance, controlling fatigue, and minimising the risk of injury. Conventional metrics that assess acceleration and velocity independently do not adequately consider their combined impact on high-intensity movements during gameplay. This study introduces the external power approach [1], based on individual acceleration-speed profiles (ASP) to provide a more thorough analysis of player workloads [2].

METHODS: Data were gathered from 51 professional rugby official matches across two seasons using a GPS system (gpexe Pro², 18.18 Hz). Acceleration events (accs) and distances (D-acc) exceeding 2.5 m/s² were evaluated alongside the external power parameters, which combine acceleration and velocity, for a more effective assessment of mechanical load; based on the individual ASP, bursts and external mechanical work surpassing 80 % of the maximum power output across the entire speed spectrum were calculated.

RESULTS: Regardless of playing time, the number of accs and the corresponding D-acc per unit of time were 0.47 events/min and 0.82 m/min, respectively. In contrast, the external power approach provided a more precise and tailored assessment of neuromuscular load. Indeed, the number of bursts was 0.21 events/min, corresponding to a mechanical energy output, above the 80 % power threshold, of 205.8 J/kg for an overall playing time of about 89 minutes.

CONCLUSION: Traditional acceleration metrics frequently misrepresent and overestimate player demands by disregarding the influence of initial velocity, leading to an erroneous classification of high-intensity efforts [1].

A comparison of match workload patterns between rugby and soccer players [2] further clarifies this situation. Due to the lower starting speed of plays in rugby, the number of accelerations is generally greater than that in soccer for the same number of bursts. This implies that certain runs exceeding 2.5 m/s² in rugby do not necessarily require a substantial amount of effort since the low initial velocity facilitates surpassing the acceleration threshold. Indeed, the average ratio accs/bursts for rugby and soccer players is 2.06 and 0.58, respectively. This indicates that, relying solely on the acceleration number, the most demanding actions experienced by the players are overestimated in rugby and underestimated in soccer.

By addressing the limitations of traditional metrics, the external power approach presents a more accurate method for assessing mechanical load in rugby. This model supports improved monitoring, targeted training strategies, and performance optimisation while mitigating injury risk.

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**SPORT-SPECIFIC AND INDIVIDUAL DETERMINANTS OF THE ENERGY COST OF CONSTANT SPEED RUNNING IN TEAM SPORTS**

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INTRODUCTION: Metabolic Power has emerged as a valuable metric for assessing the physical demands of team sports, considering both speed and acceleration to provide a comprehensive view of energy expenditure. However, accurately determining the energy cost of constant speed running (EC0) remains crucial for refining these estimations and improving player load management. The energy cost of constant speed running, a key component of this approach, is influenced by factors such as running velocity and $VO_2$max. While traditionally determined from steady-state oxygen consumption, EC0 may differ between athlete groups due to specific training adaptations. A more precise estimation of energy expenditure based on positional data will enhance player monitoring, training recovery, and load management in team sports.

METHODS: An experimental cohort study was conducted, with data collected from 368 incremental treadmill tests across different team sport athletes to determine the energy cost of constant speed running. 15sport students, 12 elite male handball players, 24 elite mal field hockey players, 197 elite female field hockey players and 121 elite male soccer players. Athletes performed a treadmill protocol to exhaustion while oxygen uptake, CO2 output, respiratory exchange ratio and ventilation was measured breath-by-breath. Data processing included verifying steady-state conditions, net EC0 was calculated from the energy expenditure above resting divided by the speed. Type of sports, velocity, and VO2max were defined as fixed effect variables.

RESULTS: Our random intercept and slope model with all predictors performed best. Sport students had the highest EC0 (estimated total mean, in J/kg/m) with 4.12 CI95% 3.91, 4.18 followed by handball players (4.05 CI95% 3.97, 4.28), field hockey players (3.98 CI95% 3.99, 4.03) and soccer players (3.60 CI95% 3.51, 3.69). However, the increase seems to be rather curvilinear with a decrease in EC0 starting at a velocity of 3.5 m/s (see Figure 2). If the sample is split into smaller groups and only athletes who complete the same steps are compared, the EC0 stays constant over different velocities. Athletes with a higher VO2max exhibit lower RER values at the various speed levels compared to athletes with a lower VO2max.

CONCLUSION: The original approach established an $EC_0$ value of 3.6 J/kg/m based on mountain endurance runners, which was later refined to 4 J/kg/m. Our data suggest that multiple predictors must be considered to determine an appropriate $EC_0$ for each individual athlete. Although $EC_0$ remains relatively constant across different velocities for a given athlete, it varies significantly across sports and $VO_2$max levels, highlighting the need for individualized assessments. Ideally, $EC_0$ should be calculated for each athlete to ensure accuracy in energy cost estimations. These findings may enhance the accuracy of the Metabolic Power approach and enable a more precise analysis of metabolic data based solely on positional tracking.

**KEY PERFORMANCE INDICATORS IN ELITE BLIND AND PARTIALLY SIGHTED FOOTBALL.**

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INTRODUCTION: Athletes with vision impairment compete within three adapted forms of futsal: (1) male blind football, where players, at best, can perceive light; (2) partially sighted football, where individuals use their remaining sight; and (3) female blind football, where athletes compete together. Key performance indicators (KPIs) for scoring and winning in these forms of the sport are currently unknown. The study aimed to identify KPIs in elite blind and partially sighted football.

METHODS: Notational match analysis of 39 male blind, 18 female blind and 15 partially sighted world championship matches were conducted. Team win ratio was calculated by dividing the number of games won by the number of games played. The impact of team strategy was assessed by hybrid KPIs such as total ball possession index (TBPI), defensive ball possession index (DBPI) and offensive ball possession index (OBPI). Separately, hybrid and notational data were used within linear mixed models to identify significant predictors of a teams win ratio.

RESULTS: Male blind football: possession (%), attacking third entries and open play passing success (%) were significantly predictive of win ratio. Open-play passing success (%) had the most significant impact on a teams win ratio. Female Blind football: win ratio was significantly predicted by open play passing success, possession, attacking third entries, players used, and total shots. Attacking third entries had the greatest impact on a teams win ratio. Partially sighted: the number of VI players who competed within a game per team significantly predicted win ratio; open-play passing success was trending towards significance but did not reach this threshold. TBPI, OBPI and DBPI were significant predictors of win ratio for blind (male and female) and partially sighted football. In each version of the sport, OBPI had the greatest impact.

CONCLUSION: In male-blind football, teams with greater passing success are likely to make it more difficult for opposing players to orient the balls location and attempt to regain possession whilst impacting the oppositions defensive positioning, which could lead to a teams improved chance creation and therefore correspond to improved offensive performance. Female blind football teams that employ an offensive game strategy will likely be more successful. This supported by attacking third entries being strongly predictive of win ratio and suggesting regular pressure on opposing teams contributes to greater success. The physical demands of futsal may explain why squad rotation was such a key performance

metric, as the world championships were a knockout competition, and players competed frequently over a short period, possibly contributing to physical fatigue. Therefore, teams that could rotate their squads could maintain these effects more regularly on their physical performance.

## Conventional Print Poster Presentations

### CP-AP04 Sports Equipment

**RUNNING ECONOMY OF ELITE DISTANCE RUNNERS DURING PROLONGED RUNNING IN ADVANCED FOOTWEAR TECHNOLOGIES**

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INTRODUCTION: Since the introduction of advanced footwear technologies (AFTs) in 2016, all world records from 5km to the marathon have been broken (1). This is due to an improved running economy (RE) with AFTs (2). To this date, these improvements have been investigated only during short running bouts, while there are indications that performance effects may be greater over longer distances (3). The aim of this study was to compare RE during a 90min run in AFTs compared to lightweight trainers (non-AFTs) in elite distance runners.

METHODS: Nine elite distance runners visited our laboratory on two separate sessions within 14 days. In each session, they performed a submaximal threshold assessment treadmill test, followed by a 90min run below the first lactate threshold. Blood lactate concentration (BLa) as well as ratings of perceived exertion (RPE) were assessed every 15min. Mean VO2 determined during the last 3min of each 15min period was expressed as RE. We used linear mixed effects models (with random intercepts for participants) to examine the effects of time, shoe condition, and their interaction on energetic and oxygen cost of transport (ECOT and OCOT). Post hoc pairwise comparisons of estimated marginal means were performed using Tukey's correction.

RESULTS: The nine participants (55.6% females, age: 32.4±8.4y, body mass index: 20.8±1.2kg/m2) had a highest achieved world athletics score of 929.9±83.8 points which corresponds to 10km times of 30:17 and 36:09min for males and females, respectively. ECOT and OCOT were lower in AFTs (ECOT: 2.8±0.7%, $p<0.001$, $\beta=0.56$ [0.41 to 0.71]; OCOT: 1.9±0.9%, $p<0.001$, $\beta=0.40$ [0.26 to 0.55]). ECOT and OCOT increased over time (ECOT: $p<0.001$, $\beta=0.40$ [0.30 to 0.51]; OCOT: $p<0.001$, $\beta=0.33$ [0.23 to 0.44]) from minute 15 to 90 (ECOT: 6.1±3.7%; OCOT: 5.3±3.7%) but these changes did not differ between shoes (time x shoe interaction: ECOT: $p=0.809$; OCOT: $p=0.649$). RPE was lower in AFTs up to 60min ($p=0.007$, $\beta=0.40$ [0.16 to 0.64]), while BLa did not differ between shoe conditions at any time point ($p=0.908$).

CONCLUSION: Although the change of RE during the 90min run did not reveal statistical differences between shoe conditions, AFTs maintained their beneficial properties over time. The duration and intensity of the exercise may have been too small to reveal differences in RE deterioration between shoe conditions over time. Therefore, AFTs are probably a good choice for long distances, but future studies should investigate the effects of AFTs during more intense and even longer running.

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**INVESTIGATION OF THE EFFECT OF CYBERDYNE HAL LUMBAR AND TECNOBODY D-WALL COMBINED EXERCISES ON EXPLOSIVE POWER IN HEALTHY INDIVIDUALS**

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INTRODUCTION: Jump, a significant component in the assessment of explosive power, constitutes a fundamental element of sporting performance. The squat jump (SJ) is a prevalent evaluation method employed to ascertain lower extremity strength, explosive power and balance.In recent years, there has been a notable advancement in the integration of advanced technologies into exercise and rehabilitation processes.In this context, a study was conducted to analyze the effects of the Cyberdyne Lumbar HAL and TecnoBody D-Wall systems on jump performance. The Cyberdyne HAL system employs hybrid support technology to optimize muscle activation, while the TecnoBody D-Wall system utilizes digital analysis of movement in three dimensions. The present study aims to evaluate the effects of both systems on jump height, force production and acceleration parameters in healthy subjects.

METHODS: Thirty healthy volunteers, aged between 20 and 40 years, participated in this study. The participants performed four different exercise protocols using the Cyberdyne HAL Lumbar device, and their jump performance was evaluated with the TecnoBody D-Wall. Total work (Joule), jump height (cm), maximum acceleration ($m/s^2$) and peak force (Newton) were measured as part of the SJ tests. The exercise program consisted of 60-minute sessions performed three times a week for eight weeks, performed using the Cyberdyne HAL Lumbar devices Cybernetic Voluntary Control (CVC) mode. Data were

analyzed with IBM SPSS 26.0; continuous variables were presented as mean ± standard deviation, and categorical variables were presented as percentage (%). The normality of distribution was analyzed using the Shapiro-Wilk test, and a Paired t-test was used for intergroup comparisons. A significance level of $p \leq 0.05$ was accepted.

RESULTS: A total of 30 healthy individuals, 13 males (43.3%) and 17 females (56.7%), participated in this study. The mean age of the participants was 28.7 years (±4.79 years), height 169.83 cm (±8.76 cm), body weight 65.56 kg (±10.09 kg) and BMI (body mass index) 22.71 kg/m² (±2.97 kg/m²). The present study investigates the effects of the combined use of Cyberdyne HAL Lumbar and TecnoBody D-Wall systems on jumping performance in healthy individuals. According to the data obtained after the applied exercise protocol, a statistically significant increase was observed in Joule and cm values ($p<0.05$). However, no significant change was found in m/s² and Newton values ($p>0.05$).

CONCLUSION: The findings of this study indicate that the incorporation of Cyberdyne HAL Lumbar into an exercise program results in a favorable impact on lower extremity endurance and energy production. However, it does not yield a substantial enhancement in terms of maximum force production and acceleration. Consequently, further comprehensive studies are advised to ascertain the long-term implications of combined exercise protocols on neuromuscular adaptation and motor performance.

**A COMPARISON OF MATCH DEMANDS USING BALL-IN-PLAY VS WHOLE-MATCH DATA IN SUPER RUGBY AMÉRICAS FROM THE 2023 CHAMPION TEAM**

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INTRODUCTION: Rugby union is an intermittent, high-intensity sport requiring players to perform various physical activities with distinct positional demands (1, 2). Previous research assessing match demands using whole-match (WM) GPS data may underestimate peak physical outputs (1, 2). This study aimed to compare match demands in Super Rugby Américas using ball-in-play (BiP) vs. WM data.

METHODS: GPS data from 35 elite players of the 2023 Super Rugby Américas champion team was collected across 14 matches. Metrics analyzed included total distance (TD), high-speed running (HSR), accelerations (ACC), and high metabolic-load distance (HMLD). Data were reported in absolute terms and relative to playing time (per minute). Linear mixed models assessed differences between BiP and WM data, considering positional variations between forwards and backs.

RESULTS: BiP phases exhibited significantly higher physical demands than WM periods. Absolute match demands were generally lower in BiP than in WM, except for HSR, which showed no significant difference. TD per minute was ~2.5 times greater in BiP (114.9 ± 7.7 m/min) than WM (45.5 ± 3.2 m/min; $p < 0.001$). Similar trends were observed for ACC per min (0.8 ± 0.1 vs. 0.2 ± 0.03, $p < 0.001$), HSR per min (15.4 ± 2.6 vs. 3.4 ± 0.4, $p < 0.001$), and HMLD per min (27.9 ± 3.7 vs. 6.6 ± 0.7, $p < 0.001$). Positional differences were evident, with backs covering greater TD ($p < 0.001$) and engaging in more HSR than forwards ($p < 0.001$) (1, 2).

CONCLUSION: BiP analysis provides a more accurate representation of peak match demands than WM data, highlighting the need for training programs tailored to BiP-specific intensities (1, 2). Given the significantly higher relative demands observed in BiP, training should emphasize high-intensity efforts rather than relying solely on WM averages, which underestimate match intensity. These insights may contribute to more effective game strategies and physical conditioning programs. Additionally, positional differences reinforce the need for individualized training interventions to optimize performance. Future research should explore tactical variations influencing BiP demands, as well as how different styles of play impact the physical demands experienced during elite-level competition.

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**EFFECTS OF THERMAL ALUMINUM SHEET ON THE PHYSIOLOGICAL STRESS EXPERIENCED WHILE STAYING IN A SNOW CAVE: COMPARISON OF THE INNER/OUTER AND OUTER COVER CONDITIONS**

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INTRODUCTION: This is a field study on using snow caves to prevent hypothermia while participating in mountain activities. Thermal aluminum sheets are effective at preventing hypothermia in snow caves [1-8]. A previous study found that using the inner cover condition of thermal aluminum sheets accurately reflects heat emitted by the body [9]. We hypothesized that the thermal aluminum sheets' inner and outer covers would work together to provide even greater benefits. The efficacy of the double-cover thermal aluminum sheets was compared to that of the outer cover using physiological and psychological indices.

METHODS: Eight healthy Japanese male volunteers (35 ± 6yrs old, 171 ± 5 cm tall, 68 ± 6 kg) were randomly divided into two groups of four. The control group consisted of only one cover (outer cover). The experimental group used the double-

cover (inner and outer covers) configuration. All subjects wore identical outfits, including hats, gloves, and footwear. Heart rate, rectal temperature, blood pressure, perceived cold temperature sensation, and urinary catecholamine levels were all measured. The subjects stayed in a tunnel-style snow cave for an hour in pairs, with one subject under the double-cover thermal sheets. The weather was cloudy, with a temperature of 4°C outside and 1°C inside. This study was authorized by the Research Ethics Committee.

RESULTS: The decrease in rectal temperature in the experimental group (0.2°C) was significantly less than in the control group (0.4°C). The control group's heart rate (80bpm ± 6) was 8 bpm higher than the experimental group's (72bpm ± 12), but the difference was not significant. The systolic blood pressure in the control group (120 ± 6 mmHg) was nearly identical to that in the experimental group (124 ± 6 mmHg). The control group had higher diastolic blood pressure (80mmHg ± 4) compared to the experimental group (70mmHg ± 8). The control group (3; Median) reported a higher subjective cold temperature sensation than the experimental group (2). However, these differences ware not statistically significant.

CONCLUSION: The study's novelty is that it clarified that using both inner and outer aluminum sheet coverings increases heat retention. Cold stimulation increases the heart rate. Cold stimulation causes an increase in diastolic blood pressure. Cold stimulation increases the subjective sensation of cold temperature. Our hypothesis is supported by the improved heat retention of the double-cover thermal aluminum sheets. Aluminum sheets are likely useful because they reflect far infrared rays (wavelength 10 μm) emitted by the human body, reflected by the aluminum sheet as radiant heat, resulting in an increased heat retention effect. The logic behind double covering is that the gaps between layers of clothing provide the most insulation. The heat retention effect of the double-cover condition is significantly greater than the single cover condition.

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**EFFECTS OF VIRTUAL REALITY VIDEO USING A HEAD-MOUNTED DISPLAY ON AUTONOMIC NERVOUS SYSTEM AND STANDING CENTER OF GRAVITY SWAY**

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INTRODUCTION: The number of Virtual reality launches is rising every year. As the number of users increases, health risks have also been pointed out. Health risks can be broadly classified into two types: "light stimulus load type" and "spatial information confusion type. The most serious health problem of the spatial information disruption type is called VR sickness. It is said that peripheral vision stimulation and visually-induced self-motional sensation are likely to be induced by Virtual Reality images, and more effective and practical training would be possible if clinical application becomes possible.

METHODS: Ten young adult students (10 males: 23.3±0.9 years old) with no subjective abnormalities in vision, balance, or hearing were selected. The students were presented with two conditions: a stimulus image using a virtual reality head-mounted display and a static standing posture, and their center of gravity sway was measured using a center of gravity sway meter.

RESULTS: The results showed that the total trajectory length increased more in the VR standing condition than in the static standing condition in all segments, suggesting that visual stimulation in VR has a greater influence on the standing center of gravity sway than in the static standing posture.

CONCLUSION: We examined the effects of visual stimulation on total locus length and autonomic balance in 10 young adult students. The results showed that the total trajectory length increased more in the VR standing condition than in the static standing condition in all segments, suggesting that visual stimulation in VR has a greater influence on the standing center of gravity sway than in the static standing posture. The fact that there was a significant difference in the total trajectory length in the VR standing condition compared to the static standing condition is discussed. This may be due to the visual change caused by VR. Previous studies have also shown that visual changes affect the center-of-gravity sway. In the VR standing condition, the visual information changes in accordance with the head movement, and it is considered that the sensation of visually induced self-motion sensation is more easily generated.

**INSTRUMENTED CLIMBING HOLD FOR FORCE MEASUREMENT IN SPEED CLIMBING**

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INTRODUCTION: Speed climbing is the discipline of climbing a standardized route on a 15-meter wall as fast as possible. This discipline was held as a stand-alone event at the 2024 Paris Olympics and is attracting worldwide attention. Competitors in speed climbing have been checking and improving their performance daily. Currently, performance evaluations generally rely only on geometric motion information from video or motion capture systems. Although information on forces applied to the limbs is important in motion analysis, it is not widely used since it is difficult to obtain the force information. To detect force information, several force measurement systems have been proposed in speed climbing [1][2]. These systems require specially constructed walls, which have high installation costs and make it challenging to install them in competition venues and climbing gyms. Therefore, an instrumented climbing hold to sense the force applied to

the hand hold in speed climbing is proposed in this paper. This system can be installed on existing speed climbing walls at low costs.

METHODS: The proposed instrumented climbing hold measures 3-axis force and 3-axis moment by embedding a 6-axis force sensor into the hand hold in speed climbing. It can transmit force data via wireless communication and is battery powered. Thereby, cables and other wiring do not interfere with competitors movements.

The devices such as a force sensor, microcomputer, battery, and wireless communication module are embedded inside the hold. Therefore, there is no major change in appearance. Battery power can be supplied from a connector located on the side of the hold, allowing power to be supplied without removing the proposed system. Furthermore, assuming that a point of effort exists on the hold surface, the point of effort is calculated from 6-axis force. This information is useful to the competitors in indicating where the force is being applied to the hold.

RESULTS: An experiment to verify the usefulness of the instrumented climbing hold was conducted. It was installed on a starting position hand hold in speed climbing and measured the forces and moments applied to the hold by a professional climber. The climber applied a large force at the moment of start. The force was equivalent to 145% of body weight. Also, the point of effort estimated from the measured data was nearly matched to the position where the professional climber gripped the hold.

CONCLUSION: We proposed an instrumented climbing hold for force measurement that can be installed on existing speed climbing walls at low costs and does not interfere with climbing movements. The experiment shows that the instrumented climbing hold works properly in actual environments, and the point of effort can be estimated from the measured data.

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**WHY TRAINING THE IRON CROSS WITH HERDOS DEVICES AND EXTERNAL LOAD ADDED TO BODY WEIGHT IS BENEFICIAL FOR YOUNG GYMNASTS**

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INTRODUCTION: The iron cross on the rings (IC) demands holding ones body weight with fully extended arms, exerting adduction effort at a 90º angle in the frontal plane. This position places significant stress on the upper body [1,2]. To minimize injury risk, it is essential to develop training methods supported by research that examines muscle interactions in different training conditions. Intermuscular coordination is crucial for stabilizing the shoulder complex [3] and the elbow joint, which serves as a connection between the shoulder and hand, acting as a fulcrum for the forearm lever [4]. We investigated whether training IC with assistive devices (herdos; HIC) and added external load (LHIC) while matching the force moments on the rings could serve as an intermediate step between the unloaded herdos condition (HIC) and the standard IC on the rings.

METHODS: EMG activity was normalized relative to a standing IC before comparing gymnasts capable of performing the IC on the rings (achievers) and those who were not (non-achievers) under HIC and LHIC conditions. Seven muscles were analyzed using EMG: Pectoralis Major (PM), Latissimus Dorsi, Teres Major (TM), Lower Trapezius, Serratus Anterior, Biceps Brachii (BB), and Triceps Brachii (TB). Additionally, three indices were calculated to assess coactivation levels: Elbowidx, Scapulaidx, and Shoulderidx.

RESULTS: The greatest variations in EMG activity across conditions were observed in the PM and BB ($F \geq 30.7$; $P<0.001$). When comparing overall muscle activity, as well as PM, TM, BB, and TB activation between groups, non-achievers exhibited higher activation levels than achievers, regardless of the herdos condition ($P \leq 0.046$). Among the calculated indices, only the Elbowidx of achievers was significantly higher ($P \leq 0.005$) during IC compared to LHIC and HIC.

CONCLUSION: The fact that non-achievers could sustain the IC in the LHIC condition without being able to do so on the rings suggests two key factors: 1) the reduced number of upper limb joints involved in LHIC decreases the need for overall tension, which non-achievers struggle to generate; 2) herdos devices significantly reduce torque at the elbow, preventing excessive hyperextension and safeguarding joint integrity. PM and BB EMG activity showed particular sensitivity to changes in training conditions, regardless of achievement level. We recommend incorporating external load in herdos training to enhance muscle activation to levels closer to ring performance while mitigating injury risks.

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**USING WEARABLE TECHNOLOGIES TO INVESTIGATE THE PHYSIOLOGICAL DEMANDS OF AN ULTRA-DISTANCE OBSTACLE COURSE RACE IN THE DESERT: A CASE STUDY**

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INTRODUCTION: Obstacle sports will appear in the Modern Pentathlon at the 2028 Summer Olympic Games. Obstacle course races (OCR) range from 60 meters to ultra-distance and have occurred in indoor, desert, and mountain environments. However, the physiological demands of OCR have yet to be determined. This study investigated the physiological demands of extreme competitive OCR using wearable technologies.

METHODS: The Tough Mudder Infinity event is a competitive time-constrained OCR where participants complete maximal distance (repeated 10 km laps with 20 obstacles) within 9 hours, and in February 2024 occurred in the desert in AlUla, Saudi Arabia. This event provided a complex demand for endurance, strength, and thermoregulation within moderate heat stress (ambient temperature:20.3±3.5°C; relative humidity:30%; wind speed:19.0±1.9 km·h-1; WBGT:13.8°C). A case study observational and descriptive approach was used to study one female athlete (age: 32 years) who completed 70km and 120 obstacles in 8h and 43mins on sand, in daylight. Wearable sensors monitored physiological and biomechanical variables synchronously and in real-time using the methods previously described (Muniz-Pardos et al., 2021b). The primary outcome measure was the core temperature (Tcore) achieved by swallowing a temperature pill (12h and 3h prior to the start). Additional measures included heart rate (telemetric chest strap and wrist-worn), GPS, and running biomechanics via a foot-worn inertial sensor. Real-time monitoring was achieved by a 'gateway', connected to a bespoke app within a smartwatch with e-SIM, and transmitted to the research team's remote applications.

RESULTS: This is the first-time physiological data from a competitive OCR has been presented. In addition to the variable ambient conditions (16-25°C, wind gusts up to 49.4km·h-1 and direct sun exposure), the nature of the obstacles presented an additional challenge to both the athlete and technology battery life, including repeated sudden immersion to ice water. The athlete's Tcore increased by 1.24°C to a peak of 39.07°C during the 8:43:13 race, heart rate peaked at 153 b·min-1. Biomechanical data was affected by the water immersion on some laps, but smartwatch battery life was maintained throughout (min 11%).

CONCLUSION: The participant reported to the investigators that the wearable technology did not interfere with performance or comfort during the race. The race organisers agreed that the technology inclusion was not intrusive and were satisfied with the style of information. This novel technique utilising wearable technology enabled the athlete to be monitored in real time from a remote location and offers the opportunity to protect the health of athletes during extreme competition. Considerations should be made for optimising measurement accuracy and data privacy. The rise of biometrics has relevance for broadcasting, as well as public health and sports performance.

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**EVALUATION OF A HELMET-INTEGRATED PPG SENSOR FOR REAL-TIME HEART RATE MONITORING IN DIVERSE PHYSICAL ACTIVITY CONDITIONS**

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INTRODUCTION: Photoplethysmography (PPG) sensing module has been adopted as a heart rate (HR) sensor for the last decades. Base on detecting volume changing of blood vessels caused by heartbeat, PPG sensors can be located in various regions of human skin. Although wrist PPG sensing is widely used for different wearable devices, errors due to blood redistribution especially caused by different exercise modes lead to inaccuracy of HR measurement. Due to head blood supply is vitally essential for physiological status maintaining, a relatively stable blood supply going through facial skin would be expectable. In the current study, a PPG HR sensor was integrated into a cycling helmet to determine its feasibility for HR measurement on facial skin during various conditions.

METHODS: Ten amateur cyclists were recruited for the current study. All participants completed a time serial test with resting, warm-up and exercise phases. During the test, all participants wore a HR chest strap and two PPG sensors located on the skins of wrist and temple, respectively. Data acquired from three sensors were compared using repeated measure one-way ANOVA. Pearson's correlation was used to analyze relationship among data of various sensors.

RESULTS: Along the time serial, HR data were divided and averaged for every 10-second period. During the initial 60 seconds of the rest phase, HR values showed no significant differences and consistently high correlation co-efficient ($r>0.95$, $p<0.001$) among the three sensors. In the subsequent 6-minute warm-up phase, a significant lower HR was observed from the wrist-worn PPG as compared electrocardiography (ECG) chest strap heart during the 0~10th second ($p=0.012$) and 11th~20th second period ($p=0.022$). In the same time periods, relatively lower correlation co-efficient ($r=0.599$, $p=0.088$ and $r=0.742$, $p=0.022$, respectively) were shown between wrist-worn PPG HR and ECG HR. On the other hand, no significant difference and high correlation were revealed between the HR data of helmet-integrated PPG and ECG chest strap throughout the warm-up phase. In the following 6-minute exercise stage, no significant differences and high correlation were shown among data of three sensors.

CONCLUSION: In general, PPG HR values demonstrated highly consistency and correlation to ECG HR sensors during rest and exercise. By using ECG HR data as a standard, PPG HR data from a sensor located on facial skin showed higher accuracy, which might be due to a high physiological priority of blood supply redistributions.

## Conventional Print Poster Presentations

### CP-AP05 Sports Technology / Monitoring I

**VIENNA TEST SYSTEM: A WIDELY USED METHOD FOR ASSESSING COGNITIVE FUNCTION IN THE ATHLETIC POPULATION: A SCOPING REVIEW**

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INTRODUCTION: In psychology, questionnaires are often used to permit valuable insights into an individual's cognitive functions, however, supplementary objective alternative measures are needed to collect a more diverse range of information about such outcomes. The Vienna Test System (VTS) is one of the most widely used computerized tools for assessing psychology-related constructs in the athletic population. In the present scoping review, we aimed to draw attention to the challenges in the practical application of the VTS for assessing cognitive functions.

METHODS: A systematic literature search was conducted across four databases (PubMed, Web of Science, ELSEVIER Scopus, and EBSCOhost). Besides the participants' characteristics and key findings, the highest Scimago Journal Ranking (SJR) of each paper in the year of the publication was also considered.

RESULTS: Our literature search identified 41 relevant articles, including 2 of our previous papers (Horvath et al 2022, Horvath et al 2023). The total number of participants was 1789 (n = 256 females and n = 1316 males, seven studies did not provide information on gender) with a mean age of 21.2 years (range between 10-64 years). The participants' field of sport ranged from yoga-practicing older females to professional athletes (e.g., racing drivers, soccer players, wrestlers and taekwondo competitors, Polish amateur boxers, and rhythmic gymnasts). Of the 41 articles, 10 were published in Q1 journals, 7 in Q2, 6 in Q3, and 2 in Q4. Notably, 16 (39% of the studies) were published in journals that do not appear in SJR.

CONCLUSION: The wide spectrum of cognitive tests of the VTS has the potential to assess e.g., sustained attention, reaction time, peripheral perception, stress reactivity, or time movement anticipation. However, the relatively poor experimental designs of many studies using VTS make it difficult to draw clear conclusions about its validity and feasibility.

**IS THE LOW-COST COOSPO H808S AS RELIABLE AS THE POLAR H10 CHEST STRAP HR MONITOR?**

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INTRODUCTION: Heart rate (HR) and HR variability (HRV) are widely used in sport to assess training intensity, autonomic adaptation, and recovery [1]. Chest strap heart rate (HR) monitors are currently the most used sensors for HR measurements due to their high accuracy and comfort when compared to other sensors. However, differences in signal processing, electrode quality, and transmission protocols can affect measurement agreement between different brands. The Polar H10 is one of the most validated HR monitors, known for its high precision and reliability which is comparable to gold-standard ECGs [2]. Recently, the Coospo H808S chest strap has emerged as a low-cost alternative, but its accuracy and consistency remain unexplored. Therefore, this study aims to compare the agreement of the Coospo chest strap HR monitor with the Polar H10 during different conditions.

METHODS: Sixteen recreational runners (25±5 years) participated in this study. Participants simultaneously wore Polar H10 and Coospo H808S chest straps, with strap placement (upper or lower positions) randomized. HR and HRV data were recorded via a smartphone app (HRV Logger) in three conditions: supine, seated, and running at RPE 2-3 out of 10. Each condition lasted 5 min, and the last 4 min of recordings were analyzed using Kubios HRV in two ways: raw data and medium-filtered data. Agreement was assessed using intraclass correlation coefficient (ICC) and Bland-Altman plots.

RESULTS: In the supine position, Coospo and Polar showed excellent agreement for RR, RMSSD, and HR (>0.967) before filtering. After filtering, there was a slight reduction in agreement for RR (0.917), RMSSD (0.930), and HR (0.911). When seated, the devices maintained a high agreement, with RR, RMSSD, and HR presenting > 0.990 before filtering. Post-filtering, HR, RR, and RMSSD (>0.990) remained highly correlated. During running, RR showed a correlation of 0.930, and HR maintained an excellent correlation (0.944) before filtering; however, RMSSD demonstrated a poor ICC (-0.244; +17.6 ms; LoA = -73.8 – 109.0). After filtering, RR (0.917) and HR (0.909) remained similar but correlation dropped to 0.132 for RMSSD (-5.1 ms; LoA = -40.4 – 30.1).

CONCLUSION: The Coospo H808S showed excellent agreement with the Polar H10 for HR and HRV measures in resting conditions, and excellent agreement for HR during low-intensity running. However, agreement for HRV measures decreased in running condition, especially for vagal modulations. Unexpectedly, filtering reduced agreement between devices, therefore suggesting that these monitors may have some differences in internal signal processing methods.

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**THE VALIDATION OF AN ORAL WEARABLE SENSOR FOR MEASURING HEART RATE IN COMBAT SPORTS**

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INTRODUCTION: Combat sports (Boxing, MMA, Wrestling) often have a high aerobic demand with high heart rates between rounds [1], and elevated blood lactate concentrations [2]. Applied research and athlete monitoring in combat sports face significant barriers due to restrictions imposed both by the nature of the sport and its governing regulations. Since combat sports involve intense physical contact—such as grappling, striking, and punching—most heart rate monitors cannot be worn safely during training and/or competition. Therefore, the purpose of this study was to determine the agreement of an oral wearable sensor (ORB Sport smart mouthguard, OS), against previously validated heart rate monitors and an electrocardiogram (ECG) [3].

METHODS: Twenty healthy volunteers (11 male, 9 female; age (mean±SD) 28.2±4.2 years) completed the protocol while wearing the OS (ORB Innovations, UK), Polar H10 heart rate monitor (Polar Electro, Finland) and Movesense MD ECG sensor (Movesense Ltd, Finland). The protocol consisted of 5 minutes of seated rest, incremental walking and running (from 4 km/h, increasing 1 km/h every 1 min) on a treadmill (Precor, UK) up to a mean (±SD) heart rate of 170 ± 7 beat/min, followed by 5 minutes of seated recovery. The OS, Polar H10, and Movesense MD data were processed using manufacturer applications and Kubios HRV Scientific (KHS) software (Kubios OY, Finland). Heart rate algorithms for Polar, Sunnto, and KHS provided a total of three criterion heart rate measurements. Following inspection of each participant's data, three were excluded from the final analysis – two for errors in the heart rate monitor or ECG data and one for errors in the mouthguard data. Heart rate data were averaged (5 second intervals) and temporally aligned for statistical analysis. Mean Absolute Percentage Error (MAPE), Intraclass Correlation Coefficients (ICC) and Bland-Altman Limits of Agreement [4] were calculated.

RESULTS: The oral wearable sensor had MAPE (mean±SD) of 4.7±5.2%, 5.5±5.3% and 5.5±5.5%; ICC of 0.96, 0.95 and 0.96; Bias with Upper and Lower Limits of Agreement of 1.1[16.4, -14.2], 1.4[17.5, -14.7] and 1.0[17.5, -15.5] beat/min compared to Polar, Suunto, and KHS, respectively. For comparison, MAPE between criterion heart rate monitors and ECG were 2.7±2.8% and 2.5±2.8% for Polar versus Suunto and KHS, respectively, and 1.9±3% for Suunto versus KHS.

CONCLUSION: These results demonstrate that the oral wearable sensor has levels of agreement comparable with other wearable devices [5] and can provide a useful estimate of heart rate to determine the intensity of training and competition in combat sports.

[1] Journal of Sport and Exercise Science, 4(1), 40–43

[2] Journal of Sport Sciences, 628: 38(24), 2819–2841

[3] Eur. J. Appl. Physiol. 119, 1525–1532

[4] Lancet, 1(8476), 307-10

[5] Journal of Sports Sciences, 38:17, 2021-2034

**WEARABLE TECHNOLOGY IN SPORT: A SCOPING REVIEW**

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INTRODUCTION: Wearable technology is defined as a wireless electronic device worn on the user's body and can transmit real-time data. Wearable technology within sport exists in many forms, such as smart jewellery (e.g., watches, rings), body-mounted sensors, and smart clothing, measuring a range of variables. These devices are used in sport to reduce injury risk, assist with rehabilitation, and optimise training load. With the exponential expansion in the field of wearable technology in sport, there remains a large degree of uncertainty regarding the breadth and depth of available technologies, and therefore, a review of the published literature is needed. The objective of this scoping review is to identify which wearable technologies have been developed, or are in development, for use in sporting activities to measure physiological variables.

METHODS: The scoping review was conducted in accordance with the Joanna Briggs Institute manual for scoping reviews and reported according to the PRISMA extension for scoping reviews (PRISMA-ScR). The review protocol was preregistered at https://doi.org/10.51224/SRXIV.280. Seven databases were searched (inception – September 2024), including four scientific databases (PubMed, Scopus, SPORTDiscus, and Web of Science), one grey literature database (OpenGrey), one conference database (IEEE), and one UK doctoral thesis database (EthOS). Only studies where human participants wore a wearable technology device on the skin that could measure a physiological variable (e.g., heart rate) during sport or structured exercise were included. Following screening, 217 studies were found eligible for inclusion.

RESULTS: All individual wearable devices were counted, including studies that assessed multiple devices. In total, wearable technology had been placed on 14 locations on the body, with the most frequently identified being: the wrist (n = 150), the thorax (n = 108), the abdomen (n = 32), the upper arm (n = 15), and forearm (n = 13). There were 15 categories of wearable technologies, with the most frequently identified being: wristbands (n = 164), chest straps (n = 85), patches (n = 48), shirts (n = 29), and armbands (n = 12). There were 10 physiological variables identified, with the most frequently identified being: heart rate (n = 282), energy expenditure (n = 63), sweat rate (n = 39), respiratory rate (n = 32), and skin temperature (n = 20).

CONCLUSION: The review identified multiple locations, categories, and physiological variables associated with wearable technology. The wrist was the most common location, wristbands were the most frequently categorized wearable type, and heart rate was the most common physiological variable. This synthesis of the literature will assist researchers who wish to review the wearable technologies that have been developed or are in development for use in sporting activities to measure physiological variables.

**V'$O_2$MAX ESTIMATION VIA ONE-MINUTE WINGATE TEST AND MACHINE LEARNING MODEL**

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INTRODUCTION: Aerobic capacity is essential in sports science to optimize training, performance, and health monitoring [1]. Direct V'$O_2$max measurement through pulmonary gas exchange is the gold standard but requires expensive metabolic carts and controlled lab settings, limiting practicality. Indirect methods, estimating V'$O_2$max using standardized exercise tests and regression models, provide a more accessible alternative but often trade off accuracy. The current goal is to improve estimation while reducing test duration and participant burden. We previously showed that variables from the modified one-minute Wingate test correlate with aerobic capacity, and machine learning models outperform linear regression by capturing complex nonlinear relationships [2]. This study combines the Wingate test with machine learning models for a new V'$O_2$max estimation method.

METHODS: A sex-balanced cohort of 180 subjects (22.64 years, 69.59 ± 9.46 kg, 170.16 ± 6.62 cm) performed a progressive incremental test (25 W·min$^{-1}$) on a cycle ergometer, with breath-by-breath gas data collected via a metabolic cart. V'$O_2$max, determined by the gold standard, was the regression target. In a separate session, after a 5-minute warm-up at 50 W, subjects completed a 60s all-out Wingate test (final 5s warm-up at 160 rpm, test starting at minute 5, maintaining peak power for 1 min). Peak, mean, and minimum power, fatigue rate, and time-to-peak power, along with age, weight, and height, served as predictors. Multiple regression models (Linear Regression, Support Vector Machines, Gaussian Process Regression, Decision Trees, and Ensemble Methods) were trained and validated using leave-one-out cross-validation The best model was selected based on the lowest root-mean-square error (RMSE) between reference and estimated outputs [2].

RESULTS: The subjects average V'$O_2$max was 3511 ± 426 m$LO_2$/min (range: 2769–4553). Among tested models, Gaussian Process Regression (GPR) with an exponential kernel best captured predictor-V'$O_2$max relationships (RMSE: 121 m$LO_2$/min). Combining the one-minute Wingate test with GPR yielded an $R^2$ of 0.93 vs. the gold standard. The bias between real and estimated V'$O_2$max was 0.41 ± 110.35 m$LO_2$/min, with LOA of 216.69 and -215.88 m$LO_2$/min.

CONCLUSION: Indirect submaximal tests for estimating V'$O_2$max typically yield $R^2$ values of 0.70–0.85 [2], while our model achieves 0.93, showing superior performance. These results pave the way for a rapid V'$O_2$max estimation test, with the core assessment completed in one minute.

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**BRIDGING THE GAP: CHALLENGES IN APPLYING BEST-PRACTICE TRAINING LOAD AND ATHLETE RESPONSE MONITORING IN ELITE AND SUB-ELITE SPORTS**

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INTRODUCTION: Athletes are monitored routinely to optimize adaptation, performance, and health. Best practice involves tracking both prescribed and performed loads alongside athlete responses [1]. Monitoring should be efficient, use valid and reliable methods [2], and adopt a multifactorial approach [3]. However, ineffective monitoring can create skepticism among athletes and coaches, highlighting the need for clearer guidelines [4]. This study examines monitoring strategies in elite and sub-elite sports, identifying gaps between best practices and real-world applications.

METHODS: A total of 111 practitioners (48% strength and conditioning coaches, 18% physiotherapists,14% coaches, 20% other) completed the survey. Participants worked with elite/sub-elite athletes (>=3 sessions/week, >=1 hour/session) and had >=2 years experience. Respondents represented 29 sports (48% Olympic, 38% professional, 14% development) across 15 countries. The survey consisted of 49 multiple-choice and open-ended questions across 6 sections: Participant, Load Monitoring, Response Monitoring, Womens Metrics, Communication, and Future Directions.

RESULTS: Of 111 practitioners, 66% monitored both load and response, 30% monitored only load, 2% did not monitor, and 1% only tracked responses. External load was objectively monitored by 85%, internal load by 40%, and subjective training load by 62%. Response was assessed objectively (55%), subjectively (50%), and 19% used biomarkers. Common load monitoring methods were RPE (57%), weight lifted (53%), and GPS (46%), while response was measured via isometric tests (28%), body weight (26%), and sleep quality survey (26%). Half of the practitioners used objective load monitoring every session, 46% used subjective monitoring each session, whilst 29% monitored internal load in selected sessions only. Practitioners tracking responses adjusted training more frequently compared to those who monitored load only (26% vs.

11%) and they also perceived monitoring to be more effective in preventing maladaptation (33%) and improving performance (46%). Only 3% used best practice approaches combining external and internal load with athlete response, and 9% used both subjective and objective data. Most practitioners (88%) expressed a desire to improve their monitoring practices.

CONCLUSION: Most practitioners monitor training load, yet fewer integrate response measures despite best practice recommending both. Communication gaps were noted between strength and conditioning coaches and physiotherapists, as under 40% shared data between them, potentially limiting best practice care. These findings reveal variability and critical gaps between best practice and current approaches. Improved education and interdisciplinary collaboration are recommended to align practices with best-practice guidelines.

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1.Coutts et al. (2018) 2.Impellizzeri et al. (2023) 3.Coles et al. (2017) 4.Burgess (2017)

**SYNCHRONIZATION OF IMU AND GNSS IN TWO COMMONLY USED SPORTS TRACKERS**

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INTRODUCTION: Sports trackers are widely used to analyze performance in various sports, including alpine skiing, cross-country skiing, football, handball, rowing, and others. Typically, these devices record both GNSS (position) and IMU (accelerations and rotations) data. However, it is unclear if data from the two sources are perfectly synchronized or if a time offset should be considered when performing analyses using data from both sources.

METHODS: Three units from each of two brands of sports trackers, ASI AdMos and Catapult OptimEye S5, were mounted on a longboard that was suddenly accelerated from rest by pulling an attached rope. 11 repetitions were performed. The associated peaks in acceleration were identified in the IMU data and calculated using the second-order derivative of the position from the GNSS data. A 4th-order Butterworth low-pass filter, with cut-off frequency at 6 Hz, was applied to the raw IMU data. The 10 Hz GNSS data were upsampled to the same frequency as the IMU data (200 Hz with ASI AdMos and 100 Hz with Catapult OptimEye S5) using the resample_poly method of Scipy in Python [1]. The offset in peak acceleration was calculated for each of the six units and each of the 11 repetitions.

RESULTS: The GNSS data of the ASI AdMos units were delayed compared to the IMU data, with a mean difference in time, i.e., latency, equal to 0.19 s (lower quartile: 0.13 s; median: 0.20 s; upper quartile: 0.23 s). The mean of the standard deviation of the latency between the three ASI AdMos devices was 0.036 s. Contrary, the GNSS data of the Catapult OptimEye S5 were ahead of the IMU data, with a mean latency of -0.17 s (lower quartile: -0.28 s; median: -0.15 s; upper quartile: -0.11 s). The mean of the standard deviation of the latency between the three Catapult OptimEye S5 devices was 0.070 s. Moreover, the mean absolute difference in GNSS time for the peak in acceleration using GNSS data with the ASI AdMos units was 0.009 s, whereas with the Catapult OptimEye S5, the mean absolute difference was 0.064 s. Supplementary data and figures illustrating the results are made available on Figshare [2].

CONCLUSION: Practitioners should be aware that the GNSS and IMU data of commonly used sport trackers are not perfectly synchronized, but that an offset in time of approximately 0.2 s is likely. Somewhat surprisingly, which of the data sources (GNSS or IMU) that were delayed depended on the sports tracker brand. Practitioners working with both data sources and requiring high temporal accuracy should verify synchronization in their specific setup. Our study examplifies a method for this.

[1] https://docs.scipy.org/doc/scipy/reference/generated/scipy.signal.resample_poly.html (accessed 2025-02-03)

[2] https://doi.org/10.6084/m9.figshare.c.7655174

**REFINING DECELERATION TESTING IN FIELD SETTINGS: CROSS-VALIDATING GPS AND TIMING GATE DATA**

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*LUNEX*

INTRODUCTION: Deceleration ability is critical for performance in multidirectional sports, yet accurately identifying the onset of deceleration remains challenging in field settings. This study introduces a novel method that cross-validates approach velocity at timing gates with GPS data to precisely determine deceleration onset. By integrating conditional formatting, the method classifies athletes responses as anticipatory or reactive, providing new insights into decision-making and decelerating ability.

METHODS: Twenty-one athletes performed acceleration-deceleration ability (ADA) tests, comprising a 20m sprint followed by maximal deceleration. Approach velocity at the timing gate was cross-validated with GPS-derived braking points to identify deceleration onset, with conditional formatting rules applied to classify standard errors as anticipation (negative values) or reaction (positive values). Metrics such as distance to stop (DTS), time to stop (TTS), and peak deceleration were calculated. Exponentially weighted moving averages (EWMA) were used to reduce GPS data noise and improve measurement reliability.

RESULTS: The cross-validating method identified a standard error of 0.25 ± 0.23 seconds between timing gate and GPS-derived braking points, revealing variations in athletes braking strategies. Conditional formatting revealed that 91% of athletes consistently delayed their braking points, providing insights into the quality of the instructions provided and the

individual decision-making tendencies. EWMA significantly reduced high-frequency noise, enhancing the interpretability of deceleration curves.

CONCLUSION: This cross-validating method enhances the accuracy of deceleration analysis in team sports by combining GPS and timing gate data with objective thresholds for anticipation and reaction classification. The approach is cost-effective, field-ready, and offers actionable insights for developing targeted training interventions to improve braking efficiency and decision-making under pressure. Future studies should validate this method against laboratory-grade tools and expand its application to unplanned deceleration scenarios.

## Conventional Print Poster Presentations

### CP-AP10 Coaching I - Team Sports

**VERBAL INSTRUCTIONS AND PERFORMANCE IN YOUTH SOCCER: POSITIVE OR NEGATIVE FEEDBACK?**

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INTRODUCTION: Communication between coaches and athletes is key to athlete development and performance. Verbal communication is the most used strategy by coaches to transmit suggestions and instruction to athletes and it was shown the nature of this feedback can influence the training and competition climate. [1] This study compares youth soccer players technical and physical performance when positive or negative feedback is provided.

METHODS: 41 young soccer players (15.5 ± 1.8) performed six bouts of 5vs5 small-sided games on two occasions during the teams regular training. Coaches provided standardised positive or negative feedback in a randomised order in each session. Several technical and physical outcomes were monitored during the game through video analysis, GPS, and heart rate monitoring. The two conditions (e.g., positive and negative verbal feedback) were compared. Data are presented as mean ± SD for continuous variables and median [interquartile range] for discrete ones.

RESULTS: The number of offensive passes (11 [7 to 14] vs 8 [5 to 11], p = 0.014) and kicks on the target (5 [3 to 5] vs 3 [1 to 4] p = 0.044) seems to be higher with positive than negative feedback. The type of feedback also influenced the external load, increasing the number of sprints (11 [6 to 17] vs 7 [5 to 15], p = 0.004), the number of accelerations at moderate (129 [111 to 145] vs 118 [107 - 137], p = 0.043) and very high-intensity (7 [4 to 13] vs 6 [4 to 9], p = 0.012), and the distance covered at moderate- (1004.7 ± 197.4 m vs 936.9 ± 219.0, p = 0.003), high- (478.0 ± 122.7 m vs 438.1 ± 147.2 m, p = 0.009) and very high-speed running (131.3 ± 89.7 m vs 110.9 ± 71.5 m, p = 0.028), when coaches used the positive feedback. No difference in heart rate was found between feedback conditions.

CONCLUSION: Our results showed that coaches' communication style affects young soccer players physical and technical performance during small-sided games, highlighting the increase in the external load and attacking technical actions when positive feedback is used. These novel findings confirm the literature that showed the importance of a coach's positive behaviour in creating a more motivational climate and an optimal learning environment [2], suggesting the use of positive verbal feedback to push young soccer players to make more courageous decisions and to try more attacking actions, limiting at the same time the mistakes.

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**MAPPING THE ACCURACY OF SOCCER PLAYERS PERFORMANCE IN 11-M PENALTY KICKS: HEIGHT AND DIRECTION**

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INTRODUCTION: In recent decades, 11-m penalty kicks have become pivotal in determining soccer-match outcomes. Bar-Eli and Azar (2009) found that scoring is heavily impacted by the vertical dimension, since powerful, well-placed shots – particularly to the top corners of the goal – greatly reduce the goalkeepers chances of stopping the ball, leaving success almost entirely dependent on the kickers execution. Yet, kickers tend to avoid targeting these areas, likely due to the inherent difficulty of executing the kick with the necessary precision. The aim of this study, therefore, was to examine whether the accuracy of the 11-m penalty kick is consistent across all goal areas, while analyzing ball-flight speed – to gain deeper insights into player performance.

METHODS: Thirty soccer players (aged M=17.9 years, SD=0.64), from three clubs in Israels Youth Premier League, participated in three sessions, each spaced 2–7 days apart. Kicking accuracy and ball-flight speed – when aiming at different goal zones – were measured under three controlled conditions: no goalkeeper, no crowd, and no physical fatigue. Each player performed 15 penalty kicks per session, targeting nine randomized goal zones. All kicks were video recorded, and

accuracy was analyzed after the sessions. Ball-flight speed (km/h) was measured using a radar gun. After the third and final session, each player completed a survey regarding their attitudes towards penalty kicks.

RESULTS: The vertical direction of penalty kicks significantly impacted kicking accuracy (p<.01), with the highest accuracy (61%) seen in the lower third of the goal. Horizontal direction, session order, and trial sequence did not significantly influence accuracy. Ball-flight speed varied across goal zones, with the highest speed recorded in the central zones (96 km/h), and the lowest speeds in the right-hand zones. Analysis of the self-reporting questionnaires revealed players' challenges in aiming at the upper corners of the goal, the impact of pressure on performance, and the crucial role of penalty-kick training.

CONCLUSION: Kicks aimed at the upper corners of the goal, which are considered optimal for scoring, are notably more challenging in terms of accuracy. As the participants were youth players rather than professional experts, their performance likely reflects a lack of preparation and focused training. These findings highlight the need for dedicated training – especially in youth leagues – to improve accuracy in targeting upper corners, combined with mental training – to better manage pressure that is associated with such situations.

Bar-Eli, M., & Azar, O. H. (2009). Penalty kicks in soccer: an empirical analysis of shooting strategies and goalkeepers' preferences. Soccer & Society, 10(2), 183-191.

**POSITIONAL EFFECTS ON TECHNICAL CHARACTERISTICS IN PROFESSIONAL GREEK MALE SOCCER PLAYERS**

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INTRODUCTION: The physical and technical demands on soccer players are determined by their positional role in the team (1) and the style of play of the team. Studies investigating the positional differences in technical characteristics in soccer are limited (2). The purpose of this study was to investigate the technical demands across different playing positions of Greek professional soccer players.

METHODS: The study included 125 elite soccer players allocated into 5 groups according to their position: Attackers (A) (n=25, age 23.2±0.5 yrs, Training Experience 15.1±0.5 yrs, Body Mass 79.8±0.6 kg, Height 183.0±0.7 cm), Centre Backs (CB) (n=25, age 23.5±0.3 yrs, Training Experience 15.0±0.4 yrs, Body Mass 82.0±0.3 kg, Height 185.2±0.5 cm), Fullbacks (FB) (n=25, age 22.5±0.5 yrs, Training Experience 14.5±0.5 yrs, Body Mass 73.5±0.7 kg, Height 175.9±0.7 cm), Wide Midfielders (WM) (n=25, age 23.0±0.5yrs, Training Experience 15.0±0.5 yrs, Body Mass 73.1±0.6 kg, Height 176.5±0.6 cm), Central Midfielders (CM) (n=25, age 22.8±0.4 yrs, Training Experience 14.7±0.5 yrs, Body Mass 76.1±0.7 kg, Height 179.3±0.7 cm). Technical performance characteristics were measured during a football match (i.e. passes, successful passes, dribbles, ball touches, shots, headers). One-way between groups ANOVA models were used. A statistical level of $p<0.05$ was accepted and all descriptive data are expressed as Mean±SEM.

RESULTS: The groups were similar in terms of age and years of training experience. However, CB were significantly heavier (82±0.3 kg) and taller (185±0.5 cm) compared to most other groups. CM completed significantly more passes (42±0.4) and with higher accuracy (81%±0.5) as compared to all other groups. Wingers touched the ball significantly more times (128±1.6) compared to all other groups, while Attackers performed significantly more dribbles compared to CB/FB, but not when compared to CM/WM. CB performed significantly more clearances (3.9±0.2), headers (13.5±0.5) and tackles (3.6±0.2) compared to all other groups. Attackers performed significantly more shots (2.2±0.2) compared to CB/FB but not compared to CM/WM. Also, CB won significantly more ball possessions (23.1±0.5) and lost the ball significantly less times (15±0.3) compared to all other groups, while Attackers won significantly less possessions (8.3±0.2) compared to all other groups, and FB lost significantly more possessions (22.8±0.4) than most of the other positions.

CONCLUSION: As expected, professional soccer players have different technical demands determined by their playing position. Central midfielders, as the play makers, complete more passes and with higher accuracy. Centre backs are involved in significantly more headers, clearances and tackles as well as winning significantly more times the ball and losing it significantly less. This evidence can inform position specific coaching interventions.

**EXPLORING PERFORMANCE METRICS OF THE DUAL-TRACK GAME-ENDING MECHANISM IN 3×3 BASKETBALL**

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INTRODUCTION: The 3×3 basketball game is derived from traditional 5×5 basketball but demonstrates significant differences in its rules and competition formats. Notably, the "dual-track" game-ending mechanism stands out as its most unique feature. According to FIBA regulations, each game lasts 10 minutes and ends early if a team scores 21 points; otherwise, the team with the higher score at the end of regulation wins. These distinct game-ending mechanisms significantly influence the offensive pace and the technical and tactical performance of winning and losing teams. This study utilizes indicators derived from the ball possession formula to examine the differences in performance between winning and losing teams under dual-track game conditions.

METHODS: The game-ending rate was calculated as the ratio of score-end (time-end) games to total games in a given tournament. An independent samples t-test compared the two rates. The boxscores from the 2019,2022, and 2023 World Cup 3×3 mens basketball games and the 2021 and 2024 mens 3×3 Olympic basketball games were utilized. A total of

152 games from the World Cups and 68 games from the Olympic Games were analyzed. A 2 (endings) by 2 (outcome) mixed design MANOVA was used to analyze the number of possessions (POSS), field goal attempts (FGA), free throw attempts (FTA), scoring rate, 1-point and 2-point FGA rates, and the turnover rate to POSS, with game outcome as the repeated factor.

RESULTS: The independent samples t-test revealed a significantly higher score-ending rate of 72.71% than a time-ending rate of 27.29% across the five tournaments, p<.001. The MANOVA results indicated a significant interaction effect, p<.001. Further examination of the ANOVA results pointed to significant interactions regarding the scoring rate, 2-point field goal attempt rate, and turnover rate (ps < .05). The differences were generally greater between winning and losing teams in score-ending games than in time-ending games, with winners from the score-ending teams performing significantly better than those from the time-ending games.

CONCLUSION: The dominating score-ending games observed in the World Cups and the Olympic Games indicate that 3×3 mens basketball promotes a performance-driven, high-intensity style of play. The 2-point scoring rate based on the number of possessions is the key performance indicator for winning the game. The higher scoring and lower turnover rates observed from the winning teams of the score-ending games further emphasize the importance of offensive efficiency in support of performance-oriented play.

**COMPRESSION GARMENTS AND ADAPTATIONS TO PLYOMETRIC TRAINING IN SOCCER PLAYERS: A RANDOMIZED-CONTROLLED STUDY**

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INTRODUCTION: In soccer, players may be exposed to a congested schedule of training sessions leading to fatigue accumulation. To avoid an increased risk of injury and a decrease of performance, it is of importance to limit fatigue without interfering with training adaptations. Studies have shown the beneficial effect of compression garments on post-exercise recovery. However, to our knowledge, no study focused on the effects of a chronic use of compression garments on training adaptations. This study aimed to analyze the impact of a chronic use (6 weeks) of compression garments on training adaptations following plyometric training in soccer players. It was hypothesized that compression garments will have a beneficial effect on training adaptations, compared to a placebo.

METHODS: Twenty soccer players from a reserve team of a professional club were randomly assigned to receive either compression garments (Elite Compression Tight, RVE, Deinze, Belgium) or a placebo for 24 hours following a plyometric session. The players participated to a plyometric training program: 2 sessions per week during 6 weeks. The groups were tested before and after the training program on the following parameters: countermovement jump performance, one-leg sprint power, pennation angle of the calf muscles, creatine kinase levels, soreness and recovery perception. The results were analyzed using a two-factor mixed linear model.

RESULTS: All the performance parameters were significantly improved following the training program (p<0.001). No significant condition effect was observed when comparing compression garments and placebo. However, countermovement jump performance showed a moderate improvement in the compression garments condition (ES = 0.578), and a small improvement in the placebo condition (ES = 0.427). No significant effect of the condition was observed for the other parameters.

CONCLUSION: The results did not confirm our hypothesis, as no significant effect of condition was detected for performance evolution. However, the larger amplitude of increase observed in the compression garments condition for countermovement jump height shows that wearing compression garments following each training session may lead to better results compared to a placebo condition. Wearing compression garments had no detrimental effects on training adaptations.

**THE IMPACT OF H:Q RATIO ON KNEE JOINT MECHANICS DURING LUNGE IN MALE COLLIGIATE BADMINTON PLAYERS**

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INTRODUCTION: Hamstring-to-Quadriceps (H:Q) ratio is a key indicator of knee injury risk in athletes [1]. While badminton lunges create substantial knee loads [2], the relationship between the H:Q ratio and knee joint mechanics during these movements remains unclear [3].

METHODS: Sixteen male collegiate badminton players (20.3±1.2 years) performed isokinetic strength testing (HUMAC-NORM) at 60°/s and 180°/s. Three-dimensional motion analysis of 60-degree sidestep lunges was captured (Motion Analysis Corp., 200 Hz). Knee joint reaction forces were calculated using ANYMOCAP across three axes. Pearson correlations examined relationships between H:Q ratios and joint forces.

RESULTS: H:Q ratio significantly correlated with Y-axis (medial-lateral) joint reaction forces (r=0.674, p<0.05), but not with X-axis (r=0.183, p>0.05) or Z-axis forces (r=0.025, p>0.05). Mean H:Q ratios at 60°/s were 0.62±0.08.

CONCLUSION: The significant correlation between the H:Q ratio and medial-lateral knee forces suggests its importance in maintaining knee stability during badminton-specific movements. These findings have implications for training program design and injury prevention strategies.

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**OPTIMIZING HIIT PRESCRIPTION IN TEAM SPORTS: A COMPARISON OF ANAEROBIC SPEED RESERVE AND VIFT-BASED APPROACHES**

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INTRODUCTION: Managing exercise intensity is crucial for optimizing endurance training, particularly in team sports where time constraints demand efficient prescription methods. Various methods refine training prescriptions to enhance performance efficiently. Interval training, specifically different modalities of HIIT (short and long), is among the most effective strategies. The primary goal of these approaches is to maximize the time spent above 90% of $VO_2$max, a key stimulus for aerobic capacity enhancement. Traditionally, maximal aerobic speed (MAS) has been used to prescribe HIIT sessions, particularly for short- and long-format intervals. However, this prescription model does not account for individual differences in locomotor profiles, leading to significant variability in acute training responses among athletes. A more individualized approach, incorporating anaerobic speed reserve (ASR), may offer a more homogeneous acute response. This approach could improve the effectiveness of interval training programs by ensuring that athletes experience a more consistent and targeted training stimulus.

METHODS: The sample comprised fifteen male semi-professional football players. Testing included a 40-meter sprint test (MSS), the VAM-Eval test (MAS), and the 30-15 intermittent fitness test (vIFT). Participants completed two randomized 10-minute HIIT sessions involving straight-line running. Acute training responses were evaluated using a paired t-test, comparing session rating of perceived exertion (sRPE), blood lactate [La], and time spent above 90% HRmax (t>90%HRmax) between sessions. Additionally, the effect of training prescription on intersubject variability was assessed through a paired t-test by comparing mean residuals for each training condition. In the ASR-based session (20% ASR), intensity was prescribed as a percentage of the difference between MAS and MSS, while the vIFT-based session was set at 95% of the final velocity reached during the 30-15 IFT. Testing and training sessions were conducted on a football field, with a minimum of 48 hours between sessions.

RESULTS: No statistically significant differences were observed between sessions in t>90%HRmax, sRPE, or [La]. However, residual analysis revealed significant differences in t>90%HRmax and sRPE ($p<0.05$), while no significant difference was found in [La] between sessions. Notably, sessions prescribed based on 95% vIFT resulted in a lower cardiac response (t>90%HRmax), whereas sessions based on ASR elicited a lower perceptual response (sRPE).

CONCLUSION: Contrary to previous research, our findings suggest that ASR-based HIIT prescription may not necessarily reduce intersubject variability. A possible explanation lies in the methods used to prescribe training, as the 30-15 IFT is likely more familiar to football players than the VAM-Eval test. Since ASR-based prescription accounts for both MAS and MSS assessments, it inherently introduces more variability, which may explain the differences observed in intersubject response.

## Conventional Print Poster Presentations

### CP-AP13 Coaching II - Mixed

**BEING COACHED DOES NOT IMPROVE ADHERENCE TO PLANNED TRAINING LOAD IN TRIATHLETES: DIFFERENCES BETWEEN SEXES, AGE CATEGORY & RACE DISTANCE PREFERENCE**

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INTRODUCTION: Optimal training for aerobic endurance sports is based on a planned program that specifies load in each session and variations between micro and macrocycles that align with the concept of periodisation (Bull et al., 2001). Although adherence to training has been studied (Santos et al., 2023) it is usually measured as proportion of sessions in a program that were completed, rather than the proportion of each session. This more precise measure of adherence is unknown triathlon (Clemente-Suárez et al., 2021). The current study aimed to quantify adherence to planned training load in age-group triathletes.

METHODS: Data representing all training sessions over 6 months from 37 triathletes were analysed (4,040 sessions in total). Adherence was based on the percentage difference between planned training and actual training, for total duration and total distance in each session. Adherence was calculated as mean bias and root mean squared error.

RESULTS: Triathletes completed less training than planned (duration; mean bias –5.4 %, rmse 18.9%, and distance; mean bias –1.3%, rmse 16.9%). Focussing on training duration, adherence was not different ($p=0.56$) between females (mean bias –7.1 %, rmse 15.8%) and males (mean bias –5.1 %, rmse 19.3%) and not different ($p=0.40$) between the younger (<= 39 years, mean bias –12.0%) and older age categories (>=40 years, mean bias -0.7 to -8.3%). Adherence to planned

training duration not different (p=0.94) between athletes that race both Long and Short course (mean bias -7.9%) compared to those that race only Long (-4.9%) or only Short course (-5.2%). Adherence was also not different (p=0.42) in athletes who were coached (mean bias –4.7%) compared to those who were not (-6.6%).

CONCLUSION: There are small differences in adherence to planned training that are not statistically significant, but they may be practically important. The imperfect adherence reported here represents the equivalent of 3-5 weeks of missed training per year. Furthermore, the large rmse's represent the magnitude of both over and under training, which may undermine important variations in training load between different phases of a program. Coaches should monitor and manage adherence carefully as targeted periodisation objectives may not be achieved, leading to sub-optimal adaptations.

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**INSTRUMENTATION OF A CONTROLLED-MANUFACTURING SURFBOARD DURING SURFING IN ORDER TO QUANTIFY THE INFLUENCE OF FLEX IN THE OVERALL PERFORMANCE OF THE MATCH ATHLETE-BOARD.**

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INTRODUCTION: Despite the last OGs and a recent interest for cutting-edge training, surfers and equipment manufacturers dont have any tool guarantying them a consistent board-athlete match, mostly due to the incapacity to control the mechanical behavior of the board (McCagh 2013). The aim of this research is to develop a tool and gather data about the boards mechanical behavior to help define the factors of the performance match. It is proposed to make an instrumented surfboard, measuring its rigid-body motions and deformations, synchronized with biometric data from an instrumented surfer.

METHODS: A Wyve surfboard is made with a built-in electronic system made of 5 strain-gauges, IMU (Inertial Measure Unit), Bluetooth (BT) communication governed by an Arduino Nano v3. It measures and acquires at 15hz, communicates at 50Hz.

The board is calibrated on a 3-points static bending bench with tunable value and position of the input force. Data is calibrated with the inversion method (Kern 2002). Torsion is calibrated with the same method.

A surfer is surfing this board in oceanic waves from 0.8 to 1.5m. The experiment lasts for 10min or until 2 waves caught, repeated 5 times (Lestrade 2016).

The surfer is instrumented with EMGs (Electromyograph) (Cometa MiniWave Infinity) at a sample rate of 2000Hz. SENIAM references are followed to place the electrodes after skin preparation. The muscles activity (Trapezius Descendens (upper), Triceps brachii, Biceps femoris, Gastrocnemius Medialis) were recorded (Ruess 2013). The legs and lower body position was measured with IMUs (Cometa WaveTrack) calibrated using standing T-pose (Cordillet 2019).

RESULTS: On the 3-point bending bench, the system gives the application point positions and force value with this precisions: 1% in x (longwise), 13% in y (in width) and 13.5% in F (force value).

In-situ, the surfboard shows good qualitative data in bending. However, due to the ever-changing limit conditions on the nose, bending calibration is irrelevant. Torsion-wise, data was calibrable. It shows that the tail tilts toward the heel of the surfer when he is standing up. On a trimming phase, the tilt-angle is around 0.4°, near 0° during a frontside bottom turn, around 0.5° during the top turn, up to 0.8° during some turns (for an intermediate surfer).

About physiognomy, we have the following proportion of the cited-before muscles activity (%), considering a wave being the phases: Paddling (2.4s) 33%. Take-off (0.5s) 12%. Trimming (2.2s) 20%. Bottom turn (0.5s) 6%, Top turn (0.8s) 9% and finish (1s) 20%.

CONCLUSION: An instrumented surfboard has been made. It shows interest in measuring the tail torsion in-situ. Further methods will be tested.

A physiognomic protocol has been validated and tests with different stiffness boards and pro-athlete will follow.

**RECREATING THE NORDIC HAMSTRING EXERCISE USING A NOVEL ADAPTIVE RESISTANCE TRAINING MACHINE TO REDUCE ACUTE SORENESS AND EXTEND RANGE OF MOTION.**

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INTRODUCTION: Hamstring injuries are a common and significant problem for athletes. The Nordic Hamstring Exercise (NHE) has been shown to reduce hamstring injury risk, but its application is limited when athletes lack the knee flexor eccentric torque needed to perform NHEs through the full range of motion, leading to extensive muscle damage that

hinders subsequent athletic performance. The purpose of this study was to test the efficacy of a novel adaptive resistance training machine (Akuis Sintesi, Italy) in assisting the NHE to enhance its effectiveness as a training intervention.

METHODS: The study was approved by the Research Ethics and Governance Committee and participants signed informed consent. Sixteen participants were randomized into assisted-NHE or non-assisted NHE groups to complete 15 NHE repetitions. Assessments before NHE included maximal voluntary knee flexion isometric torque (MVC) and biomechanical analysis of NHE using the Noraxon Portable lab, integrating electromyography (EMG) of bicep femoris and semitendinosus, knee and hip goniometry, shoulder and trunk accelerometery, ankle force and 2D videos. Assessments were repeated 48h later. Sintesi partially off-loaded body mass in the assisted-NHE group via a chest harness, proportional to the athlete's anthropometry, body mass and strength. Two-way repeated measures ANOVA was used for group and time interactions, with significance set at $p<0.05$.

RESULTS: Assisted-NHE resulted in a greater range of motion ($P<0.05$), with similar peak EMG and ankle force compared to non-assisted. Assisted NHE had lower muscle soreness at 48h and better preservation of MVC (both $p<0.05$).

CONCLUSION: The Sintesi machine can enhance the effectiveness of NHE by allowing greater range of motion and reducing muscle soreness and damage. This has applications for optimising hamstring training and rehabilitation.

**THE EFFECTS OF CHALLENGE AND THREAT APPRAISALS ON MOTOR PERFORMANCE UNDER PRESSURE**

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INTRODUCTION: Previous studies have established a relationship between stress-induced psychological states and motor performance, with high-pressure conditions often associated with performance deterioration. However, according to the cognitive-affective motor neuroscience (CAM) model of performance under pressure, stress may not necessarily lead to performance decline; rather, it may enable performers to achieve superior performance. Nevertheless, there is currently no research that directly tests the CAM model. This study aimed to examine the role of stress perception in motor performance by testing CAM model under pressure. Specifically, we investigated whether individuals who perceive stress as an opportunity (PO) exhibit enhanced motor performance, while those who perceive it as a threat (PT) demonstrate impaired performance.

METHODS: A total of 38 novice golfers were recruited and divided into two groups (PT group, n= 20; PO group, n=18). Two conditions were manipulated during the experiment. Only the high-pressure condition included manipulations such as leaderboards, feedback, and cash prizes, while the low-pressure condition had no pressure-related manipulations. Within the high-pressure condition, participants received different types of feedback. Feedback was provided every five trials. PO received encouraging feedback, emphasizing that their performance was close to surpassing or slightly above 50% of others, reinforcing a sense of opportunity. In contrast, PT received negative feedback, highlighting that their performance was well below 50% and required significant improvement, cultivating a sense of threat. To assess the effectiveness of the pressure manipulation, participants completed the State Anxiety Inventory (STAI-S) before putting tasks before both high- and low-pressure conditions. Additionally, a visual analogue scale (VAS) was used to ensure that participants anxiety level remained consistent throughout the experiment. Mean radial error (MRE) was measured using the Vicon Motion Systems to evaluate putting performance.

RESULTS: The STAI-S results in both groups showed higher pressure levels in the high-pressure condition compared to the low-pressure condition. In addition, the results confirmed that VAS-measured anxiety levels remained consistent. In the MRE analysis of putting performance, PO had lower MRE as better putting accuracy under high-pressure conditions. Conversely, PT exhibited higher MRE as poorer putting accuracy under high-pressure conditions. However, there was no significant difference between the two groups under low-pressure conditions.

CONCLUSION: These findings suggest that pressure does not necessarily impair performance; rather, individuals who perceive stress as an opportunity may experience enhanced motor performance. This research provides new insights into the interaction between stress and motor performance, highlighting the potential to stress as a tool for improving athletic outcomes.

**THE RELATIONSHIP BETWEEN CENTRE OF PRESSURE DATA AND ARCHERY PERFORMANCE**

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INTRODUCTION: Postural stability plays a pivotal role in archery performance, particularly during the aiming phase (i.e., the critical period between anchoring and releasing the arrow).1 Centre of pressure (CoP) data have been used to assess postural stability in archery. Previous research has identified key findings: a) maximum CoP sway velocity is a predictor of shooting performance;2 b) an inverse relationship between body sway and expertise level was observed;3 c) both CoP and bow sway are likely to influence shot accuracy.4 Given the scarcity of studies addressing this topic, this study aimed to further investigate the relationship between shooting performance and CoP data during the aiming phase.

METHODS: Thirty-one archers aged 18 and over were selected (19 men; 32.7 ± 17.1 years; archery experience: 13 with less than 2 years, 10 with 2-5 years, 3 with 5-10 years, and 5 with more than 10 years, age categories: 3 juniors, 20 seniors, 8 veterans). Each archer shot 10 sets of 3 arrows at a target (18 m; official competition indoor distance) with recurve bows. Shooting performance was assessed based on the target score and the distance between the arrow and the centre of the target. CoP data was collected using a RSscan pressure plate (50 Hz). In order to achieve the CoP data of the aiming phase, a camera (CANON EOS 550D; 25 Hz) was used. The following CoP parameters were computed: amplitudes of the anteroposterior and mediolateral displacements; maximum anteroposterior and mediolateral velocities; ellipse area (95%). Spearman test was used to analyse the correlation between CoP and shooting performance variables. Mann-Whitney test was used to compare subjects with more than 5 years of archery experience to those with less.

RESULTS: The data did not reveal any correlation between CoP data and shooting performance variables. However, when an individualized analysis was conducted, it was found that 10 subjects (8 with less than 5 years of archery experience) exhibited a correlation between CoP parameters and shooting performance variables ($p < 0.05$). The group with more than 5 years of archery experience exhibited better shooting performance ($p < 0.05$); however, no differences in CoP data were observed between this group and those with less than 5 years of experience.

CONCLUSION: The findings of the present study did not align with previous research that linked CoP data to shooting performance. This suggests that other variables, such as centre of gravity or bow sway, may be more closely related to archery performance and could serve as more accurate predictors. However, based on our results, CoP data may still hold value as a performance-enhancing parameter in individualized analyses, particularly for individuals with less archery experience.

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**A STUDY ON CAREER TRANSITION ANXIETY AND SOCIAL SUPPORT NEEDS OF PROFESSIONAL E-SPORTS PLAYERS**

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INTRODUCTION: The explosive growth of the e-sports industry has spawned a group of young professional players. However, the short career of this group (average retirement age is 25 years old) makes them face multiple challenges during the transition period. Retired players not only need to deal with the rupture of identity, but also need to reposition themselves in the traditional job market. The existing support system is mostly focused on psychological counseling or financial assistance, but ignores the deep needs of skill reshaping and social recognition.

METHODS: This study uses qualitative research methods to deeply explore the sources of anxiety and unmet social support needs of e-sports players during the transition period, and provides a theoretical basis for building a more targeted career transition mechanism. The study takes 20 former professional e-sports players who have retired for 1-3 years as the research subjects, covering mainstream game type. Through in-depth interviews and participant observation, the focus is on the players career transition experience, psychological experience and social interaction. The interviews were semi-structured and focused on four core dimensions: career planning, skill application difficulties, social prejudice perception, and support needs. Each interview lasted 60-90 minutes and was supplemented by textual materials such as players social media content. The research design emphasizes contextual understanding to capture the diversity and contradictions of individual experiences.

RESULTS: The data analysis adopted the three-level coding process of grounded theory. The study found that the core of transition anxiety stems from three aspects of tension: the disconnection between the professionalism and universality of skills, the lack of social recognition of e-sports identity, and self-doubt about professional values. Most respondents said that although e-sports training has cultivated the ability to make quick decisions and teamwork, these skills are difficult to identify in the traditional recruitment system. The study also revealed that existing support policies are often misaligned with the actual needs of players.

CONCLUSION: Thereby, this study proposes that an e-sports skill certification system should be established to transform abilities into assessable workplace competitiveness. At the industry level, the study suggests that clubs should be encouraged to cooperate with vocational education institutions to develop customized courses for retired players, and all sectors of society can reconstruct the image of e-sports through public publicity, emphasizing the universal value of soft skills. The study is not only about the transformation of individual career paths, but also involves the reconstruction of cultural capital and the renegotiation of social identity. At the practical level, the research conclusions provide a roadmap for the e-sports industry association to shift from "crisis response" to "preventive support."

**EXPERT OPINION ON THE ROLE OF SKILL ACQUISITION SPECIALISTS IN APPLIED SPORT SCIENCE: A DELPHI STUDY**

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INTRODUCTION: Skill acquisition is a rapidly evolving field of sport science, but its definitions, roles, and professional practices remain inconsistently articulated. Despite growing recognition of its importance, there is a lack of consensus regarding the core competencies and responsibilities of skill acquisition specialists, which creates barriers for the development of professional accreditation and development pathways. The aim of this study was to consult with experts to establish a consensus definition of the field of skill acquisition, clarify the roles of its specialists, and understand the needs and requirements of effective applied practice.

METHODS: A panel of 22 international experts in skill acquisition (15.2 ± 8.4 years' experience) took part in a Delphi study using online surveys following the Guidance on Conducting and Reporting Delphi Studies (CREDES). The panel included some of the most noteworthy skill acquisition researchers in the world, practitioners in professional sport across three continents, successful early career skill acquisition specialists, and other roles including high performance managers and coach developers. The survey comprised seven sections: (i) panellist information; (ii) definitions of the field of skill acquisition; (iii) definitions of the role of the skill acquisition practitioner; (iv) the need for skill acquisition specialists in MDTs; (v) knowledge requirements; (vi) technical skills; and (vii) professional competencies. Consensus was set at 75% (17 out of 22 respondents agree).

RESULTS: The panel reached consensus that skill acquisition specialists represent a unique and currently underrepresented role within multidisciplinary support teams in sport. The panel developed and agreed upon a clear definition of the field: 'an applied science addressing the performance, learning, and refinement of perceptual, cognitive, and motor skills across the spectrum from novice to expert performers.' There was also consensus on the definition of the role of skill acquisition specialists: 'skill acquisition specialists work in partnership with key individuals and groups (e.g., coaches, athletes) to apply research-led and theoretical principles to enhance and measure the perceptual, cognitive, and motor skills of performers.' Key responsibilities of a skill acquisition specialist were identified as practice design, individualised skill development, and education at the organisational level. Furthermore, the panel reached consensus on the essential knowledge and professional skills required to fulfil this role effectively.

CONCLUSION: Findings present a first step towards establishing a framework for professional development and accreditation in skill acquisition as a standalone discipline of sport science. This is key for the integration of high-quality, evidence-based skill acquisition practices within sport organisations.

**DUAL-TASK LANDING CHALLENGES ON DYNAMIC POSTURAL STABILITY IN ATHLETES DURING DROP JUMP**

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INTRODUCTION: Athletes often perform motor and cognitive tasks simultaneously during sports events, which inevitably involve dual-task. According to the attention demand theory, dual-task challenges can impair athletes postural control and coordination, resulting in suboptimal and even injury [1], and dynamic postural stability can be used to assess the extent to which athletes are disturbed by motor tasks [2]. Few studies have investigated the effect of unintended landing combined with dual-task. This study aims to examine the dynamic postural stability during drop-jump with or without dual-task, simulate a distraction scenario and assess postural control.

METHODS: This study recruits 8 college female athletes. The dual-task intervention consisted of using a hand-held wireless grip strength meter to control 30% of maximum grip strength while performing a 30 cm platform drop-jump with single-leg balance test, collecting 3 successful movements for analysis. Data were collected using 12 Vicon cameras and 2 Kistler force plates to analyze the dynamic postural stability index (DPSI), center of pressure (CoP), center of mass (COM), and lower extremity joint kinematics. A paired-sample t-test was used to compare dual-task (DT) and non-dual-task (NDT).

RESULTS: According to the results of the paired-sample t-test, no significant differences were found in lower extremity kinematics and ground reaction forces. However, the CoP total sway distance ($p = 0.035$), Medial-Lateral sway velocity ($p = 0.007$), and the vertical range of the COM ($p = 0.046$) were significantly lower in the DT compared to the NDT.

CONCLUSION: This study found that the dual-task had less total sway and slower velocity at the CoP with less vertical range of COM.

This highlights the heightened challenge athletes face when encountering unexpected landings combined with DT. A restricted lower limb cushioning preparatory posture adopts a more conservative postural stability control strategy and exhibits poorer dynamic postural stability characteristics compared to the NDT. Research indicates that when athletes face threats to postural stability, they tend to adopt a more stable landing strategy while sacrificing secondary task performance to optimize postural stability[3]. Dual-task challenges may vary among athletes at different levels, and further studies are needed to explore the influence of athletic proficiency.

1. Huxhold et al. (2006) 2. Pletcher et al. (2021) 3. Mohammadi et al. (2016)

Conventional Print Poster Presentations

CP-AP15 Individual Sports

**COMPARISON OF OPEN AND SQUARE STANCE IN THE FOREHAND AMONG COMPETITIVE TENNIS PLAYERS: A PRELIMINARY STUDY**

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INTRODUCTION: The kinetic chain in tennis originates from the legs, and a proper stance is crucial for effective energy transfer to the ball [1,2]. Among the stances, the open stance forehand has gained popularity in the last twenty years despite the traditional square stance [3,4]. Hypotheses favoring open stance were supported by a study [5] that argued that this stance offers more power in strokes, allowing athletes to generate more spin and reach wider angles, however, the results in the literature are sometimes discordant [6,7] and many studies have linked the open stance to increased injury risk [8,9,10], but a clear understanding of the performance differences between the square and open stances remains elusive. This study aims to compare the effectiveness between forehand played in open and square stance, in terms of performance: 1) ball speed, 2) accuracy, 3) gesture economy.

METHODS: Ten healthy competitive players (8 males, 2 females) were involved in the study. Eighty forehands were played by each subject with open and square stance, in lateral and diagonal-inside running structured situations, receiving the ball from a ball-throwing machine, and aiming to play in a square-shaped target with 2 m sides. The ball's speed, accuracy of the shot and heart rate were acquired. Kruskal-Wallis's tests and Dunn Post Hoc tests were used to compare the effect of stance and tactical situation on these performance variables. Wilcoxon signed-rank t-test was applied for a separate comparison of each between the two types of stances. Jasp (Version 0.18.3) and R software (Version 4.4.2) were used for the statistical analysis of the data.

RESULTS: Square stance consistently resulted in significantly higher ball speeds in both lateral running (ΔMedian: 8 km/h) and diagonal-inside running (ΔMedian: 8.5 km/h), while differences in accuracy and metabolic demand were not significant.

CONCLUSION: This preliminary study found that, in the examined group of competitive tennis players, square stance technique provided a clear advantage in terms of generating ball speed. Although the higher accuracy found was not significant, so was the difference in metabolic effort, it follows that the advantages in performance, together with and reduced risk of injury seem to make the square stance the preferable choice. A larger survey of a greater number of subjects is required.

**THE IMPACT OF OPEN AND SQUARE STANCES ON THE PERFORMANCE OF FOREHAND DRIVES IN FAVORABLE TENNIS SITUATIONS**

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INTRODUCTION: In tennis, open and square stances are both used to produce forehand drives, especially when players are not under time pressure [1], like in offensive situations. Interestingly, even though some biomechanical differences between these stances have been found [2;3], studies about their impact on performance are sparse. Indeed, a few studies showed no differences in racket speed [4;5] between square stance and open stances among high-level players, while the impact on shot accuracy has never been studied.

Hence, the objective of our study was to examine the impact of using open or square stances during the execution of forehand drives in offensive tennis situations in terms of ball speed and shot accuracy.

METHODS: Thirteen tennis players (two women and eleven men), at the regional to national level, performed a laboratory task that involved executing winning down-the-line forehand drives with the highest possible speed and accuracy.

Subjects were required to perform 8 series of 5 strokes (4 series with open stances and 4 series with square stances) aiming at a target integrated into the projection of a tennis court image.

A radar (Stalker Pro II) was used to record ball speed. Stroke accuracy was assessed through the distance between ball impact and the center of the target, using video footage processed with the Kinovea software.

RESULTS: Wilcoxon paired samples T tests showed a significant effect for ball speed (W=8; p=.006) but not for accuracy (W=65; p=.191). Stroke speed was higher when players used square stance (130.46 km.h-1±13.49) than when they used open stance (123.3 km.h-1±11.46).

An additional analysis examined whether players tended to hit higher or lower, more to the left or to the right depending on the stances used. It did not show any accuracy bias based on stance modality.

CONCLUSION: While looking at the two key factors of performance in tennis forehand drives (ball speed and accuracy), only ball speed varied based on stances used. Previous studies showed no difference in terms of racket speed [4;5] but did not put players in specific situations (hitting an offensive shot within a target), hence probably hiding the overall differences. Moreover, these differences may be attributed to the players level of expertise, the controlled laboratory setting of our experiment, or the fact that all their drives occurred under favorable conditions, i.e., without time constraints. Hence it

seems worthwhile to continue studying these strokes in favorable situations to analyze which stance is the most effective in a real-life situation on the tennis court.

1.Landlinger et al. (2010) 2.Bahamonde & Knudson (2003) 3.Pozzo et al. (2005) 4.Knudson & Bahamonde (1999) 5.Kawamoto et al. (2019)

**EFFECT OF VIBRATION DAMPENERS ON PLAYERS PERCEPTION AND PERFORMANCE IN TENNIS: A PILOT STUDY**

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INTRODUCTION: Traditional tennis vibration dampeners (VD) are small devices placed between the strings of a tennis racket to reduce vibrations [1], with the purpose of providing a more comfortable playing experience. However, some studies [2,3] found that VDs reduce some high frequencies, but do not reduce racket frame vibration transfer to the forearm. Thus, we hypothesize that VDs are relevant mainly to players acoustic preferences and, to a lesser extent, to proprioceptive comfort. The relevant question is whether VDs influence players' perception and performance.

METHODS: Thirty experienced tennis players (> 4 years of playing experience) wore during the test an earmuff (30dB attenuation) and used a racquet where the presence of the VD was masked. Unaware of the situation, they participated crosswise in 2 groups: Vibration Damper (VD) and Control Group (CG). The subjects performed 2 sets of 10 long line forehand shots for each situation on the same day, receiving the ball from a ball-launching machine, aiming to play as fast as possible into a 2mx2m area on the other side of the court. A speed radar (Pocket Radar Inc., Santa Rosa, CA, USA) measured the ball speed. A questionnaire regarding the presence or absence of VD and playing comfort was filled. Repeated measures MANOVA was used to detect changes in ball speed, accuracy of the shots and players comfort between the two groups. Statistical analysis was carried out with Jasp software (Version 0.18.3). Preliminary results are presented.

RESULTS: The results of one participant are shown. The player perceived no difference in the sound of impact. However, being used to playing with the same racquet model of the experiment with VD, he recognized his usual situation as a playing feel and correctly guessed when the racquet had the VD. In terms of performance, there was no significant difference in accuracy between the two situations (VD: 56%; CG: 50%) and a difference of almost 3km/h, but still not significant occurred in ball speed with VD compared to the other condition: (VD: 127.3; CG: 124.5 km/h).

CONCLUSION: The preliminary results provide initial insights into the potential effects of VDs on tennis performance. These findings suggest that the presence of VD, where the player was accustomed, might have subtly influenced his gesture, potentially leading to a slight increase in swing speed; highlighting the role of subjective perception and player familiarity in influencing performance and comfort feel. The analysis of the full sample size, as well as the use of inertial sensors, handle pressure sensors, and video cameras, may contribute in future studies to understanding the impact of VD on tennis performance.

**LONGITUDINAL MONITORING OF SHOULDER STRENGTH ASYMMETRIES IN ELITE YOUTH TENNIS PLAYERS**

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INTRODUCTION: Longitudinal monitoring of shoulder strength asymmetries in athletes is essential, as these imbalances are associated with reduced sports performance and increased injury risk. Tennis players, who frequently perform repetitive overhead motions, are particularly susceptible to strength discrepancies in the shoulder complex. Identifying and quantifying these asymmetries in elite youth tennis players can provide valuable insights for optimizing performance and reducing injury risk. This study aimed to examine longitudinal changes in shoulder strength asymmetries in elite youth tennis players.

METHODS: Twelve elite youth tennis players (5 males, 7 females; mean age: 14.5 ± 1.8 years) underwent two isokinetic strength assessments, separated by a 12-month period, using a Biodex dynamometer. Measurements included peak torque, peak torque/body weight, and peak power for internal and external rotation at 90° shoulder abduction and a velocity of 60°/s. Asymmetry magnitudes were calculated using the percentage difference method: ((dominant value – non-dominant value/dominant value) * 100). Data normality was assessed with the Kolmogorov-Smirnov test. Repeated-measures ANOVA's analysed changes in dominant and non-dominant internal and external rotation strength, as well as the asymmetry magnitudes, over time separately for male and female players. Statistical significance was set at $p < 0.05$.

RESULTS: All data were normally distributed. Strength measures were significantly higher ($p < 0.05$) in the dominant shoulder except for external rotation peak power, which showed no significant difference. Most strength metrics increased significantly over time, except for peak power/body weight in both internal and external rotation. Male players exhibited significantly greater internal and external rotation power than females. Asymmetry magnitudes ranged from 12.8 % to 34.1 %, with internal rotation asymmetry decreasing significantly over time, while external rotation asymmetry remained unchanged.

CONCLUSION: These findings confirm the presence of significant shoulder strength asymmetries in elite youth tennis players, which evolve over time. Given the potential impact on performance and injury risk, targeted strength and conditioning programs are essential to address these imbalances. Due to the considerable variation in asymmetry magnitude, individualized assessments are recommended. Additionally, as the young age of participants precluded testing at higher angu-

lar velocities (e.g., 180°/s), future research should investigate whether significant asymmetries persist at greater angular speeds.

**PREVALENCE AND FACTORS ASSOCIATED WITH PATELLAR TENDINOPATHY AMONG YOUNG TENNIS PLAYERS**

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INTRODUCTION: Tennis is a sport in which proficiency begins at an early age. It differs from other sports in the duration of matches, the rigid playing surface and the fact that its an asymmetrical activity. Additionally, tennis players must combine various physical abilities, such as short and rapid sprints, changes in direction, agility and muscle strength, to achieve high performance levels. These factors may create significant loads on the joints and may lead to injuries. This study was aimed to identify the prevalence and the factors associated with patellar tendinopathy among young tennis players.

METHODS: Eighty-six young tennis players (29 girls), aged 8-18 years (12.7±1.9), members of the youth national teams participated in the current study. Measurements for both legs included: A Training Load Questionnaire, anthropometric measures, age, dynamic balance (Y-Balance test -YBT), agility (Hexagon Hop Test), bone strength (Quantitative Ultrasound Speed of Sound), muscle strength (by Handheld Dynamometer) and range of motion (ROM) (by Goniometer). Additionally, each participant underwent a clinical examination (Royal London Hospital Test) by a physiotherapist to identify patellar tendinopathy.

RESULTS: One hundred seventy-two legs were evaluated. For patellar tendinopathy only 165 legs were clinically examined (7 legs were excluded), with 83 legs (50.3%) identified with patellar tendinopathy. Significant differences were found between the injured and uninjured legs indicating that dynamic balance ($p<0.01$), hip abductors ($p<0.01$), hip flexors ($p=0.001$) and knee extensor muscle strength ($p<0.01$) were reduced in the injured legs compared to the uninjured legs. Additionally hip abductors ROM ($p<0.01$), hip flexor ROM ($p<0.01$) and knee flexors ROM ($p=0.01$) were higher in the injured legs compared to the uninjured legs. Other examined variables were not significantly different between injured and uninjured legs ($p>0.05$). Logistic regression analysis indicated that greater hip abduction ROM (OR=1.14, $p<0.001$), greater hip flexion ROM (OR=1.05, $p=0.02$) and fewer training hours per week (OR=0.93, $p=0.01$) were associated with an increased risk of patellar tendinopathy.

CONCLUSION: About fifty percent of the legs were diagnosed with patellar tendinopathy. Reduced dynamic balance, lower hip and knee muscle strength and greater hip and knee joint ROM were found in the injured legs compared with the uninjured legs. Additionally, greater hip ROM and reduced training hours were associated with increased risk for patellar tendinopathy. It might be suggested that a combination of insufficient weekly training hours, which are insufficient for building muscle strength and achieving optimal range of motion, along with poor dynamic balance, may increase the risk of patellar tendinopathy. These findings may contribute to the development of prevention and intervention programs aimed at reducing patellar tendinopathy in young tennis players.

**THE EFFECTS OF A 4-MONTH MOVEMENT THERAPY TREATMENT ON YOUTH SHORT TRACK SPEED SKATING ATHLETES**

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INTRODUCTION: When developing the Balance² movement therapy training method, our goal was to harmonize muscle balance disorders present in the body at any age, regardless of their cause. The foundation of the method lies in revisiting basic infant reflexes and fundamental movements within a comprehensive training framework. This approach enhances motor coordination skills, thereby improving fundamental movements and posture.

For competitive athletes, it is essential to recognize that sport-specific movements place unique demands on the body and the musculoskeletal system. Finding an appropriate complementary movement form alongside these specialized movements poses a challenge.

In our study, we tested the Balance² method as a supplementary movement form for short track speed skating.

METHODS: Examined Group:

Short track speed skating athletes aged 11-16

Baseline Assessments:

Stabilometric measurements

Balance² assessment

Starting Point:

All participants had been competing in short track speed skating for at least one year and followed a corresponding training program, including on-ice practice, strength training, and speed workouts.

Before the assessment, we assumed that flexibility deficits would be the primary issue. However, the evaluation revealed that overall coordination skills needed improvement. Athletes approaching peak growth showed satisfactory lateral stability, while those in the midst of or past their peak growth phase exhibited significant instability.

Method:

Participants attended Balance² movement therapy training sessions twice a week as a supplementary exercise.

RESULTS: All athletes participating in the study showed significant improvement over four months. After an average of two Balance² movement therapy sessions per week, enhancements were observed in static and dynamic balance abilities, the overall coordination of the anterior and posterior muscle chains, and core stability. Postural alignment also improved significantly, as assessed by the weight-bearing line analysis.

CONCLUSION: Based on the measurement results, the Balance² movement therapy training method could also be suitable as a complementary exercise for other sports. Additionally, it may serve as an effective movement form for adolescents who do not compete in sports, helping to improve overall posture.

**SEASONAL CHANGES IN BODY COMPOSITION AND PERFORMANCE IN MALE AND FEMALE ICE HOCKEY PLAYERS**

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INTRODUCTION: Recent developments in women's ice hockey such as allowing tackles suggest that physical demands will increase and be more similar to men's game. Yet, research indicates that female players may exhibit suboptimal strength and physical capacity training compared with their male counterparts (1,2). We were therefore interested in comparing seasonal changes among top-level Swedish ice hockey players. This prospective study aimed to examine seasonal changes in body composition, strength, and on- and off-ice performance in male and female ice hockey players, focusing on potential sex differences and time-dependent variations.

METHODS: Male (n=25) and female (n=23) elite ice hockey players underwent measurements at three time points (May/June, August, December) within one season. Body composition was assessed by DXA, and performance tests included both on-ice (e.g., sport-specific drills/sprints) and off-ice measures (back squat, power clean, bench press, 10/30-meter sprint, and broad jump). Repeated-measures ANOVA was used to analyze the effects of sex (between-subjects) and time (within-subjects), as well as their interaction.

RESULTS: Analyses consistently showed a strong main effect of sex ($p < 0.001$), indicating higher overall performance scores and lower body fat percentages in male players. By contrast, the effect of time (month) on outcome measures was either non-significant or of smaller magnitude, suggesting limited seasonal fluctuation in tested variables. Where tested, the interaction between sex and time was generally non-significant ($p > 0.05$), implying that changes over time did not differ substantially between male and female players.

CONCLUSION: These findings support earlier indications that physical and performance discrepancies persist between male and female hockey players. Although both groups undergo similar seasonal training and match demands, the data suggest that sex differences, rather than seasonal fluctuations, predominantly drive variations in body composition and performance. However, the small changes over time in this sample contrast with some previous reports of greater seasonal body composition shifts in female players (3). The present results underscore the need for tailored strength and conditioning programs that address specific performance demands of both male and female ice hockey players.

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**THE IMPACT OF PHYSICAL FITNESS ON PERFORMANCE IN THE EMERGING OLYMPIC SPORT OF IQFOIL: INSIGHTS FROM JUNIOR WINDSURFERS**

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INTRODUCTION: The debut of IQFoil as an Olympic event at the Paris 2024 Games has marked a significant evolution in competitive windsurfing. This new class, characterized by its unique hydro-foiling design, imposes distinct physical demands on athletes, necessitating a comprehensive understanding of how physical fitness influences performance outcomes. Effective fitness training not only enhances athletes capabilities but also helps in injury prevention, which is crucial given the physically demanding nature of windsurfing. This study aims to investigate if any correlation between physical fitness metrics and competitive results within the context of junior windsurfers, providing insights that could inform future training strategies and improve competitive performance in the IQFoil class.

METHODS: Seventeen junior windsurfers (10 males and 7 females; mean age 15.7 ± 0.62 years) participated in the study. Pre-competition assessments measured rowing power profiles, maximal aerobic running speed, and $VO_2$ max. Performance rankings were derived from the cumulative results of five races over two days. Descriptive statistics and Pearson correlation analysis were employed to explore relationships between competition rankings, fitness metrics, body weight, and height, with statistical significance set at $p < 0.05$.

RESULTS: The maximum race duration was 5 minutes and 13 seconds, during which competitors sustained 90% - 100% of HRmax for maximum of 2 minutes and 28 seconds. Analysis revealed significant positive correlations between competition ranking and maximum rowing power metrics for males: ten-second power (r = 0.90), one-minute power (r = 0.67), and four-minute power (r = 0.84). However, no correlations were observed for female participants regarding rowing power. A significant correlation was also found in body weight (r = -0.88) for males. No correlation was found between competition ranking and relative maximum power metrics, nor between maximal aerobic running speed and $VO_2$ max for either gender. These findings suggest that race intensity is high, and enhancing absolute rowing power is crucial for success in IQFoil, particularly for effective pumping throughout races.

CONCLUSION: IQFoil presents high-intensity physical demands with shorter competition durations. Due to the design changes of IQFoil, body mass and absolute rowing power significantly influence performance. Further investigation is warranted to evaluate the impact of technical skills, as prioritizing technical proficiency may be essential before optimizing fitness levels to meet the sports rigorous demands.

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**SINGLE-LEG LATERAL JUMP TESTS DISCRIMINATE GENDER AND COMPETITIVE LEVEL IN TABLE TENNIS PLAYERS**

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INTRODUCTION: Table tennis (TT) requires explosive and reactive actions in the frontal plane. Therefore, this study aims to assess mediolateral movement patterns in TT players.

METHODS: Fifty-three TT players (Males=43; Females=10) of different age categories (Senior=32; Under 19=21) and competitive levels (High=12; Medium=20; Low=21) executed 3 single-leg lateral jumps: for the Maximal Lateral Rebound Jump test (MLRJ), players stood on one leg, performed a lateral jump, and rebounded with the opposite leg as fast as possible returning to the stance leg, reaching the maximal lateral jumping distance [1]; the Lateral Squat (LSJ) and Countermovement (LCMJ) Jump tests were executed on the mediolateral direction pushing with one leg and landing on the opposite leg [1]. The leg corresponding to the playing hand was defined as the Playing Side (PS), while the opposite leg was identified as the Non-Playing Side (NPS). Each test was repeated three times per leg and the average value was used for the statistical analysis. Contact Time (CT) of the rebounding leg was registered for MLRJ, and jumping distance was measured for MLRJ, LSJ, and LCMJ. The trochanterion height (TH) was measured for each participant from the floor to the trochanterion landmark [2].

RESULTS: A significant difference in the TH emerged between genders ($p<0.001$; $d=1.474$), and among competitive levels only for female sample ($p=0.015$; $\eta 2=0.129$).

No differences emerged between age categories, whilst gender differences were found for jumping distances (normalized by TH) in the MLRJ (PS: $p=0.003$, $d=1.091$; NPS: $p=0.001$, $d=1.209$), LSJ (PS: $p=0.001$, $d=1.380$; NPS: $p=0.016$, $d=0.905$), and LCMJ (PS: $p<0.001$, $d=1.614$; NPS: $p<0.001$, $d=1.340$), with males outperforming females.

Differences among competitive levels emerged only in the MLRJ. In male group, high (169.3±12.4 cm; $p=0.031$, $d=1.105$) and medium (167.2±11.9 cm; $p=0.035$, $d=0.936$) level players reached longer jumping distances for the PS leg than low level players (157.4±8.8 cm), even if no differences emerged for CT. For the NPS leg, high level players (171±13.9 cm; $p=0.013$; $d=1.099$) performed longer jumping distances than low level players (158.8±7 cm), without any differences for CT. In female group, the only difference emerged in the NPS leg, with longer jumping distances (normalized by TH) reached by high level players (1.79±0.09 AU; $p=0.036$; $d=2.980$) compared with medium level players (1.56±0.06 AU), without any differences for CT.

CONCLUSION: The preliminary analysis on gender demonstrates the capability of the 3 jump tests to discriminate differences between male and female TT players. However, only the MLRJ is able to discern differences among competitive levels. The greater performance demonstrated by the high level players highlights their higher ability in reactive strength, specifically in the application of an efficient stretch-shortening cycle.

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## Conventional Print Poster Presentations

### CP-AP16 Combat Sports and Strength

**TRAINING AT ALTITUDE: PREPARING AN ELITE JUDOKA FOR THE OLYMPICS**

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INTRODUCTION: Hypoxic training is frequently used to enhance sea-level exercise performance (Bonetti and Hopkins, 2009). Recently, the application of hypoxic training for accelerating return to play has gained popularity (Narang et al.,

2024). The use of hypoxic training for aiding in return to play whilst simultaneously preparing an athlete for the Olympic Games is yet to be explored. Therefore, the aims of this study were: (1) to examine data collected from a 12-week hypoxic training programme on exercise performance of an elite judoka returning from injury and preparing for the Olympics; (2) to explore the practices and perceptions of an elite judoka on the efficacy of hypoxic training for return to play and Olympic preparation.

METHODS: This study adopted a single-subject case-study research design which allowed for a detailed analysis of the individual physiological changes and responses to hypoxic training in an elite judoka. An elite female judoka completed a 12-week hypoxic training programme developed and implemented by British Judo. Exercise testing (2,000 m time-trial) was completed throughout the programme to measure aerobic performance. A 20-minute semi-structured interview was conducted by the primary researchers post-Olympic Games to explore the judoka's experiences and perceptions of hypoxic training. Data collected from the testing sessions were reported using relative percentage change. Interview data was analysed using a 6-step thematic analysis (Braun and Clarke, 2006).

RESULTS: Time-trial performance was improved after 6 weeks of training (07:36 (-3.8%) ~95% maximum heart rate (MHR)) and was further improved at week-10 (07:28 (-5.49%) ~96% MHR)) of the programme when compared to pre-altitude time-trial performance (07:54). Eight sub-themes were organised into three higher-order themes: Altitude Training Practices, Altitude Training Benefits and Altitude Training Drawbacks. The first theme was used to describe previous and current altitude training methods adopted by the judoka (e.g. 'we definitely did some interval sessions'). The second theme captured the judokas perception of the advantages that altitude training provided her with (e.g. 'I've never felt that fit in a competition ever'). The final theme encapsulated the judokas views on the negative effects of altitude training (e.g. 'we realized we go away a lot, so it was kind of interrupted training').

CONCLUSION: Findings demonstrate that hypoxic training is an effective strategy for improving fitness during return to play and for enhancing exercise performance during Olympic preparation in an elite judoka. Hypoxic training was viewed as a beneficial aid to improving fitness, exercise performance and psychophysiological responses from training. Despite potential scheduling issues, applying an adaptable, athlete-led approach to coaching was suggested to overcome this concern. Additionally, improved motivation, enjoyment and athlete buy-in may enhance adherence to future training programmes in judokas.

**LOCAL MUSCULAR OXIDATION: A KEY COMPONENT OF COMPREHENSIVE ENERGY SYSTEM PROFILING IN PROFESSIONAL MIXED MARTIAL ARTISTS**

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INTRODUCTION: Mixed Martial Artists (MMA) performance relies on a complex interplay of anaerobic power, aerobic capacity, and local muscular performance. However, traditional energy system assessments focus largely on systemic metabolism, often overlooking local muscular metabolism. This study investigates local muscle oxygenation in conjunction with systemic metabolism to better understand sport-specific energy system demands in professional MMA fighters.

METHODS: Twenty-eight male professional MMA fighters completed comprehensive Energy System Profiling (ESP) using an Air-Bike Elite (Assault Fitness), following a protocol developed by the UFC Performance Institute (2021). This protocol consisted of two assessments: (1) a 1-minute all-out maximal glycolytic power (MGP) test followed by a 2-minute active recovery, and (2) a maximal aerobic power (VO2 Max) test using an 8-minute incremental protocol to exhaustion, during which assessments were taken before exercise, during exercise, and one-minute post-exercise for both assessments. Data was collected from the Air-Bike, recording absolute and relative power output (PWR). Near-Infrared Spectroscopy (NIRS) devices (Train.Red) were positioned on m. rectus femoris to assess muscular oxygenation, with a primary focus on Tissue Saturation Index (TSI, %) to evaluate oxygen extraction rates in the lower body. Respiratory gas exchange was measured using a metabolic analyzer (K5, COSMED) to assess oxygen uptake (VO2), carbon dioxide production (VCO2), respiratory exchange ratio (RER), and ventilation parameters throughout the testing protocols.

RESULTS: For both assessments, baseline TSI was 71 +/- 6.2%. The MGP results showed a mean PWR of 10.3 W/kg, with a minimum TSI of 41%, VO2 of 48 ml/kg/min, and a peak RER of 1.3. The 1-minute post-recovery TSI was 63%. The VO2 Max test showed a mean PWR of 6.6 W/kg, a minimum TSI of 43% at Peak VO2, VO2 of 52 ml/kg/min, and a maximum RER of 1.3, with a post-recovery TSI of 61%. A TSI of 48% at Threshold 2 during the VO2 Max test showed a strong correlation (r = 0.85) with the minimum TSI value reached in the MGP test.

CONCLUSION: The MGP results showed a significant drop in TSI, followed by a rapid recovery, indicating that athletes can quickly restore muscle oxygenation after short, intense glycolytic bouts. This suggests that their recovery is more efficient following high-intensity efforts compared to prolonged aerobic exertion, as reflected by slower recovery rates during the VO2 Max. Strong correlation between the minimal TSI during the MGP and the TSI at Threshold 2 in the VO2 Max highlights the interconnected relationship between the shift to anaerobic metabolism during the VO2 Max test and the oxygen utilization demands observed during the MGP test. This emphasizes the often-overlooked role of local muscular performance and monitoring within ESP, providing a more comprehensive evaluation of an MMA fighters energy systems strengths and deficiencies.

**FACTORS DETERMINING KICKING PERFORMANCE IN TAEKWONDO: THE ROLE OF ISOKINETIC KNEE AND HIP STRENGTHS**

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INTRODUCTION: The movement dynamics of the knee and hip joints emerge as a crucial component among the key biomechanical parameters that determine kicking performance. The influence of hip and knee isokinetic strength on the biomechanics of the kicking motion is significant, as these forces contribute to the overall effectiveness and accuracy of the strike [1]. The coordination of these muscle groups is essential for generating the necessary power and stability during the kicking action [2]

METHODS: The study was conducted with the voluntary participation of 20 elite taekwondo athletes. The isokinetic strength performance of the athletes knee and hip joints was assessed using a Cybex (Humac Norm) isokinetic dynamometer (CSMI, Stoughton, MA). Knee extension (EXT) and flexion (FLX) torques were analyzed at 60°/s, 180°/s, and 300°/s angular velocities, and hip FLX and EXT torques were analyzed at 60°/s and 180°/s angular velocities. Kicking speeds were measured using Kinovea (0.9.5).

RESULTS: The analysis of the relationship between athletes left kick speed and isokinetic knee strength revealed statistically significant correlations in the dominant limb at 60°/s FLX ($r = 0.463$), 180°/s FLX ($r = 0.647$), 300°/s EXT ($r = 0.506$), and 300°/s FLX ($r = 0.704$). In contrast, no significant relationships were found between the dominant limb isokinetic strength and right kick speed ($p > 0.05$). On the other hand, significant correlations were identified between left kick speed and the non-dominant limb at the hip joint for 60°/s EXT ($r = 0.527$), 180°/s EXT ($r = 0.517$), 300°/s EXT ($r = 0.575$), and 300°/s FLX ($r = 0.471$). Similarly, statistically significant relationships were observed between right kick speed and the non-dominant limb at 60°/s EXT ($r = 0.566$), 180°/s EXT ($r = 0.468$), and 300°/s EXT ($r = 0.506$).

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CONCLUSION: The results revealed significant relationships between right and left kicking velocities and knee and hip isokinetic torques. Significant relationships were observed especially at 180°/s angular velocity in hip isokinetic strength and at 60°/s, 180°/s, and 300°/s angular velocities in the knee. These findings indicate that lower extremity isokinetic strength contributes to kicking performance and suggest that focusing on these angular velocities in training programs may be beneficial.

**THE EXTERNAL AND INTERNAL LOADS AND INTENSITIES OF SIMULATED BRAZILIAN JIUJITSU TOURNAMENT**

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INTRODUCTION: Brazilian jiujitsu (BJJ) is a grappling based combat sport contested in one-day knockout tournaments of consecutive 5 min bouts with relatively short recovery time between bouts. The internal loads of BJJ bouts have been previously explored, but the external loads have not. Additionally, reported measurements have occurred at the end of each bout without quantifying changes in loads within the bout. The aim of this study was to measure changes in internal and external loads and intensities of BJJ simulated tournaments between bouts, and between minutes within bouts.

METHODS: N = 8 male BJJ athletes were recruited (age=39±6; mass=85±14kg; stature=176±7cm) and paired based on mass and belt. Participants took part in 5x5 mins BJJ bouts under tournament rules against the same opponent in each bout. If any submission occurred participants were instructed to immediately continue the bout from a neutral position. Each bout was interspersed by a 10 min recovery period. Throughout each bout participants wore a Catapult Vector accelerometer (Catapult Innovations, AUSTRALIA) on the T3-4 vertebrae in a secure harness to measure Playerload as external load (PLdACC) and external intensity (PLdACC·min-1), both in AU. Each participant also wore a Polar H9 heart rate (HR) monitor (Polar, FINLAND). Following each bout participants reported rating of perceived exertion (RPE) using the Foster 0-10 scale and had fingertip capillary blood lactate measured using Lactate Plus (Nova Biomedical, USA). Between min and/or between bout differences were determined for external and internal load and intensity using repeated measures ANOVA and omega squared effect size ($\omega 2$). Inference was provided by Bayes factors $\geq 3$ supporting either the hypothesis (BF10) or the null (BF01).

RESULTS: PLdACC per bout = 19.3±3 – 21.6±3AU. Differences in PLdACC between bouts was inconclusive (BF10<1, $\omega 2=0.04$). PLdACCmin-1 was different between mins within bouts (BF10=24, $\omega 2=0.09$), with min 1 being greater than all other mins (BF10=4 – 92). Post hoc analyses supported the null hypothesis of no differences between bouts 1, 3, 4 or 5 for PLdACC·min-1 profile (BF01=4). End of bout HR=164±11 – 172±6 beats·min-1 (HRmax% = 91±6 – 96±5%). HR was different between mins within bouts (BF10=11, $\omega 2=0.18$), due to min 1 being lower than all other mins (BF10=12,766 – 1.079x10+6). Bouts 1 and 2 were the only bouts to have post hoc HR profile differences to each other (BF10=3). Between bout changes in lactate (9±3 – 11±4 mmol·L-1; BF10<1, $\omega 2<0.01$) and RPE (5.8±1 – 7.3±2.6AU; BF10<1 $\omega 2=0.04$) were inconclusive.

CONCLUSION: Neither external or internal load or intensity differs between successive BJJ bouts, despite performance occurring in the aerobic-anaerobic transition zone. BJJ participants may be using external load pacing strategies to minimise the onset of fatigue during successive bouts, allowing intensity to be maintained.

**PHYSIOLOGICAL TRAINING IN STRIKING COMBAT SPORTS: A SYSTEMATIC REVIEW**

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INTRODUCTION: Combat sports can be characterised as grappling, striking or mixed combat. Striking combat sports (i.e., boxing, karate, kickboxing, muay Thai or taekwondo) incorporate strikes such as kicks, punches, elbows, and knees aimed at various body-parts of the opponent. Despite technical and tactical differences between these sports, the requirement to repeatedly execute strikes results in similar energy system demands. Physiological training is used to improve athletic performance. However, no study has reviewed the scientific literature regarding physiological training programmes for striking combat sports.

METHODS: Following the PRISMA guidelines, four databases (PubMed, Scopus, SPORTDiscus, and Web of Science) were searched for peer-reviewed original investigation articles that were written in English. Only studies that included healthy tier 2 or higher-level participants aged 16-40 years in boxing, karate, kickboxing, muay Thai or taekwondo were included. In addition, selected studies included a physiological training intervention lasting 2-12 weeks in which there was a validated pre- and post-physiological test. Following the screening process, nine studies were deemed relevant for data extraction. Risk of bias was assessed using a modified Downs and Black assessment tool.

RESULTS: Studies involved athletes from taekwondo (n = 3), karate (n = 3), boxing (n = 2), and kickboxing (n = 1). Physiological training interventions were between 2-8 weeks and included 2-4 sessions per week. High-intensity interval training (HIIT) was the most popular type of training (n = 8) with continuous training also utilised (n = 1). The most popular method of measuring physiological capacity pre- and post-intervention was an incremental exercise test (n = 8), with some studies also using a Wingate test (n = 4) and steady-state test (n = 1). Five outcome variables were measured across the nine studies and included VO2max (n = 7), VO2peak (n = 1), peak power (n = 4) and mean power (n = 2) in the Wingate test, and skeletal muscle oxygen saturation at exhaustion (SmO2; n = 1). The interventions increased VO2max by 3.3 ± 2.2 ml.kg.min-1 (7.2 ± 6.1%). In addition, peak power and mean power increased by 3.1 ± 2.8 W.kg-1 (8.3 ± 2.3%) and 0.4 ± 0.1 W.kg-1 (4.6 ± 1.7%) respectively. SmO2 increased by 5.4%.

CONCLUSION: Physiological training interventions, predominantly consisting of HIIT lasting 2-8 weeks in striking combat sports demonstrated positive physiological adaptations in the measured variables. Coaches and practitioners can use the data collated in this review to optimise the type, frequency, intensity, duration, and content of each physiological session to improve athletic performance in striking combat sport athletes.

**GENOME-WIDE ASSOCIATION STUDY ON GRIP STRENGTH IN ELITE ATHLETES: FINDINGS FROM THE IN:PROVE PROJECT**

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INTRODUCTION: Grip strength (GS) serves as a widely recognized proxy measure for overall muscular strength, with higher levels being linked to enhanced athletic performance and a lower risk of injury (Suchomel et al., 2016). Previous research has frequently explored the relationship between GS and genetic polymorphisms, suggesting a genetic relation (Willems et al., 2017). However, evidence within elite-athlete populations remains limited. Therefore, this study aims to conduct a genome-wide association study to investigate the genetic correlates of GS in elite athletes.

METHODS: A genome-wide association study on GS was conducted with a sample of 419 elite athletes (187 female). DNA was extracted from human whole blood using the Chemagic Magnetic Separation Module I (Perkin Elmer Chemagen). Genotyping was performed with the Illumina GSAv3.0+MD+Psych array. Genetic data underwent quality control, including, e.g., ancestry and Hardy-Weinberg equilibrium checks. GS was assessed using a hand-held dynamometer [N]. Age, gender, weight, height, and three genetic principal components were included as covariates. The genome-wide significance threshold was set at $p \leq 5 \times 10^{-8}$, with suggestive polymorphisms considered at $p \leq 1 \times 10^{-5}$.

RESULTS: We identified 57 polymorphisms associated with GS levels below the suggestive significance threshold ($p \leq 1 \times 10^{-5}$) including, for example, SNPs on genes DIO2 (rs225010, on chromosome 14), FOSL2 (rs9309662, on chromosome 2), or PEPD (rs153701 and rs4239576, on chromosome 19). However, no polymorphism reached genome-wide significance level ($p \leq 5 \times 10^{-8}$).

CONCLUSION: Our findings reveal new polymorphisms on genes that may be associated with grip strength levels in elite athletes as DIO2, FOSL2, or PEPD. This should be validated in larger elite athlete samples. Further steps in the project include calculating polygenic scores to validate and compare results with similar studies (Willems et al., 2017). Our findings help to elucidate the relationship between strength and genetics in elite athletes.

LITERATURE:

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**A KINETIC COMPARISON OF CONVENTIONAL AND SUMO DEADLIFTS.**

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INTRODUCTION: The deadlift is a strength exercise used in powerlifting, muscle-strengthening and rehabilitation. The deadlift generates significant forces, particularly in the lower limbs (1). There are two competitive techniques, the conventional deadlift and the sumo deadlift. This study aims to determine the kinetics differences between the two techniques from a lower limb. We hypothesized that in the sagittal plane, ankle and knee internal moments during the sumo deadlift would be relatively larger compared to those generated in the conventional deadlift, which, in contrast, would produce greater hip internal moments. Moreover, in the frontal and transversal planes, sumo deadlift would generate greater lower limb internal moments in three joints.

METHODS: Thirty healthy men (age: 26 ± 4.6 years; weight: 81.3 ± 8.7 kg; height: 178.5 ± 6.2 cm) and actively engaged in strength training performed three repetitions at 85% of 1-RM in conventional and sumo deadlifts. Kinematic data from 34 reflective markers placed on lower limb and pelvis and ground reaction force data, were recorded using an Optoelectronic system and two force plates, respectively. The ascending movement, which begins at lift-off and ends when the athlete reaches a fully upright position, was divided into two phases with the knee passing serving as the delimiter. The mean peak values of lower limb's joint moments in the three planes were compared between the two deadlifts techniques in each phase. Paired t-tests assessed the techniques effects on joint moments

RESULTS: The hip extension moments were more important in conventional deadlift, whereas in frontal and transversal plane hip moments were greater in sumo deadlift ($p<0.001$). Knee moments were larger for sumo deadlift on the two phases ($p<0.001$) except in the frontal plane on phase 2 where no difference was observed. Ankle eversion moment was observed on the two phases in conventional deadlift, while ankle inversion moment characterized sumo deadlift, the first showed greater moments. In transverse plane, ankle moment was more important in conventional deadlift on phase 1 before switch with the other on phase 2 ($p<0.001$).

CONCLUSION: It can be interesting to favor one technique over the other in order to focus on a specific joint while performing a multi-joint exercise. The forces varied according to the technique adopted. As a result of the wider stance, the knee abduction moment in the frontal plane was greater in the sumo deadlift in the first phase, where the moments were greatest, in parallel with a greater hip adduction moment compared to the conventional technique. So, to put an accent on the knee or to implement a work on frontal plane, it will be interesting to favor the use of sumo deadlift, whereas conventional deadlift will be more interesting to focus on the hip, which is relevant for exercises such as sprints.

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**WEIGHT VEST DURING PARKOUR TRAINING: IMPACT ON FATIGUE AND EXPLOSIVE STRENGTH PERFORMANCE**

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INTRODUCTION: Weight vest training already showed relevancy for explosive strength, endurance and coordination tasks. A sports discipline involving all these parameters is Parkour, in which the athletes need to overcome obstacles, primarily in urban settings. The immediate impact of weight vest training on movement efficiency, fatigue and recovery remains unclear. Therefore, this study aims to investigate the acute effects of weight vests during Parkour sessions on lower-limb performance, subjective fatigue, and delayed onset muscle soreness.

METHODS: Seventeen young, healthy, sportive participants (age: 21.7 ± 2.8 y; 6.0 ± 2.3 hrs of physical activity/week for the past 10.1 ± 5.8 years; 6 women; novice Parkour runners) underwent three familiarization sessions followed by two experimental sessions, each lasting two hours and separated by one week of rest. Each session started with participant preparation, warm-up, pre-tests, a 1-hr Parkour session, and post-tests. Two experimental conditions were included: Parkour without additional weight (PK) and Parkour with an additional weight vest (PK WV), representing 10% of body mass of each individual. Rating of Perceived Exertion (RPE) and delayed onset muscle soreness (DOMS) (24h to 72hr after each session) were obtained. Different physical tests were included, i.e., vertical jumps (squat jump, countermovement jump, drop jump, standing long jumps, 10-m sprints with or without obstacles).

RESULTS: RPE and perceived fatigue were higher after PK WV compared to PK ($p<0.05$). Between conditions, DOMS were significantly worsened at the level of quadriceps 24 hours and calves 72 hours after the PK WV session compared to PK.

Several significant differences were observed for performance measures, such as standing long jump and 10m sprint with obstacles. These parameters significantly reduced after PK WV, whereas no significant differences were observed in the PK condition ($p<0.05$). Other performances were not affected by PK WV: squat jump, counter movement jump, classic 10-m sprint. Finally, we did observe an unexpected significant improvement of drop jump height in the PK WV condition ($P<0.001$).

CONCLUSION: As expected PK WV fatigued participants substantially more compared to PK, resulting in decreased jump and sprint performance. The most affected performances were those requiring the highest level of motor control (long

jump, sprints with obstacles), while squat jump or classical sprint remained unaffected. Overall, this might show that, while not affecting muscle power, WV might alter motor control. Interestingly, drop jump height increased despite fatigue in the PK WV condition. This might be due to an enhanced neuromuscular potentiation. The drop jump heavily relies on the stretch-shortening cycle, which benefits post-activation potentiation. The weight vest might have induced neural alterations to recruit motor units more effectively during explosive movements after removing the weight vest, thus temporarily enhancing neuromuscular efficiency.

## Conventional Print Poster Presentations

### CP-AP17 Handball, Volleyball and Football

**APPLICATION OF THE YMCA STEP TEST TO INDIVIDUALS WITH VISION IMPAIRMENT**

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INTRODUCTION: The purpose of this study was to examine whether the YMCA step test is suitable to determine aerobic fitness in individuals with vision loss.

METHODS: 52 males between the ages of 19-36 participated in the study voluntarily. 15 of the participants were goalball players (age: 27.20±4.07 years; height: 181.36±7.18 cm; body weight: 84.54±9.09 kg) and 20 of them were athletes without vision loss (age: 26.85±4.04 years; height: 176.07±6.00 cm; body weight: 77.11±7.64 kg). As a control group, 17 male sedentary individuals with visual loss (age: 27.23±5.00 years; height: 176.11±5.63 cm; body weight: 82.21±7.89 kg) were included in the study. Initially, physical characteristics were determined and PAR-Q questionnaire was applied. Afterwards, YMCA step test was applied to assess the aerobic fitness of the participants. One-way ANOVA was used to determine the differences in physical characteristics (age (years), height (cm), body weight (kg), body mass index (kg/m2), body fat percentage (%), body fat mass (kg), fat-free mass (kg)) and physiological responses (maximal heart rate (HRmax), RPE, recovery heart rate (HRrecovery)) to YMCA step test among the three groups. If overall statistical difference was observed for the dependent variable ($p<0.05$), the Bonferroni post hoc test was used to identify the location of pairwise differences.

RESULTS: The results revealed significant differences in height (cm) ($F(2,49)=3.78$, $p=0.03$), body weight (kg) ($F(2,49)=3.86$, $p=0.02$), body fat percentage (%) ($F(2,49)=30.85$, $p=0.00$), body fat mass (kg) ($F(2,49)=21.33$, $p=0.00$), fat-free mass (kg) ($F(2,49)=39.11$, $p=0.00$) whereas no statistically significant difference was found in the variables of age ($F(2,49)= 0.04$, $p=0.95$) and BMI ($F(2,49)= 2.00$, $p=0.14$). A statistically significant difference was found in HRmax (bpm) ($F(2,49)=4.55$, $p=0.01$), RPE ($F(2,49)=26.62$, $p=0.00$) and HRrecovery (bpm) ($F(2,49)=38.12$, $p=0.00$) as physical responses to YMCA step test ($p<0.05$).

CONCLUSION: This study showed that the YMCA step test can be applied in individuals with vision loss to determine aerobic fitness.

**PHYSICAL PERFORMANCE TESTING IN TEAM HANDBALL: A COMPARATIVE ANALYSIS ACROSS EXPERIENCE LEVELS**

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INTRODUCTION: Team handball requires multiple physical attributes including strength, speed, and agility for competitive success. However, the relationship between specific performance tests and playing experience levels remains incompletely understood, particularly when comparing experienced versus less-experienced players.

METHODS: This cross-sectional study examined thirty-one male handball players divided into experienced (EP; n=14; age: 27.9±4.3 years; playing experience: 8.4±2.1 years) and less-experienced (LEP; n=17; age: 29.4±4.1 years; playing experience: 3.2±1.4 years) groups. A comprehensive testing battery assessed: (1) lower-limb power: squat jumps (SJ) and countermovement jumps (CMJ), (2) sprint capacity over 15m and 30m, (3) change-of-direction ability via T-Half test, (4) throwing performance using medicine ball throw, (5) aerobic fitness through Yo-Yo intermittent recovery test, and (6) muscle volume measurements of upper and lower limbs.

RESULTS: EP demonstrated significantly superior performance in agility (T-Half test: EP: 5.91±0.15s; LEP: 5.56±0.40s, $p=0.002$, $\eta p2=0.28$), explosive power (CMJ: EP: 42.3±4.8 cm; LEP: 36.7±4.2 cm, $p=0.002$, $\eta p2=0.28$), and throwing ability (medicine ball throw: EP: 12.8±1.4 m; LEP: 10.9±1.2 m, $p=0.009$, $\eta p2=0.21$). Linear sprint performance showed no significant differences (30m sprint: EP: 4.20±0.17s; LEP: 4.21±0.14s; $p=0.662$, $\eta p2=0.01$). Muscle volume measurements revealed similar values between groups for both upper (EP: 2856±423 cm3; LEP: 2789±398 cm3, $p=0.724$) and lower limbs (EP: 6234±856 cm3; LEP: 6198±812 cm3, $p=0.892$).

CONCLUSION: The findings demonstrate that handball-specific movements requiring complex motor control and power production (agility, jumping, sprinting) better differentiate experience levels than linear sprinting or muscle volume. This aligns with recent research showing sport-specific testing batteries are more sensitive to playing level than general athletic measures. The similar sprint times between groups likely reflect the limited occurrence of maximum-speed linear running in handball compared to multidirectional movements. Practitioners should prioritize specialized training regimens targeting these discriminating performance markers while considering experience level in training prescription.

**FUNCTIONAL TESTS FOR UPPER LIMB STRENGTH AND POWER TO PREDICT THROWING PERFORMANCE IN HANDBALL**

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INTRODUCTION: In Handball, athletic performance is closely tied to the execution of technical movements, like throwing the ball. Two key aspects contribute to an effective throw: accuracy and ball speed. Our aim was to evaluate if throwing speed can be predicted by upper-limb strength and power assessed as Ballistic Push-ups (BPU), bench press one repetition maximum (1RM) and power at different intensities (30, 60 and 90% RM).

METHODS: Nine handball athletes with strength training experience (five men and four women; age: 21.5 ± 2.2 years; height: 1.7 ± 0.1 m; body mass: 75.2 ± 12.1 kg; body mass index: 24.8 ± 1.8; fat-free mass: 57.8 ± 13.4 kg; fat mass: 23.9 ± 6.2 kg) participated in the study. Following two familiarization sessions, they attended four laboratory visits. During the first visit, body composition was assessed, followed by the 1RM test for the bench press. The second visit involved the submaximal acceleration test in the bench press (with loads of 30%, 60% and 90% of 1RM). On the third day, they performed the BPU test and on the fourth day, they completed the specific handball throwing tests, consisting of ball speed (BS) in standing throw (ST) and jump throw (JT). All sessions were preceded by a warm-up (stationary bike, mobility exercises, and horizontal arm abduction using an elastic band). On days involving the bench press, participants also performed two sets of twelve and eight repetitions at 50% and 75% respectively of their one-repetition maximum (1RM). Correlation analyses were conducted aiming to analyze associations between the weight lifted in the 1RM test and the power generated in the acceleration and BPU tests with ball speed during ST and JT. Correlation coefficients were considered as strong, very strong and nearly perfect according to the Pearson's product-moment correlation coefficient (r = 0.5-0.69, 0.7-0.89, and 0.9-0.99, respectively). Additionally, a simple linear regression technique was used to evaluate the prediction level of the tests. Statistical significance was set at $p < 0.05$.

RESULTS: Strong associations were observed between ST together with 1RM (r = 0.67) along with BPU and ST (r = 0.60). Very strong associations were observed between ST and 30%1RM (r = 0.712) and 90% 1RM (r = 0.817), and between JT and 90% 1RM (r = 0.704). Linear regression analyses revealed that all the loads in the acceleration test can predict BS for ST: 30%1RM [$F(1,7) = 7{,}212$, $p < 0{,}05$; $R^2 = 0{,}363$]; 60%1RM [$F(1,7) = 6{,}818$, $p < 0{,}05$; $R^2 = 0{,}493$]; 90%1RM [$F(1,7) = 14{,}008$, $p < 0{,}05$; $R^2 = 0{,}667$]. Furthermore only the 90%1RM load was able to predict BS for JT [$F(1,7) = 6{,}860$, $p < 0{,}05$; $R^2 = 0{,}495$].

CONCLUSION: Our results reveal that it is possible to predict handball throwing performance by employing general tests aiming to assess upper-limb strength and power. Considering that these tests are highly reproducible, they can be used as assessment tools for athletes, thereby enabling the development of parameters for training, which can be useful for all coaches.

**INVESTIGATION OF THE INTRA AND INTER-DAY RELIABILITY OF THE ATHLETIC SHOULDER TEST USING THE WII BALANCE BOARD IN VOLLEYBALL PLAYERS**

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INTRODUCTION: The athletic shoulder test (IYT test) has been widely used to assess shoulder stability and strength in athletes, particularly in sports requiring overhead movements such as volleyball. Reliable measurements are crucial for both injury prevention and performance assessment. This study aims to evaluate the intra-day and inter-day reliability of the IYT test using the Nintendo Wii Balance Board (WBB) in volleyball players.

METHODS: Research Design

The study followed a prospective cohort design, measuring the reliability of the athletic shoulder test over two separate days. Measurements were taken at specified intervals, and both intra-day and inter-day reliability were assessed using the Wii Balance Board. The study adhered to the Helsinki Declaration guidelines, with ethical approval from Erzurum Technical University (Date: 06.06.2024, No: 7/13).

Participants

Twenty experienced volleyball players (age 14.48 ± 1.327 years) participated in the study. Inclusion criteria included no chronic health problems, no acute injuries, and at least 3 years of regular volleyball training. Exclusion criteria included acute neck or shoulder injuries, pain lasting over 20 minutes after the test, or an inability to assume test positions due to limited range of motion.

Athletic Shoulder Test (IYT Test)

Anthropometric measurements were taken using a stadiometer (0.01-meter precision) and a calibrated Weighing Digital Platform (0.01-kg precision). Participants performed the IYT test in a prone position with the forehead resting on a foam block. The Wii Balance Board (WBB) was used for data collection, connected to specialized software (IzWii) developed by İnce (2024b). The I test involved shoulder abduction to 180°, the Y test to 135°, and the T test to 90°, with full elbow extension in all positions. Force data from the WBB was recorded during the tests.

RESULTS: Intra-day reliability showed excellent consistency, with ICC values ranging from 0.908 to 0.969, while inter-day reliability also demonstrated strong results, with ICC values between 0.819 and 0.948. SEM values ranged from 1.996 to 6.781 N, indicating minimal measurement error, and MDC values ranged from 5.533 to 18.708 N, suggesting the test's ability to detect meaningful changes. Coefficient of Variation (CV) values were within acceptable limits, further supporting

the stability and consistency of the test. Overall, the IYT test showed good to excellent reliability for both intra-day and inter-day measurements in volleyball players.

CONCLUSION: The IYT test demonstrates excellent intra-day and inter-day reliability in volleyball players. The use of the Wii Balance Board as a measurement tool ensures accurate and consistent data collection, making it a valuable method for assessing shoulder function in athletes.

**LONGITUDINAL PRELIMINARY DATA ON CHANGES IN PHYSICAL FITNESS IN YOUNG FEMALE VOLLEYBALL PLAYERS**

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INTRODUCTION: Physical fitness (PF) has been identified as a critical health marker in youth and is significantly influenced by environmental factors, such as the specificity of training [1]. While sports participation generally enhances PF levels [2], the relationship between training, lifestyle behaviours and fitness improvements is complex and multifaceted [3]. Volleyball is one of the most played sports worldwide, particularly among women. Given the specific characteristics of the volleyball game, it is essential to understand how regular practice influences physical fitness over time. Therefore, this study aims to investigate changes in motor, muscular and cardio-respiratory PF of young female Portuguese volleyball players over a one-year period, after adjusting for age.

METHODS: A total of 51 female Portuguese volleyball players from the same club, aged 12 to 19, were sampled. The athletes practised volleyball for an average of 7.45 hours per week (SD: 0.27 hours), 47 of which as their single sport participation (92 percent). Two assessments were conducted: one at baseline and another at a one-year follow-up. PF was assessed using four tests: the hand-grip strength test (muscular fitness component, MFC), the three-minute step test (cardio-respiratory fitness component, CRFC), and the shuttle-run and 30-meter run tests (motor fitness component; MoFC). Analysis of covariance (ANCOVA) was used to examine yearly changes in PF across each test, with age included as covariate. Statistical analysis was performed using SPSS 29, with the significance level set at 5 per cent.

RESULTS: Over the one-year period, changes in the volleyball players' PF varied, depending on the PF component assessed and the test used. While the 30-meter run performance showed no significant changes ($p>0.05$), the shuttle-run test performance improved significantly ($F=7.056$, $p=0.011$, $\eta p2=0.13$). Athletes reduced their shuttle-run test times by -0.327 s (SE: 0.074 s; $p < 0.001$). Hand-grip strength also showed significant improvement ($F=7.545$, $p=0.008$, $\eta p2=0.13$), with an increase of 0.918 kgf (SE: 0.448 kgf; $p=0.046$). Finally, the CRFC did not change over a one-year period ($p>0.05$).

CONCLUSION: Young female volleyball players improved their PF over a one-year period, but dependant on component evaluated and test used on that regard. On performance-related PF, in the evaluation of this type of population, the shuttle run seems to be a better fit when evaluating the MoFC, than the 30-meter run. On health-related PF, though there was an improvement on the MFC, the lack of improvement in CRFC is concerning and warrants further investigation. Caution should be taken in the generalisation of this results given small-sample size overestimation risks.

1. Sgrò, F. et al. (2024)

2. Prat, I. et al. (2020)

3. Tabacchi, G. et al. (2019)

**THE INFLUENCE OF CIRCUIT TRAINING EXERCISE SEQUENCING ON LEG STRENGTH DEVELOPMENT IN YOUTH VOLLEYBALL ATHLETES**

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INTRODUCTION: Circuit training (CT) is widely recognized as an effective training method for athletes with limited equipment to enhance muscular endurance and general strength during the pre-season phase. Previous studies have demonstrated that an 8-week CT program can improve muscular strength and endurance in volleyball players. However, to date, no research has directly compared the effects of manipulating bodyweight exercise sequencing patterns for improving the general strength of youth volleyball players. This study aimed to compare the impact of a 6-week bodyweight CT program, using two different sequencing patterns, on leg strength in female youth volleyball players.

METHODS: Twenty-nine female volleyball players (mean age: 14 ± 1 years) were randomly assigned to either an IN-PLACE-CT group ($n = 15$) or a STAGE-CT group ($n = 14$), with both groups work-matched. Each CT program consisted of 12 exercises, performed for 20 repetitions across 3 total sets, three times per week. In the IN-PLACE-CT group, participants performed the exercises sequentially (from exercises 1 to 12) with 30 seconds rest between exercises and 3 minutes of rest between sets. In contrast, the STAGE-CT group completed each exercise in 3 sets, with 30 seconds of rest between sets, and 3 minutes of rest between exercises. During the 6-week training period, participants were instructed to maintain a consistent diet and adhere to their specific training program. Pre- and post-training assessments of knee extensor and knee flexor peak torque, and hamstrings-to-quadriceps (H/Q) ratio, were conducted using an isokinetic dynamometer at a velocity of 90 deg/sec for both the dominant and non-dominant legs.

RESULTS: After 6-weeks of training, the IN-PLACE-CT group showed a significant increase in peak torque of the knee extensors ($p < 0.001$) and flexors ($p < 0.001$) in the dominant leg, while only knee flexion peak torque increased in the non-dominant leg ($p < 0.001$). In the STAGE-CT group, a significant increase in peak torque was only observed for knee flexion in the non-dominant leg ($p = 0.011$). However, no significant between-group differences were found in peak torque at the

end of the training period. Similarly, the H/Q ratio did not differ between groups in either the dominant (p = 0.176) or non-dominant (p = 0.926) leg.

CONCLUSION: The programming of CT exercises, whether sequentially or in sets, did not result in a marked difference in leg strength between groups. However, the IN-PLACE-CT group led to significant pre-to-post test changes in knee extensor and flexor strength, particularly in the dominant leg. Therefore, our results suggests that the structure of bodyweight CT exercises may be an important consideration for optimizing the strength development of youth volleyball players. Based on our findings, IN-PLACE-CT may offer a more efficient approach for enhancing general strength in this population.

**EEG ANALYSIS OF NEUROMOTOR PROCESSES IN SUCCESSFUL SOCCER PENALTY KICKS: A PILOT INVESTIGATION**

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INTRODUCTION: Understanding the neuromotor processes underlying successful and unsuccessful performance in lower limb movements, such as football kicking, is essential for athletes. However, there has been a knowledge gap in research regarding whether higher activation of the prefrontal and central cortices that are associated with motor programming, such as motor planning and motor control, negatively influence motor performance in a difficult task. To address this issue, this pilot study aimed to investigate neuromotor processes in skilled football players performing penalty kicks under a difficult condition.

METHODS: 10 skilled football players were recruited and asked to perform 30 kicks under a difficult condition where the target size was adjusted to maintain a kicking success rate between 40% and 60% for each player while we recorded EEG data during motor preparation. Afterwards, EEG power in the 8-13 Hz frequency band was analyzed at frontal (Fz) and central (Cz) regions before action.

RESULTS: The manly results indicated that successful penalty kicks were associated with lower 8-13 Hz power at frontal and central regions before action, suggesting efficient neural activation for motor planning and control during motor preparation.

CONCLUSION: These findings support the model of attention allocation and the psychomotor efficiency hypothesis, aligning with similar neuromotor processes observed in golf studies that manipulate task difficulty. This underscores the importance of motor planning and control in successful athletic performance in lower limb movements.

**THE INFLUENCE OF MATURITY ON PLYOMETRIC TRAINING RESPONSES IN YOUTH SOCCER PLAYERS**

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INTRODUCTION: The role of biological maturation in the effectiveness of plyometric jump training (PJT) remains unclear, with studies suggesting that both pre- and post-peak height velocity (PHV) athletes may benefit from neuromuscular adaptations [1]. However, the impact of PJT on speed, power, reactive strength and stiffness may differ across maturation stages due to growth-related changes in muscle architecture, tendon properties, and motor control [2]. This study examines how plyometric training influences these performance attributes in adolescent soccer players, considering a dependence on maturity offset.

METHODS: This 12-week randomized controlled trial included 39 male soccer players (aged 10–17 years), categorized into pre-PHV and post-PHV groups using the Mirwald method. Participants were randomly assigned to either a PJT group, performing two weekly plyometric sessions, or a control group following standard soccer training. Performance was assessed pre- and post-intervention. Sprint speed (20 m sprint), change of direction (L-run), explosive power (countermovement jump (CMJ), broad jump), reactive strength (triple jump), reactive strength index (drop jump), and leg stiffness (20-hop test) were measured. A quadratic regression model was applied to relative performance changes to examine non-linear interactions with biological maturation. Regression analysis with linear and quadratic terms was used to analyse relationship between changes during training (Δ between pre- and post-test) and maturity offset.

RESULTS: PJT significantly improved sprint speed (p = 0.014) compared to the standard training with non-significant maturation dependence (p = 0.083). Leg stiffness significantly increased in the plyometric group (p < 0.001) with significant U-shape relationship on maturity offset (p = 0.048). The quadratic model showed that improvements in leg stiffness were less pronounced around PHV but more likely to occur at earlier or later maturity. CMJ height followed an reverse U-shape relationship, with the greatest relative improvements occurring near PHV and minimal changes at extreme maturity offsets (p = 0.041). Reactive strength, measured via the triple jump, showed a linear relationship (p = 0.046) on maturity offset, with greater improvements in less biologically mature athletes. The plyometric group also experienced a significant reduction in body fat (p = 0.003) compared to the standard training

CONCLUSION: Plyometric training enhances sprint speed, leg stiffness, and explosive power in adolescent soccer players, but its effectiveness varies non-linearly with biological maturation. Adaptations in leg stiffness were less evident near PHV, while CMJ height gains peaked around PHV. These findings emphasize the importance of maturity-specific plyometric training to optimize athletic development.

1. Ramirez-Campillo et al., 2023 2. Radnor et al., 2018

**DESCRIPTIVE ANALYSIS ON INJURIES IN YOUTH ELITE FEMALE SOCCER PLAYERS.**

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INTRODUCTION: Soccer is a widely practiced sport among young female athletes, but it also presents a high risk of injuries that can impact their careers and the prevention of future injuries. Understanding the role of the first injury, its mechanism, and its potential influence on subsequent injuries is crucial for developing effective prevention strategies and screening tests. The aim of the study is to describe the first injury and to investigate whether it plays a role in subsequence injury.

METHODS: This study is a retrospective cohort study designed to investigate the first injury in elite young female soccer players. Data were collected using a questionnaire distributed to 137 athletes from the U15, U17, and U19 categories of several professional Italian teams.

RESULTS: 110 (80.3%) athletes reported experiencing at least one injury. The first injury occurred at a mean age of 13.2±2.1 years and in 104 (94%) athletes who have been practicing soccer for more than 4 years.

Findings indicate that most injuries occurred through a non-contact (NC) mechanism (56%) compared to a contact (C) mechanism (44%). The main locations of the first injury were the knee joint (31%) and the ankle (29%) and the principal reported injury types were ligament (29%), muscle (21%) and tendon (13%).

Regarding the injury mechanism involving the most affected joints of the knee and ankle, NC injuries account for 68% and 38%, while C injuries account for 32% and 62%, respectively. Following the first knee injury, six athletes sustained an ACL rupture, with 83% occurring through a NC mechanism and 17% through a C mechanism.

Considering athletes who experienced their first injury at the knee or ankle (n=66) and analyzing the second injury, the most affected anatomical areas were the ankle (29%) and the knee (15%). NC injuries occurred in 32% of cases at the ankle and 64% at the knee, while C injuries accounted for 68% and 36%, respectively. Following the second injury, a total of five athletes sustained an ACL rupture. Among them, 60% had their first injury at the ankle and 40% at the knee. Additionally, 67% and 50% of these injuries, respectively, occurred without direct contact.

CONCLUSION: This study highlights the prevalence of injuries among elite young female soccer players, with NC mechanisms being the most common, particularly in knee injuries. ACL ruptures were strongly associated with NC mechanisms, suggesting a potential pattern in injury recurrence. The findings emphasize the need for targeted prevention strategies focusing on neuromuscular training and biomechanical assessments to reduce the risk of severe NC injuries. Future research with larger cohorts and prospective designs should be conducted to establish cause-and-effect relationships between the mechanism and anatomical location of the first injury and subsequent ones to enhance injury prevention programs.

## Conventional Print Poster Presentations

### CP-AP18 Power and Strength I

**IMPACT OF THE MENSTRUAL CYCLE PHASE ON BARBELL VELOCITY IN A MULTI-EXERCISE VELOCITY-BASED STRENGTH TRAINING**

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INTRODUCTION: Most studies investigating the effects of different menstrual cycle phases on maximal strength have focused on maximal performance tests (e.g., 1RM tests). However, the influence of the menstrual cycle on performance in more practical, real-world settings, such as training sessions utilizing submaximal loads (%1RM), remains largely unexplored. This study aimed to investigate the effect of the menstrual cycle on strength performance variables during a velocity-based strength training session.

METHODS: Twenty healthy, young, naturally menstruating women with strength training experience completed three identical velocity-based strength training sessions. These sessions were conducted during three distinct phases of the same menstrual cycle: (a) early follicular, (b) pre-ovulatory, and (c) mid-luteal. These menstrual cycle phases were individually determined using a combination of procedures, including a mobile application that tracked menstruation onset for four months prior, as well as continuous monitoring of body temperature and body weight throughout an entire menstrual cycle. During each strength training session, participants performed two sets of six repetitions at 80% 1RM in the semi-squat, bench press, deadlift, and barbell row exercises. They were instructed to execute each repetition at maximal velocity. Barbell velocity values for each repetition were recorded using a rotary encoder. The rating of perceived exertion (RPE) was measured at the end of the strength training session. A two-way analysis of variance (ANOVA; 2×12, menstrual cycle × repetition) was conducted to compare the effects of the menstrual cycle phase in each exercise (one-way ANOVA for RPE values). A Bonferroni post hoc analysis was performed when a significant F-value was detected.

RESULTS: There was a main effect of the menstrual cycle on mean velocity during semi-squat (F= 4.91, P= 0.01), and bench press (F= 5.91, P< 0.01), with no effects on deadlift (F= 2.98, P= 0.06) and barbell row (F= 2.17, P= 0.13). The post hoc analy-

sis revealed that for semi-squat exercise, mean velocity was lower during the early follicular than pre-ovulatory (0.36±0.10 vs 0.39±0.11 m/s, P=0.02) and luteal (0.40±0.10, P< 0.01). Likewise, mean velocity was lower during early follicular than pre-ovulatory (0.29±0.10 vs 0.31±0.10 m/s, P=0.01) and luteal (0.31±0.10 m/s, P< 0.01) during the bench press exercise. Finally, there was a main effect of the menstrual cycle on RPE (F = 15.56; P < 0.01) which was higher in the early follicular phase with respect to the preovulatory phase (P < 0.01;) and the mid-luteal phase (P < 0.01).

CONCLUSION: These findings suggest that barbell mean velocity may decrease, while RPE values increase, during velocity-based strength training in the early follicular phase compared to the pre-ovulatory and mid-luteal phases. This information could be valuable for strength and conditioning professionals working with women to optimize strength training sessions across the menstrual cycle.

**PHASE ANGLE AND PHYSICAL FITNESS IN ADOLESCENT GIRLS: ASSOCIATIONS WITH STRENGTH, POWER, AND AGILITY**

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INTRODUCTION: Phase Angle (PhA), derived from bioelectrical impedance analysis as the arctangent value of the ratio of Xc (reactance) to R (resistance) (Martins et al., 2023). PhA, in fact, is considered an indicator of cellular integrity and muscle quality (Ballarin et al., 2022). Its association with physical fitness parameters such as muscular endurance, power, and agility in adolescent is unclear and, in particular, in girls samples is not well established (Akamatsu et al., 2022). This study aims to investigate the relationships between PhA and key physical fitness components, identifying its potential role as a predictor or affecting the performance in this population.

METHODS: A total of adolescent girls 65 (mean age 12.52) were evaluated for core endurance (sit-ups), lower-limb power (Sargent vertical and standing broad jump [SBJ]), and agility (using T-agility test). PhA and anthropometric variables (i.e. weight, height and waist circumference) were also measured in different and dry location. The biological maturation was determinated as the menarchal status (age). Stepwise regression analysis was conducted to identify predictors of physical performance while ANOVA was used to assess differences among PhA quartiles.

RESULTS: Stepwise regression identified PhA as a significant predictor of sit-ups (adj $R^2$ = 0.274), Sargent jump (adj $R^2$ = 0.21), T-agility test (adj $R^2$ = 0.273), and SBJ (adj $R^2$ = 0.297). Waist circumference and fat mass (FM) also contributed to Abalakov, t-test, and SBJ performance. ANOVA revealed significant differences across PhA quartiles. Post-hoc analyses showed that girls in the highest quartile (Q4) outperformed those in Q1 in agility (p = 0.009), power (p = 0.003), and muscular endurance (p = 0.026), with notable Q1-Q4 differences. The stratification according to manarchal tempo did not show any significant differences (adj R2 =0.274).

CONCLUSION: PhA is positively associated with strength, power, and agility in adolescent girls, suggesting its potential role as a functional marker of physical fitness. These findings highlight the importance of considering PhA in athletic performance assessments and during the plan of training periodization because we can included the biological condition of people within the training progression.

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**DIFFERENCES IN MINIMUM VELOCITY THRESHOLD AMONG ATHLETES OF SIMILAR LEAN BODY MASS, BUT DIFFERENT TRAINING BACKGROUND**

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INTRODUCTION: Powerlifters have the lowest minimum velocity threshold (MVT) among strength trained individuals [1]. This may be related to either neural adaptations or the size of the lean body mass (LBM). The aim of the study was to investigate the relationship between MVT and LBM among experienced athletes who have similar lean body mass but train with either high or low external loads.

METHODS: Nine powerlifters (height 1.77 ± 0.05 m, age 29.62 ± 7.54 years, body mass 92.52 ± 13.37 kg, resistance training experience 8.00 ± 2.39 years, competition experience 1.81 ± 1.80 years) and eight experienced gym trainees (height 1.85 ± 0.05 m, age 23.54 ± 4.64 years, body mass 89.31 ± 13.14 kg, resistance training experience 6.50 ± 4.11 years) participated in this study. Data collection occurred over three sessions. In the first session, maximum strength (1RM) was evaluated for the squat (SQ), bench press (BP), and deadlift (DL). In the second session, lean body mass (LBM) was assessed using dual-energy X-ray absorptiometry (DXA). In the third session, the force-velocity relationship was analyzed using external loads corresponding to 30%, 50%, 60%, 70%, 80%, 90%, and 100% of athletes' 1RM in each exercise. Statistical analysis included descriptive statistics, independent sample t-tests, and Pearson's r correlation coefficient (p < 0.05).

RESULTS: No significant differences in LBM were observed between the groups (p > 0.05). Powerlifters had a 36% higher performance in the total lift sum than the other group (p < 0.05). The MVT was 37% lower in powerlifters' DL (p = 0.033). No significant differences were observed in MVTs of SQ and BP between the groups (p > 0.05). In powerlifters, only MVT in SQ

was positively correlated with total and arms' lean mass ($r = 0.67$-$0.69$, $p \leq 0.05$). In experienced gym trainees, only MVT in DL was positively correlated with total, arms' and trunk's lean mass ($r = 0.77$-$0.82$, $p < 0.05$). When all participants considered as one group, only MVT in SQ was positively correlated with trunk's LBM ($r = 0.495$, $p = 0.043$).

CONCLUSION: In conclusion, according to the results of the present study, it seems that LBM is not consistently related to MTV, and it seems that the correlations between MTV and LBM depends on the exercise and on athletes' training background. Thus, it may conclude that LBM has only a minor impact on MTV, and other physiological factors, such as the function of neural system may determine MTV.

1. Helms et al. (2017)

**PERFORMANCE AND NEUROPHYSIOLOGICAL RESPONSES TO DECEPTION AND WITHHOLDING INFORMATION DURING THE BENCH-PRESS EXERCISE**

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INTRODUCTION: Deception and withholding information have both been shown to impact performance outcomes, regulation of pacing strategies, and neurophysiological responses. Although these approaches are used in a range of training and competition settings, previous research has focused on endurance exercise, leaving the context of resistance exercise unexplored. This study examined the effect of deception and withholding lifting load information on performance and neurological and physiological responses during to-failure resistance exercise.

METHODS: Ten moderately trained, regular gym attendees completed five sessions containing two sets of bench presses with concealed resistances. Set one was performed at 60% of one repetition maximum (1RM) and deemed the control (18 ± 2 repetitions). During set two, participants completed as many repetitions as they could during one of five randomly assigned conditions: 60% of 1RM with correct information provided (CONT), a misleading 10% increase (DEC-A) or a misleading 10% decrease (DEC-B), or no information provided while lifting 70% of 1RM (WITH-A), or lifting 50% of 1RM (WITH-B). Throughout sets one and two, pre-frontal cortex oxygenation (oxyhemoglobin (O2Hb), deoxyhemoglobin (HHb) normalised tissue haemoglobin index (nTHI)), and triceps, pectoralis major and anterior deltoid muscle activation (EMG) were recorded. Immediately after each set, heart rate (HR), rating of perceived exertion (RPE), and number of successful repetitions were recorded.

RESULTS: Total repetitions lifted were higher in WITH-B ($p=0.001$) and less in WITH-A compared to CONT ($P=0.001$). DEC-A and DEC-B repetitions were lower compared to CONT ($p=0.001$ - $0.019$). Post-set RPE was higher in WITH-A ($P=0.007$) and lower in WITH-B compared to CONT ($P=0.049$). Prefrontal cortex HHb levels were significantly higher in set 2 during WITH-A and DEC-A, while lower in WITH-B and DEC-B at various intervals ($P= 0.007 – 0.033$). Muscle activation in both muscles and HR were not significantly different within or between conditions ($P>0.05$).

CONCLUSION: These findings indicate that deception of load during to-failure exercise can impact performance, however, changes in repetitions to failure when withholding information were reflective of changes in load. The changes in RPE appear to be reflective of load despite load information being withheld and may suggest some conscious contribution to workload. Neural activity also indicates greater activity in the pre-frontal cortex when athletes are deceived or are completing work at a higher load. Understanding how athletes respond to information delivery formats may provide useful insights for training and testing practices to maximise performance and manage neurophysiological and perceptual responses.

**MUSCLE ACTIVITY OF AGONIST AND ABDOMINAL MUSCLES DURING RESISTANCE EXERCISE WITH ASYMMETRICAL LOADS**

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INTRODUCTION: The abdominal muscles, particularly the deep muscles such as the internal oblique and transversus abdominis, play a crucial role in stabilizing the trunk, maintaining posture in response to external perturbations, and enabling the limbs to generate significant force. Therefore, developing effective training methods for the abdominal muscles, including the deep muscles, is essential for improving quality of life and sports performance. One such training method involves performing resistance exercises in an unstable environment using specialized equipment (e.g., sling-based push-ups, Maeo et al. 2014; Kohiruimaki et al. 2019) or using free weights with asymmetrical loads (e.g., asymmetrical bench press, Saeterbakken et al. 2020). However, it is beneficial to propose a more practical and safer method for implementation. Therefore, this study examined the muscle activity of agonist and abdominal muscles during resistance exercise using a conventional machine performed with asymmetrical versus symmetrical loads.

METHODS: Fifteen healthy young men performed chest presses using a chest press machine (Life Fitness) under four different load conditions combining 30% and 70% of their one-repetition maximum (1RM) load: two symmetrical (Right-Left: R30-L30, R70-L70) and two asymmetrical (R30-L70, R70-L30) conditions. Muscle activity during the exercise was measured from the pectoralis major, lateral head of the triceps brachii, rectus abdominis, and internal oblique on both sides (eight muscles in total) by using surface electromyography (EMG). The EMG values were normalized to those obtained during maximal voluntary contractions of each muscle (% EMGmax).

RESULTS: Muscle activity of the agonist muscles (pectoralis major and triceps brachii) was higher with a higher load in all conditions (e.g., right pectoralis major, 37.3% vs 76.2% [2.0-fold] in R30-L30 vs R70-L70, $p<0.001$). On the other hand, the

muscle activity of the abdominal muscles was the highest in the lower load side of the asymmetrical conditions, and this was prominent in the internal oblique (e.g., right internal oblique, 10.7% vs 26.4% [2.5-fold] in R70-L70 vs R30-L70, P<0.001).

CONCLUSION: The internal oblique muscle activity was the highest in the lower load side of the asymmetrical conditions even compared to when lifting a higher load under symmetrical conditions, despite the lower total weight lifted. This supports the notion that the internal oblique plays a crucial role in stabilizing the trunk and suggests that its activity is specifically enhanced during exercises performed in an unstable environment. Thus, performing resistance exercises using a conventional machine with asymmetrical loads may serve as a practical and safe training method to strengthen the deep abdominal muscles.

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**3RM AND 10RM BACK SQUAT PROTOCOLS PROMOTE DIFFERENT BRAIN OXYGENATION RESPONSES**

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INTRODUCTION: Motor tasks are intricately associated with the prefrontal cortex (PFC), which is crucial for decision-making during physical activities (De Watcher et al., 2021; Orcioli-Silva et al., 2024). The capacity to sustain exercise relies on sufficient cerebral blood flow and oxygen delivery. Participating in physical exercises significantly boosts the brains oxygen consumption compared to resting states (Teo et al., 2023; Orcioli-Silva et al., 2024). Notably, resistance training involves different loads that trigger distinct physiological adaptations. Our study aim was to analyze cerebral hemoglobin (Hb) consumption during two maximal protocols in the back squat exercise.

METHODS: Sixteen men (27.5±5.1 years; 76.4±4.1 kg; 1.74±0.02 m) performed 3 (3RM) and 10 (10RM) repetitions until failure in back squat, with 72 h of rest between them randomly. PFC response was analyzed by near-infrared spectroscopy to measure the concentration of oxygenated Hb (O2Hb), deoxygenated Hb (HHb), total Hb (tHb), and tissue oxygenation index (TOI). In both the 3RM and 10RM protocols, the initial and final repetitions were examined to understand the PFC responses throughout these efforts.

RESULTS: The O2Hb was notably higher in the 3RM protocol compared to 10RM, both at the first (14.1±3.3 µmol/L vs. 5.3±3.9 µmol/L) and last repetition (19.1±6.2 µmol/L vs. 7.4±6.2 µmol/L). Likewise, O2Hb showed an increase in the final repetition compared to the initial one for both protocols (p<0.05). No significant differences were observed in HHb and TOI between the protocols.

CONCLUSION: In conclusion, as fatigue accumulated during both 3RM and 10RM protocols, O2HB progressively increased. This rise was more pronounced with heavier loads, becoming evident from the first repetition.

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**BILATERAL DEFICIT OCCURS IN KNEE FLEXION BUT NOT IN KNEE EXTENSION**

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INTRODUCTION: The bilateral deficit (BD) is the phenomenon that the force produced during simultaneous maximal contractions of both limbs is lower than the sum of the force produced by the left and right separately (Howard and Enoka, 1991). BD has been shown to be present in various, but not all, exercise tasks and is thought to influence training outcomes (Zeleznik et al., 2022). Thus, it is important to clarify whether BD occurs or not in exercises of interest. BD is reported to be greater in lower body than upper body exercises (Skarabot et al., 2016). However, there is large variability among studies targeting the lower body in the magnitude of BD, likely because different exercise tasks were chosen across studies. In addition, the magnitude of BD may be influenced by the posture even in the same exercise task (Magnus and Farthing., 2008). Thus, the purpose of this study was to investigate whether BD occurs in two commonly performed lower body resistance exercises, knee extension and flexion, with two postures for each exercise.

METHODS: Ten untrained healthy young adults participated in this study. Bilateral and unilateral one-repetition maximum (1RM) were measured for both legs in two postures of Knee extension (seated and supine, hip flexion angle of 80 and 0

deg) and two postures of Knee flexion (seated and prone, hip flexion angle of 80 and 30 deg). In addition, we calculated the bilateral index (BI (%) = bilateral / (right unilateral + left unilateral) *100-100) to quantify the magnitude of BD.

RESULTS: Bilateral force production was not significantly different from the sum of unilateral force production in two postures of knee extension (bilateral vs the sum of unilateral: seated, 133.2 ± 13.8 kg vs 131.1 ± 23.5 kg, P = 0.746, Cohen's d = 0.106, BI = 3.46%; supine, 117.9 ± 19.1 kg vs 121.4 ± 21.8 kg, P = 0.155, Cohen's d = 0.491, BI = -2.51%). On the other hand, bilateral force production was significantly lower than the sum of unilateral force production in two postures of knee flexion (seated, 92.1 ± 9.5 kg vs 110.8 ± 13.9 kg, P < 0.001, Cohen's d = 1.648, BI = -16.50%; prone, 50.9 ± 7.8 kg vs 55.5 ± 9.5 kg, P < 0.001, Cohen's d = 1.012, BI = -7.93%). In addition, BI was significantly lower (i.e. BD was greater) for seated knee flexion than the other three conditions (P ≤ 0.004) and for prone knee flexion than seated knee extension (P = 0.038).

CONCLUSION: These results suggest that the bilateral deficit occurs in knee flexion, particularly when performed in the seated position, but not in knee extension regardless of the posture.

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**POST-ACTIVATION PERFORMANCE ENHANCEMENT DOES NOT REDUCE VELOCITY LOSS IN MULTIPLE SETS OF BACK SQUATS COMPARED TO A TRADITIONAL WARM-UP**

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INTRODUCTION: Warm-up strategies are widely used to enhance performance [1]. Post-activation performance enhancement (PAPE) involves a high-intensity conditioning activity (CA) [2] that mimics the main task and may improve short-duration, high-velocity actions [3,4]. Since velocity decline indicates fatigue in sets to failure [5], it is unclear whether PAPE can counteract this effect. Velocity-based training uses 10–20% velocity loss for strength and 30–40% for hypertrophy [6,7], but no evidence links PAPE to repetition volume across these thresholds. This study aimed to determine if PAPE delays fatigue-induced velocity loss compared to a general warm-up.

METHODS: Twenty strength-trained participants (5 women and 15 men; 23.9 ± 3.6 years; 3.9 ± 2.7 years of training experience) completed three warm-up protocols on randomized days: (1) General Warm-Up (GW): 5 minutes of treadmill running, 2.5 minutes of stretching, and 10 back squats at 50% of one repetition maximum (1RM); (2) Conditioning Activity (CA): 3 back squats at 85% of 1RM; and (3) Combined (GWCA): GW followed by CA. After completing the warm-up, participants performed three sets of squats to failure at 75% of their 1RM, with individualized recovery intervals. A linear encoder was used to velocity measurements during the concentric phase of the movement. Mean velocity (MV), peak velocity (PV), initial (MVi, highest of the first two reps) and final (MVf, last valid rep) values were recorded per set, along with averages across sets. Repetitions performed before reaching 10%, 20%, and 30% velocity loss thresholds were assessed by the encoder. Repeated measures ANOVA were performed.

RESULTS: The were no significant differences in MV loss (p=0.312) among the three protocol sets mean values. PV for GWCA and GW was significantly different to CA between protocols in the mean of the three sets (p=0.016). Regarding the PV values of the separate sets, there was a set effect (p<0.01), with no effect of protocol (p=0.359) or interaction set*protocol (p=0.787). For MVi and MVf, there was a significant effect of the moment (p<0.01), but no protocol effect (p=0.438) or interaction with the sets (p=0.865). The only statistically significant difference was observed between the GW and GWCA protocols at the repetitions performed before reaching 10% threshold in the second set (p=0.019).

CONCLUSION: PAPE does not reduce velocity loss in sets to failure compared to GW and PAPE does not affect the number of repetitions performed before different velocity loss thresholds compared to GW. With caution, we could speculate that PAPE may help maintain repetition numbers across multiple sets when velocity is sustained up to a 10% loss threshold, which in velocity-based strength training is typically used for strength and power-focused training.

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**EFFECTS OF A DETRAINING PERIOD AFTER A RESISTANCE TRAINING INTERVENTION WITH DIFFERENT VELOCITY LOSS THRESHOLDS ON STRENGTH GAINS AND JUMP PERFORMANCE**

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INTRODUCTION: Velocity loss (VL) is established as a valid indicator to determine the level of effort attained during resistance training (RT) (1). In long-term adaptations, it is well known that a low-to-moderate VL threshold optimizes strength gains and vertical jump performance (2). However, there are no available data on the residual effects of VL on strength gains after a detraining period. Therefore, the aim of this study was to compare the effects of two RT programs with differ-

ent VL thresholds (i.e., 20% vs. 40%) on strength gains and jump performance after an RT intervention and a detraining period.

METHODS: Forty-four physically active men followed an 8-week RT program based on the full-squat (SQ) exercise (16 sessions). Subjects were randomly allocated into the two intervention groups that differed in the VL attained within the set (VL20: 20%; VL40: 40%). The relative intensity (65-80% 1-RM), inter-set recovery (4 minutes), and number of sets (3) were matched for both groups in each training session. The performance was evaluated on three occasions: pre-training (PRE), post-training (POST), and after 3 weeks of the detraining period (DET). The following battery of tests was performed in each testing session in the subsequent order: 1) countermovement jump (CMJ), 2) progressive loading SQ test, and 3) fatigue SQ test. The performance variables were: 1) CMJ height; 2) 1RM; 3) mean propulsive velocity (MPV) achieved with the common absolute loads performed at PRE (AV); 4) MPV achieved with the common absolute loads lifted faster than 1 m·s-1 at PRE (AV≥1), 5) MPV achieved with the absolute loads displaced slower than 1 m·s-1 at PRE (AV<1), 6) number of repetitions completed in the fatigue test (MNR).

RESULTS: Significant main "time" effects were found for all performance variables analysed. However, no significant "group x time" interactions were observed. Both groups significantly improved strength performance against different loads (i.e., 1RM, AV, AV≥1, and AV<1), without significant differences between them. Only VL40 significantly increased CMJ height at POST ($p = 0.002$). Likewise, VL40 achieved significantly higher performance in AV, AV≥1, CMJ, and MNR than VL20 at DET

CONCLUSION: Despite the VL40 experiencing a higher level of effort within the set, both groups achieved similar strength-derived adaptations after an RT intervention. However, the VL40 group maintained better strength and jump performances after a detraining period, suggesting that accumulating higher volume and fatigue levels during an RT intervention could result in longer residual benefits on strength performance.

## Conventional Print Poster Presentations

### CP-AP21 Football

**ISOKINETIC ASSESSMENT OF THE KNEE JOINT EXTENSORS AND FLEXORS OF PROFESSIONAL SOCCER PLAYERS**

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INTRODUCTION: Muscle strength is a key factor in soccer, closely linked with performance and injury prevention (1). One of the most frequent test used to evaluate muscle strength in the limb is the isokinetic test for knee flexors and extensor (2). The aim of this study is to provide additional data to integrate normative values set for the stregth profile of the thigh in professional soccer players.

METHODS: In 2024 at the beginning of the soccer season isokinetic tests were perfomed on 14 professional soccer players from Rimini Football Club first team using a dynamometer (Isomove, TecnoBody, Dalmine, Italy). Specifically, we selected the knee flexors isokinetic strength test and knee extensors isokinetic strength test, both of which were perfomed bilaterally.

The angular velocities used for the tests were 90°/sec and 180°/sec to obtain a more complete strength profile. The players were required to perform three maximal concentric contraction at 90°/sec to test maximal strength and ten maximal concentric contraction at 180°/sec to test muscle endurance.

Peak torque (in Newton meter, Nm) and conventional hamstring to quadriceps ratio (H:Q ratio) were recorded for both angular velocities. The Limb simmetry index (LSI) was calculated for the peak torque values.

RESULTS: The mean peak torque for the right and left limbs at 90°/sec was as follows: 152,1 Nm and 150,8 Nm for hamstring, 203,7 Nm and 209,1 Nm for quadriceps. Considering LSI, only three players had an LSI<90% for flexors and only two players had an LSI<90% for extensors. No players had a H:Q ratio >0,60 (3).

At 180°/sec the mean peak torque for the right and left limbs was 113,1 Nm and 110,5 Nm for hamstring, 142,8 Nm and 147,8 Nm for quadriceps. In this test five players shown an LSI<90% for both flexors and extensors. The H:Q ratio was >0,60 at this angular velocity as well.

CONCLUSION: This preseason evaluation showed better LSI results at the lower angular velocity and valid flexors peak torque values when considering the conventional H:Q ratio for the entire sample. Monitoring these values throughout the season enables club staff to identify and study potential correlations with player performance levels and injuries.

**FOOTBALL PERFORMANCE MONITORING: INSIGHTS FROM A NATIONWIDE SURVEY OF ITALIAN FITNESS COACHES**

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INTRODUCTION: Tracking and evaluating football players performance is fundamental to improving their training regimens and mitigating injury risks. Fitness coaches play a crucial role in employing effective monitoring strategies across different levels of competitive football, including professional, amateur, and youth categories. However, disparities in the adoption and perceived effectiveness of monitoring methods in Italian football remain underexplored. This study aims to

assess the perspectives of fitness coaches on external and internal load monitoring, recovery evaluation, and injury prevention approaches.

METHODS: A total of 401 certified fitness coaches participated in an online survey conducted between April and May 2024. Participants were drawn from mens professional teams (Serie A-B, Serie C-D), amateur football, youth divisions (Professional-Club, Amateur-Club), and womens football (analyzed as a single cohort due to sample size constraints). Responses were considered valid if at least 60% of participants per subgroup completed the survey. Chi-square tests were performed to analyze subgroup differences ($p < 0.05$). The prevalence of different monitoring techniques was categorized as trivial (0–20%), small (20–40%), moderate (40–60%), large (60–80%), very large (80–90%), or huge (90–100%).

RESULTS: The study revealed that external load monitoring tools, such as GPS, were widely utilized in mens Serie A-B and Serie C-D teams (both 52%) and were predominant in womens teams (87%). Key performance indicators included total distance covered (69%), speed thresholds (60–86%), and acceleration/deceleration patterns (62–69%). Internal load monitoring, specifically the session rate of perceived exertion (S-RPE), was highly prevalent, particularly in womens teams (64%) and youth teams (81%). Injury prevention methods predominantly focused on previous injury management (95–97%), load modulation (68–73%), strength and conditioning protocols (64–72%), and recovery strategies (63–66%). Variations in training methodologies emerged based on age, gender, and training flexibility.

CONCLUSION: The study identifies significant differences in monitoring practices between various football levels. Professional teams favor GPS-based monitoring, whereas subjective assessment tools are more common in amateur and youth football. These findings emphasize the necessity for customized monitoring strategies and improved resource allocation, particularly in sectors with limited access to advanced tracking technology. Additionally, observed gaps in fitness coaches knowledge highlight the need for updated certification programs to better align with contemporary football performance demands.

**DETERMINATION OF PURE MAXIMAL GLYCOLYTIC RATE AMONG DIVERSE POSITIONS IN HIGHLY TRAINED FOOTBALL PLAYERS**

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INTRODUCTION: Football matches involve a variety of movements that occur at a wide range of exercise intensities. Aerobic performance plays a dominant role in the football match, accounting for about 90% of the total football match duration. However, crucial moments, such as scoring goals, require maximal sprints. These powerful actions rely on phosphagen and glycolytic energy systems to meet their high metabolic demands. Due to the various match strategies, each player faces different movements and metabolic demands based on their position. Therefore, this study aimed to compare metabolic demands, including pure maximal glycolytic rate ($P\nu La.max$), maximal oxygen uptake (VO2max), energetic contributions, and lactate thresholds (LTs) among different positions in highly trained football players.

METHODS: Thirty male highly trained football players participated in this study. Three position groups of forwards (n =10), midfielders (n =10), and defenders (n =10) were separated. All participants performed a 10-s all-out sprint test. During the sprint test, oxygen uptake (VO2peak) and blood lactate concentrations (resting La–, peak La–, and ΔLa–) were measured. These parameters were used to calculate three energy system contributions in kilojoules (kJ) and percentages (%) (phosphagen; WPCr, glycolytic; WGly, and oxidative; Woxi) and $P\nu La.max$. Furthermore, VO2max, LT1, and LT2 were determined during incremental ramp and step tests on a motorized treadmill, respectively.

RESULTS: Values of peak La–, ΔLa– and WGly in kJ, and $P\nu La.max$ were significantly lower in the group of midfielders than in the groups of forwards and defenders ($p = 0.0024$, 0.0015, 0.0030, and 0.0068, respectively). These parameters between forwards and defenders indicated no significant difference ($p > 0.05$). In addition, values of VO2max and LTs showed no significant differences among different groups ($p < 0.05$).

CONCLUSION: Our study outcomes revealed differences in glycolytic demands among position-specific football players during a 10-s maximal sprint test. Forwards and defenders demonstrated higher values of $P\nu La.max$ and WGly compared to midfielders. This higher glycolytic performance in forwards and defenders may support their ability to execute powerful actions, such as scoring goals during football matches. Consequently, football players require position-specific training sessions, such as repeated sprint training, which may improve explosive sprint performance and support successful performance at competitive moments.

**INTER-LIMB ASYMMETRIES IN EVOKED KNEE EXTENSION STRENGTH EXACERBATE MUSCLE FATIGABILITY IN YOUNG AND ADULT PROFESSIONAL SOCCER PLAYERS**

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INTRODUCTION: Inter-limb strength asymmetries and muscle fatigability are both suggested to be risk factors for non-contact related injuries (1), but they are rarely studied in conjunction. Large inter-limb asymmetries negatively affect change of direction (COD) and sprint but not jumping performance (2). However, little is known about the impact of strength asymmetries on muscle fatigability during soccer-specific tasks, such as CODs. The aim of this study was to compare the amount of muscle fatigability across a repeated COD test among soccer players with different degrees of asymmetries in evoked knee extension strength.

METHODS: A total of 3458 evaluations were conducted on 497 young (age: 17±1 yrs; weight: 72±7 kg; height: 181±6 cm) and 619 adult professional soccer players (age: 25±5 yrs: weight: 78±7 kg; height: 182±6 cm). Each player executed at least once (range: 1-25) an intermittent rectangular running test with multiple CODs over 8 m, consisting of four intensity levels. After each level, right and left knee extensors were electrically stimulated in resting isometric conditions to evoke a twitch response, from which peak twitch (PT) torque after the first (PT1) and fourth (PT4) levels as well as the highest absolute PT value (PTmax) were recorded for both sides. Percent asymmetries were calculated as (stronger-weaker)/stronger*100.

Players were then arbitrarily allocated to specific groups according to their degree of asymmetry (LOW: ≤5%, MID: 5-15%, HIGH: >15%). Muscle fatigability was calculated as the mean percent decline from PTmax to PT4 (PTdec). A linear mixed model was used to calculate estimated marginal means (±SE) and to detect differences among groups in PTdec. Effect sizes were expressed as Cohen's d. Significance was set at $p<0.05$.

RESULTS: When considering PT1, HIGH showed higher fatigability than LOW (PTdec: -31±1% vs -29±1%; $p=0.014$; d = -0.13, trivial). When considering PT4, HIGH showed higher fatigability than both LOW (PTdec: -34±1% vs -24±1%; $p<0.001$, d = -0.69, moderate) and MEDIUM (PTdec: -25±1%; $p<0.001$, d = -0.65, moderate).

CONCLUSION: The main finding of this study was that professional soccer players with larger asymmetries in evoked knee extension strength during repeated CODs displayed higher levels of muscle fatigability, and vice versa for players with smaller asymmetries.

**PERFORMANCE TESTING IN ITALIAN FOOTBALL: CURRENT PRACTICES AND LIMITATIONS OF CERTIFIED FITNESS COACHES**

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INTRODUCTION: Player testing is a key component of athletic preparation in both elite and amateur football. However, its implementation can be influenced by coaches' knowledge and contextual factors across different teams. This study examines the perspectives of Italian fitness coaches on testing methods in professional men's (Men), women's (Women), and youth (Youth) football. The objective is to evaluate the effectiveness, challenges, and real-world application of physical performance testing in these contexts.

METHODS: Between April and May 2024, an online survey collected 401 responses from certified Italian fitness coaches (239 Men, 23 Women, 139 Youth). Items were analyzed if at least 60% of participants per group responded. Subgroups included Men: Serie A-B, Serie C-D, and Amateur; Youth: Professional and Amateur; Women: a single group due to the small sample size. Chi-square tests ($P < 0.05$) were conducted for subgroup differences, and response incidence was categorized as Trivial (0–20%), Small (20–40%), Moderate (40–60%), Large (60–80%), Very Large (80–90%), and Huge (90–100%).

RESULTS: During the previous season, 84% of Men's teams, 96% of Women's teams, and 83% of Youth teams conducted testing sessions. Testing was mainly performed pre-season (68% Men Serie A-B, 62% Men Serie C-D, 61% Women, 62% Youth). Fitness coaches found testing useful for assessing physical capacities (85% Men, 87% Women, 96% Youth), post-injury rehabilitation (89% Men, 91% Women, 94% Youth), and return-to-play readiness (79% Men, 90% Women, 83% Youth). The most commonly used tests were: 45-15 Intermittent Test for endurance (68%, Men Serie C-D), 5-30m Sprints for maximal speed (64% Women, 67% Youth), Jump-Based Tests for strength and power (66% Youth Amateur). However, resource constraints were found in Men's Serie C-D (65%), Amateur (68%), and Youth Amateur (79%) teams.

CONCLUSION: This study underscores the widespread use of performance testing among certified Italian fitness coaches, while revealing critical resource limitations, particularly in amateur and youth settings. The findings highlight the necessity for context-specific testing protocols and increased resource allocation to optimize player development. Additionally, these insights emphasize the need for enhanced educational programs that equip fitness coaches with the latest methodologies and evidence-based practices in performance assessment. Continuous updates to training curricula and professional development pathways can help bridge existing knowledge gaps and ensure that testing strategies are effectively adapted to various competitive levels.

**ANALYSIS OF THE IMPACT OF ESPORT FOOTBALL ON REACTION TIME AND OCULO-PODAL COORDINATION IN ELITE ATHLETES**

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INTRODUCTION: Football eSports are emerging as an innovative tool for motor development through cognitive challenges, improving decision making, concentration and eye-hand coordination. These aspects can benefit the neuromuscular system in the real game. However, there is a lack of evidence on the connections between post-training muscle reactivity with eSport and athletes perceptions of motor learning and its use in personalised teaching.The aim of the study is to explore the connection between the impact of the psychophysical effects of a training protocol for the development of reaction time and oculo-podal coordination, based on the use of football eSports, and the related perceptions, opinions and knowledge. It is also analysed how increased levels of cognitive-motor reactivity, achieved through the use of football eSports, can influence young peoples perception and awareness of psychophysical effects.

METHODS: Forty young male and female footballers (12-16 years old) were recruited and divided into a control group (CG) and an experimental group (EG), the latter integrating football eSports with traditional training. Ex ante and ex post proto-

col, both groups were evaluated with BlazePod, measuring reaction times, correct responses and adaptation to visual stimuli. The CG followed standard training, while the EG integrated football video games. Subsequently, a questionnaire consisting of 2 items was administered: the first on perceptions and opinions on the use of eSports, the second on the development of awareness with respect to cognitive-motor skills (Ceruso et al, 2024; Esposito, 2024). Data analysis includes Students t-test, descriptive statistics and Chi Square test ($X^2$).

RESULTS: The EG showed significant improvements in reaction time and oculo-podal coordination compared to the CG ($P < .05$). The mean reaction time in the EG was significantly reduced, whereas the CG showed no significant change. Seventy-five per cent of the EG participants reported positive perceptions of eSports as support to traditional training. Furthermore, the Chi Square showed a significant relationship ($P < .05$) between improved cognitive-motor skills and acquired awareness.

CONCLUSION: The integration of football eSports into mainstream training can foster the development of reactivity and coordination in young athletes. Improvements in responses to visual stimuli indicate cognitive-motor enhancement, while participants perceptions and awareness highlight the positive impact of eSports on their development. eSports could be useful in personalised teaching to refine motor learning strategies.

**ANAEROBIC ENERGY METABOLISM IS MORE USED BY THIRD-MAN-PASSING SMALL-SIDED GAMES THAN REGULAR-PASSING SMALL-SIDED GAMES IN FOOTBALL PLAYERS**

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INTRODUCTION: Different human metabolic systems are simultaneously required during diverse exercises. However, the relatively predominant contributions of phosphagen (WPCr), glycolytic (WGly), and oxidative (WOxi) energy systems rely on exercise intensity and duration. In particular, coaches often adjust training rules to target specific external output during small-sided games (SSGs). However, the perspective of metabolic system contributions as internal outputs might allow for a better understanding of the real effect of tasks in preparing players. Therefore, this study compared the physiological profiles and energy system contributions of trained football players engaged in regular- and third-man-passing SSGs that included 4 versus 4 and a goalkeeper (GK).

METHODS: Ten male-trained football players participated in this cross-over study. All participants were randomly assigned to either regular-passing SSG or third-man-passing SSG (4 vs 4 with a goalkeeper, 35 m x 17 m pitch size, and 6-min match duration). During these SSGs, physiological parameters, including peak and mean heart rate (HRpeak and HRmean), oxygen uptake (VO2peak and VO2mean), metabolic equivalents (METs) in VO2peak and VO2mean, and blood lactate concentrations (peak La–, and delta La– [ΔLa–]), were measured. Energy contributions (WPCr, WGly, and WOxi) and global positioning system variables (global positioning system, total distance, total acceleration counts, mean speed, and maximum speed) were also analyzed.

RESULTS: No significant differences in physiological parameters and global positioning system variables were observed between regular- and third-man-passing SSGs. WOxi in kJ and % were significantly higher during both SSGs than WPCr and WGly ($p < 0.0001$, respectively). WPCr and WPCr + WGly levels during third-man-passing SSGs were significantly higher than those during regular-passing SSGs ($p < 0.05$, respectively). Additionally, low-to-moderate positive correlations were observed between WOxi, WGly in kJ, VO2peak, VO2mean, peak La–, ΔLa–, total acceleration counts, and mean speed ($r = 0.39 – 0.64$).

CONCLUSION: Our study demonstrated the effects of regular- and third-man-passing SSGs (4 vs 4 with a GK) on physiological responses and energy system contributions. The third-man-passing SSG compared with the regular-passing SSG induced higher WPCr and WPCr + WGly in trained football players. Therefore, third-man-passing SSGs may be useful for increasing anaerobic performance. More third-man-passing SSG sessions in preparation for football games may support high metabolic power and repeated powerful performances in trained football players.

**EFFECTS OF UNILATERAL LEG BLOOD FLOW RESTRICTION (BFR) APPLIED DURING TRAINING ON THE MITOCHONDRIAL CAPACITY OF FOOTBALL PLAYERS**

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INTRODUCTION: Considering the numerous physiological and performance benefits of the blood flow reduction method called "Blood Flow Restriction" (BFR), used in both strength and endurance training [1], we aimed to investigate the effects of blood BFR) on mitochondrial capacity and performance after 8 weeks of training in football players

METHODS: Twelve amateur football players aged between 17 and 33 (18.6 ± 4.6) participated in the study and trained 3 days a week for 8 weeks with pneumatic cuffs "The Occlusion Cuff-Elite®." The trained leg was assigned randomly to each subject.

In week 0 (pre-test) all subjects carried out a Mitochondrial Capacity test with a NIRS probe applied to the vastus lateralis of the trained and non-trained legs with BFR [2]. During this week, subjects were also familiarized with the training cuffs, using a pressure equal to approximately 40 % of the individual arterial occlusion pressure (AOP) assessed in a preliminary session. Afterwards, the percentage of AOP increased by 10% each training week, starting from 50% in weeks 1-2 to 80% in weeks 7-8. Tests were repeated during week 9 (post-test). The training intervention was structured in 8 weeks consisting

of 3 sessions a week, alternating (weekly) aerobic power to aerobic capacity on Monday, standardizing workouts with repetitions of 20" -20" at VAM and repetitions of 300m at Vt2 intensity. On Tuesday and Thursday, players performed lactate training (Z-L) and repeated sprint ability (RSA) at 80% of Vmax, plus TABATA 20" -10" bodyweight circuit training.

A one-way ANOVA for repeated measurements was applied to evaluate the differences in the time constant (τ) of muscular VO2 kinetics during recovery after leg exercise.

RESULTS: τ of POST (BFR LEG; 28.2 s ±5.0) was significantly shorter than before training PRE; 33.3 s ±4.2); mean difference -5.1 s; -15.4%; 95% CI of diff (1.46 – 8.8); P= 0.005. Significant difference also emerged in POST (BFR LEG; 28.2 s ±5.0) vs POST (CONTROL LEG; 33.9 s ±6.7); mean difference -5.7 s; -16.8%; 95% CI of diff (11.28 – 10.6); P= 0.005.

CONCLUSION: Our study showed a faster response in the time constant of mVO2 recovery at the end of a moderate-intensity exercise test (50% VO2max) after an 8-week training period with BFR. This results suggest that BFR associated with training was highly beneficial in improving mitochondrial capacity.

**RELATIONSHIP BETWEEN JUMP AND RUNNING PERFORMANCE PARAMETERS IN U21 NATIONAL TEAM SOCCER PLAYERS**

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INTRODUCTION: This study investigates the relationships between countermovement jump (CMJ) metrics, linear 40 m sprint (Lin40), the horizontal force-velocity profile (FVP) and change of direction (COD) ability in soccer players. The aim is to explore how CMJ parameters are associated with Lin40, FVP and COD parameters to optimize training strategies. Special attention is given to the interplay between horizontal and vertical force production and its impact on acceleration and deceleration phases, which are crucial for sprinting and rapid direction changes.

METHODS: Fifteen male U21 Czech national team soccer players participated in a training camp assessment, completing two trials of the CMJ, linear 40 m sprint (Lin40), and COD performance, with only the best individual results—jump height for CMJ, and time for Lin40 and COD—analyzed. Additional CMJ parameters, including braking-phase rate of force development (DecRFD) and maximal relative power (PP), were measured using K-deltas (Kinvent, France). Sprint (Lin40) and COD performances were assessed with the 1080 Sprint device (1080 Motion, Sweden) under a constant 3 kg isotonic resistance. In the COD test, athletes sprinted 15 m with 3 kg assistance, performed a 180° turn, and continued for 5 m with 3 kg resistance. COD metrics included maximal acceleration (MaxAcc) and maximal deceleration (MaxDec). Lin40 performance included maximal acceleration (MaxAcc) and horizontal force-velocity profile (FVP) metrics: maximal power output (Pmax), theoretical maximum force (F0) and maximum velocity (V0).

RESULTS: COD: 4.35 ± 0.08 s (time), 7.22 ± 0.72 m/s^2 (MaxAcc), and 8.71 ± 0.99 m/s^2 (MaxDec). CMJ: 43.4 ± 3.94 cm (jump height), 60.1 ± 5.5 W/kg (PP), and 10740.7 ± 4531.67 N/s (DecRFD). Lin40 and FVP: 5.9 ± 0.21 s (time), 7.8 ± 0.58 N (F0), 9.3 ± 0.47 m/s (V0), 17.86 ± 1.19 W/kg (Pmax), and 7.3 ± 0.62 m/s^2 (MaxAcc). CMJ height demonstrated a moderately strong positive correlation with Pmax ($r = 0.55$, $p < 0.05$) and F0 ($r = 0.51$, n.s.), as well as with CMJ PP (both $r = 0.66$, $p < 0.05$). No significant correlations were found between CMJ and COD parameters, although CMJ DecRFD was positively correlated with COD MaxAcc ($r = 0.21$), and COD MaxDec was negatively correlated with CMJ height ($r = -0.37$) but not with CMJ DecRFD ($r = 0.09$).

CONCLUSION: CMJ, Lin40 and COD performances share common neuromuscular determinants, while COD ability appears to rely more on acceleration and deceleration capacities. These findings highlight the necessity for targeted training strategies in elite U21 soccer players. Specific exercises designed to improve both explosive strength for CMJ and agility for COD are essential for optimizing performance across all facets of the game. Future research should further investigate how tailored training programs can enhance both vertical and horizontal power, thus improving overall athletic performance.

## Conventional Print Poster Presentations

### CP-AP24 Swimming

**THE RELATIONSHIP BETWEEN TRUNK POWER AND UNDERWATER PERFORMANCE IN 400 M FREESTYLE FOR SWIMMING ATHLETES**

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INTRODUCTION: The underwater phase (from wall contact to the head first break water after rolling rotation) during turns plays a crucial role in competitive swimming, as it enables faster speeds compared to surface freestyle swimming [1]. A longer and faster underwater phase is associated with better turn performance thus the overall swimming success. Trunk power may contribute to the two skills executed during underwater phase - the twisting rotation (twisting around the vertical axis of the body) and the undulatory underwater swimming. However, the relationship between trunk power and the underwater performance of turn is still unclear. 400 m freestyle requires athletes to have both speed and endurance,

and a large number of turns can be analyzed. Therefore, this study aimed to investigate the correlation between trunk power and underwater turn performance in 400 m freestyle.

METHODS: Ten national-level male swimmers (19.6±3.8 yr, 185±3.6 cm,; 74.9±8.1 kg) participated in the study. Their average personal best performance was 92.29% of the current world record. Data were collected in 7 turns during a 400 m freestyle test, including average water break time (WBT), underwater velocity and water break distance (WBD), captured by two fixed cameras (HDR-CX680, SONY, Tokyo, Japan) for assessing underwater phase performance. The front and side abdominal power tests (FAPT and SAPT) were conducted using a 2 kg medicine ball by throwing forward and sideward respectively. Each test was performed three times per direction, with a 45-second rest interval between trials. The maximum throwing distance (m) was used for analysis. Pearson correlation coefficients were calculated to determine the relationship between underwater performance and trunk power.

RESULTS: Pearson correlation showed significant positive correlations between WBT and left SAPT (r = 0.664, p= 0.036) and right SAPT (r = 0.644, p = 0.044). Strong correlations were shown between underwater velocity and FAPT (r =0.808, p =0.005), left SAPT (r =0. 747, p =0.013) and right SAPT (r =0.636, p =0.048). Similarly, WBD showed strong correlations with FAPT (r = 0.711, p = 0.021), left SAPT (r = 0.717, p = 0.020), and right SAPT (r = 0.666, p = 0.036).

CONCLUSION: The findings suggested that the underwater performance (WBT, underwater velocity, and WBD) are strongly correlated with trunk power (in the direction of front, left and right). Besides, stronger correlations were observed for left SAPT compared to right SAPT with underwater performance.

Reference:

1. Veiga et al., 2016

**NEUROMUSCULAR TRAINING PARADIGMS FOR SWIMMERS: A SYSTEMATIC REVIEW OF THE RELATIONSHIP BETWEEN EXERCISE LOADING AND EXERCISE PERFORMANCE**

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INTRODUCTION: Neuromuscular training is critical for optimizing swimming performance, yet evidence-based load prescription remains challenging [1-3]. Current research lacks consensus on: (1) dose-response thresholds for different training modalities, (2) valid load monitoring biomarkers, and (3) taper duration optimization. This systematic review establishes evidence-based guidelines for neuromuscular training periodization.

METHODS: The systematic literature search was conducted following the PRISMA-PERSiST guidelines across seven databases (PubMed, Web of Science, Scopus, SPORTDiscus, CINAHL, Cochrane Library, and EMBASE). Methodological quality was appraised via AMSTAR2 with dual-independent screening.

RESULTS: From 2,317 initial records, 42 studies met inclusion criteria (68% published 2019-2024). High-intensity training demonstrated superior performance correlation (r=0.69, p<0.01) versus volume-based approaches (NS). Strength loads at 70-85% 1RM elicited maximal sprint improvements (3.2-5.6%, ES=1.21). A 3-week exponential taper optimized time gains (Δ2.9-3.2%, p<0.01) through fatigue reduction, whereas extended tapering diminished returns (ES=0.18). Neuromuscular interventions revealed differential effects: core training enhanced stroke efficiency (Δ9.2%, p<0.05) while plyometrics improved start/turn power (ES=0.5-0.6). Session-RPE showed high validity for load quantification (ICC=0.92), with HRV thresholds (<50ms RMSSD) effectively detecting overtraining states (AUC=0.89).

CONCLUSION: Neuromuscular training efficacy in swimming depends critically on load modulation. High-intensity protocols, short-term tapering, and core/power training yield robust performance benefits. Personalized load monitoring using RPE or physiological biomarkers (e.g., HRV) is essential to balance adaptation and recovery. Future research should prioritize RCTs comparing periodization models in diverse athlete populations.

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**THE EFFECTS OF PULL-UP TRAINING ON SWIMMING PERFORMANCE AND PREDICTORS: A SYSTEMATIC REVIEW**

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INTRODUCTION: pull-ups, are widely incorporated into swim training due to their biomechanical similarity to swimming strokes. Pull-ups strengthen the muscles associated with swimming (back muscles, etc.).Despite their relevance, limited research has directly investigated the effects of pull-up training on swimming performance. This systematic review aims to (1) examine the impact of pull-up training on swimming performance and (2) explore its potential as a predictor

METHODS: A comprehensive literature search was conducted in PubMed, Scopus, Web of Science, and Google Scholar for studies published between January 2014 and July 2024. The search strategy utilized the keywords ("pull-up" OR "chin-up") AND ("swimming" OR "swimmers"). Studies were excluded if they involved non-swimmers, lacked pull-up interventions, or exhibited low methodological quality. After screening, 11 studies were included and evaluated following PRISMA guidelines. Methodological quality was assessed using the PEDro scale.

RESULTS: The included studies primarily focused on freestyle/breaststroke. Pull-up velocity and power during the concentric phase showed significant correlations with short-distance swimming performance (50m and 100m). In contrast, the maximum number of pull-ups completed in a single attempt did not correlate with short-distance performance. Pull-up endurance (maximum repetitions within 30 seconds) was associated with middle- and long-distance freestyle performance. Training interventions targeting pull-up velocity effectively improved 50m freestyle performance, particularly in the first half of the race. However, high-intensity pull-ups (≈3RM) for post-activation potentiation (PAP) provided limited benefits. In breaststroke, athletes with greater pull-up endurance exhibited higher stroke frequencies during competitions. Females 1RM pull-up performance correlated with 50-yard freestyle performance, but no such correlation was observed in males. Pull-up velocity and power partially predicted short-distance performance, while velocity and repetition count moderately predicted middle- and long-distance performance. Pull-up performance remained largely unaffected by fatigue, limiting its utility as a condition indicator. Significant gender differences were noted, with 1RM pull-ups predicting short-distance performance only in females.

CONCLUSION: Pull-up training enhances upper body strength and swimming performance, especially in short-distance events. Swimmers should focus on improving pull-up quality (velocity, power) over increasing repetition count. Gender differences in 1RM pull-up performance indicate upper body strength is more critical for female swimmers. After achieving maximal strength, training for explosive power and endurance may offer greater benefits. Limitations include small sample sizes and limited stroke coverage. Future research should explore pull-up training across strokes, distances, and genders, and assess its efficacy as a predictive metric and warm-up tool.

add(also can poster)

**EXPLORING NUTRITION AND BODY COMPOSITION CHANGES: THE CASE OF A SOLO SWIMMER ON A 100 KM JOURNEY**

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INTRODUCTION: Ultra-endurance swimming events challenge athletes with distances ranging from 10 km to over 100 km in natural bodies of water, where they face varying conditions such as currents, waves, and temperature fluctuations. Training for these events often requires months or years of preparation. Participants typically swim with support teams that provide nutrition, hydration, and safety assistance. The physical and mental challenges include fatigue, temperature regulation, and the psychological demands of long-distance swimming. A crucial aspect of performance is meeting the energy requirements during these events. This study examines changes in body composition and hydration of an athlete who completed a solo 100 km swim.

METHODS: A 22-year-old swimmer planned a solo open water swim of 100 km in September 2024 to raise money for charity and trained for about a year. He trained both in swimming pools and open sea, and added resistance training during the whole year before the event. To optimize physical and nutritional fitness, he sought support from the Sport Physiology Lab at Cagliari University. We assessed his body composition and energy intake during training and designed his diet for both training and the event. The energy cost of swimming 100 km was estimated through an incremental cardio pulmonary exercise test done in open water in which the most economical race pace was identified. A support boat accompanied him during the challenge, providing supplementation (liquid and solid) every 30 minutes. Pre- and post-race measurements of body mass, body fat percentage, skeletal muscle mass, and total body water were conducted using anthropometric methods and bio electrical impedance analysis. During the swim, the athlete used a device (Garmin Fenix 6) to track distance, heart rate, calories burned, and water temperature.

RESULTS: The athlete successfully swam 102 km in 32 hours and 40 minutes, maintaining an average pace of 1:40 min/100 m for the first 53 km and 1:54 min/100 m for the last 49 km. He ingested approximately 200 Kcal per hour from supplementation, totaling a fluid intake of about 8 liters. At the conclusion of the swim, he reported being in good health and high spirits. Body mass decreased by 4.6 kg, skeletal muscle mass by 0.4 kg, body fat by 2.6 kg, and total body water by 1.1 liters.

CONCLUSION: Our goal of supporting the athlete in preparing for and completing the ultra-endurance event while preserving his health was achieved. Despite the challenges demands, he successfully adhered to the planned schedule. Consistent with findings from other studies, we observed that body mass loss is not solely attributed to dehydration. These results warrant further investigation in larger field studies involving ultra-endurance swimmers.

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**SUBJECTIVE PERCEPTION OF PHYSICAL AND MENTAL FATIGUE IN ARTISTIC SWIMMERS DURING THE PRE-COMPETITIVE AND COMPETITIVE SEASON**

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INTRODUCTION: Artistic swimmers (AS) participate in daily training sessions requiring in-water and dry-land training [1,2]. Previous research in high-level netballers has indicated that physical fatigue (PF) and mental fatigue (MF) demonstrate a shared variance of 14.3% [3], suggesting that several factors may affect the feelings of physical and mental fatigue. Excessive increases in training load (TL) may increase the subjective feeling of PF [4]. However, it is uncertain whether fluctuations in TL mirror changes in PF and MF, since MF might be influenced not only by training, but also by school commitments [5]. Therefore, the present study examined whether fluctuations in TL are reflected on changes in MF and PF of AS over a 10-week period including pre-competition and competition training.

METHODS: Fifteen female adolescent AS (age: 14.7 ± 1.6 years, body mass: 49.2 ± 7.0 kg, body stature: 166.0 ± 0.1 cm, competitive experience: 6.9 ± 1.7 years) participated in the study. Internal TL (rating of perceived exertion x training duration), and subjective PF and MF (visual analogue scale from 1 to 10), were daily recorded across three distinct phases: phase 0 (Easter holidays: two weeks with regular training and no school obligations), phase 1 (5 weeks of reduced training, but increased mental demands due to school exams), and phase 2 (3 weeks of preparation for competitions; no school commitments). The effect of each training phase on TL, PF and MF was examined using separate linear mixed models, where the three training phases were defined as fixed effects, while the athletes were defined as a random factor. The level of statistical significance for all tests was set at $p< 0.05$.

RESULTS: Significant differences among the three training phases were observed in TL, as well as in the subjective scores of PF and MF (all, $p<0.01$). TL was higher in phase 2 (581 ± 172 a. u.) compared to phase 1 (409 ± 91 a. u., $p<0.01$) and phase 0 (449 ± 121 a. u., $p<0.01$). PF was lower in phase 2 (4.2 ± 1.6 a. u.) compared to phase 1 (4.5 ± 1.2 a. u., $p<0.05$), while MF was higher in phase 1 (4.8 ± 1.7 a. u.) than in phase 0 (4.1 ± 1.9 a. u., $p<0.01$) and phase 2 (3.6 ± 1.9 a. u., $p<0.00$).

CONCLUSION: This is the first study that examines the influence of three distinct training phases on TL, PF and MF in adolescent AS. It suggests that fluctuations in TL in this cohort of athletes does not mirror respective changes in PF and MF. These findings provide practical insights for coaches in optimizing TL management in adolescent AS and suggest that along with TL, PF and MF should be recorded in training procedure. However, the influence of TL on PF and MF warrants further investigation.

**INFLUENCE OF INSPIRATORY MUSCLE PRE-ACTIVATION ON 400 M FRONT CRAWL PERFORMANCE IN YOUNG SWIMMERS: A COMPLEX NETWORK ANALYSIS**

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INTRODUCTION: Inspiratory muscle pre-activation using airflow restriction (IMPA) has been shown to benefit athletes [1]. However, it is uncertain if IMPA is effective in swimmers, whose activity is associated with high inspiratory demand in aquatic environments. This study investigated the effects of IMPA on 400m front crawl performance using complex network model.

METHODS: Nine swimmers (16±1yrs; 68.9±4.5kg; 1.7±0.1m) were evaluated in four sessions. In the first, anthropometric measurements, body composition, maximal inspiratory pressure (MIP), and the global strength index were assessed. In subsequent randomized sessions, athletes performed a 400 m front crawl time-trial under 3 conditions: with no pre-activation (Control, C), with IMPA at only 3 cm $H_2O$ (Placebo, PLA), and with IMPA at 40% of MIP (Pre-activation, PA), using POWERbreathe K5 device. Blood lactate, skin temperature in target regions, and perceived exertion and dyspnea were assessed after each test. Data were analyzed by conventional statistics and by complex network. For this, undirected weighted graphs (G=V,E,w) were constructed for each scenario (C, PLA, and PA) to examine the degree (number of connections) and betweenness (intermediate nodes considering the shortest paths between two in a graph) centrality metrics [2]. The graphs were composed of 25 vertices (V, nodes) corresponding to the athletes profile, mechanical, and physiological parameters, and edges (E) denoted interactions based on Spearmans correlation coefficients ($r\geq0.5$) to construct the weight function (w).

RESULTS: The Friedman test showed significant difference in the stroke length between C and PLA (1.45±0.21 and 1.43±0.24m, $p\leq0.05$). In parallel, the complex network highlighted athletes' profiles and inspiratory measures as important nodes in all cases. A total of 206 connections were observed in the C scenario, 123 in the PLA, and 176 in the PA. The C graph exhibited the highest density (0.69) and connectivity with nodes such as height, arm span, and MIP (21–22 connections); betweenness was distributed among athletes' profiles and mechanical nodes (height, arm span, stroke length). In the PLA, graph density was lower (0.41), with a reduced degree (16-15 for lactate, height, and arm span), and peak lactate exhibited the highest betweenness (0.08), while other values were ≤ 0.02. The PA graph demonstrated an intermediate density (0.59), with a high degree (20-19 for arm span, height, and inspiratory values), and betweenness highlighted body fat (0.06), chest temperature (0.04), and arm span (0.03).

CONCLUSION: IMPA did not alter mechanical, physiological, and perceptual parameters in the 400m front crawl. However, the complex network indicated anthropometric, inspiratory values, and chest temperature as central nodes, suggest-

ing that after pre-activation, these parameters may play a key role in the interconnection among performance and physiological responses.

1.Cirino et al., 2023, 2. Manchado-Gobatto et al., 2022

Support: FAPESP, CNPq, CAPES, FAEPEX

**ISOLATED VS. SIMULATED TRIATHLONS: A COMPARATIVE STUDY OF PERFORMANCE, PHYSIOLOGY, AND BIOMECHANICS IN TRIATHLETES**

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INTRODUCTION: Given the gap in the literature regarding the behaviour of different loads imposed by isolated events versus a triathlon and recognizing that clarifying this could impact the development and programming of training for triathletes, this study aimed to compare performance, physiological, and biomechanical variables between separate triathlon events (swimming, cycling, and running) and combined events (simulated triathlon) in triathletes.

METHODS: Nine triathletes were randomly evaluated in both conditions (isolated triathlon -swimming, cycling and running performed separately- vs. simulated triathlon -complete race-). Performance in each segment, heart rate (HR), muscle oxygen saturation (SmO2), rating of perceived effort (RPE) and biomechanical indicators such as cycles, frequency and length of strokes in swimming; power and cadence in cycling, cadence, length and ground contact time in running were evaluated.

RESULTS: Swimming performance was worse in the isolated condition (1902.3 ± 262.1 s) compared to the simulated triathlon (1862.0 ± 229.1 s; $p = 0.02$). No significant differences were found in cycling (isolated: 4269.6 ± 321.1 s; simulated: 4464.6 ± 374.4 s; $p = 0.12$). Running performance, however, was poorer in the simulated triathlon (3044.6 ± 523.1 s) than in isolation (2676.3 ± 294.6 s; $p = 0.006$). Swimming in isolation led to reduced performance (~ 3%) and higher perceived effort.

CONCLUSION: Running after swimming and cycling resulted in worse performance (~13%) and shorter stride length. Therefore, incorporating full triathlon simulations in training is recommended to help athletes adapt to transitions. Such a strategy could enhance running efficiency following swimming and cycling, improving overall triathlon performance.

## Conventional Print Poster Presentations

### CP-AP30 Training and Testing II - Mixed

**RELATIONSHIP BETWEEN BENCH PRESS AND IRON CROSS MAXIMAL ISOMETRIC CONTRACTION – A POTENTIAL PATH TO PERFORM THE IRON CROSS ON GYMNASTICS STILL RINGS**

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INTRODUCTION: The last code of point ruling international artistic gymnastic competitions took another step toward the ubiquitous necessity of strength difficulty on still rings. The objective of the present study is to analyze the relationship between a bench press and an iron cross maximal isometric contraction. Based on this relationship, a theoretical model will be provided to help coaches with individual and personalized training recommendations relying on the gymnast's current general and specific training status.

METHODS: 52 sub-elite gymnasts (Mean ± SD 22.4 ± 5 years, 173 ± 5cm, 68.5 ± 6kg) were randomly assigned to start by one of two exercises: 1) Maximal isometric contraction in bench press position: The force applied by the athletes against an immobile bar in the bench press position was measured with a pair of handheld dynamometers. 2) Maximal isometric contraction in the iron cross position: Participants were standing on force plates to measure their body weight at rest and during a maximal contraction. The force developed was computed by subtracting the remaining weight to the initial body weight. Both maximal forces were normalized by body weight and expressed in percentages.

RESULTS: Maximal relative strength ranged between 62.2% and 230.47% in Bench Press and between 40.9% and 102.1% in Iron Cross. Contrary to the hypothesis, the relationship between the two measurements is only moderate (Pearson's $r = 0.41$; $p = 2.64e\text{-}3$; IC= [0.15; 0.61]). Nevertheless, by splitting the entire population according to Bench Press 20% interval (i.e. [60%; 80%[, [80%; 100%[, etc.) and analyzing the strongest individual in the iron cross for each subgroup, a threshold appears. Accordingly, iron cross relative strength can seemingly take any value between zero and a maximal theoretical value computed from the bench press: Iron Cross=0.5×Bench Press+15.

CONCLUSION: The main findings from the present study are twofold: First, the absence of a linear relationship between those two maximal isometric contractions. Second, the existence of a linear threshold rather than a linear trend between bench press and iron cross. Based on the present findings, a model has been developed to help coaches locate gymnasts and provide personalized guidelines to improve the performance of the iron cross depending on the athletes' current general and specific strength status. From the model, the threshold governing the interaction between those two relative strengths seems to stress the need to improve the bench press to improve the iron cross, while the absence of gymnasts with a low bench press and a high iron cross relative strength could highlight the necessities of the bench press

to perform the iron cross. In addition, the important number of gymnasts presenting a high bench press, and a low iron cross relative strength might emphasize that while being necessary, the bench press is not sufficient for the iron cross.

**VALIDITY AND RELIABILITY OF A NEW ENDURANCE TEST ADAPTED TO CHILDREN AGED 4-7 YEARS**

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*UNIVERSITY OF LIEGE*

INTRODUCTION: Currently, there is no field test to assess aerobic endurance in children aged 4-7 years, while taking into account the physiological and psychological characteristics specific to this population. The main validated test is a 3-minute continuous, round-trip 10m run (Ayan et al, 2015). However, studies show that intermittent effort is better suited to the physiological specifics of young children, notably due to their greater ability to recover quickly between brief efforts (Baquet et al., 2010). Furthermore, the integration of playful elements, such as imaginative storytelling or dramatizations, could not only increase the pleasure felt during effort, but also improve childrens motivation and engagement (Howells et al., 2023). These playful approaches seem particularly relevant for encouraging adherence to physical activity from an early age, and it seems worthwhile to propose a positively perceived endurance assessment test for younger children.

METHODS: To take into account the particularities of the target age group, we developed a 3x1 minute intermittent endurance test (recovery = 30 seconds) accompanied by a story to make it fun. To study the validity of the test and the influence of the variables "intermittent effort" and "playful context", 80 children will perform the test under 4 conditions: continuous non-playful test (reference test); continuous playful test; intermittent non-playful test; intermittent playful test. To study reliability, 80 children will perform both intermittent non-playful test and intermittent playful test twice. Children level of exhaustion and the level of amusement will be assessed using emoticons scales.

RESULTS: Preliminary tests have been carried out to arrive at a rigorous organization enabling the evaluation of a class (around 20 children) in a single session lasting less than 45 minutes. Measurements for validity and reliability are currently underway. Full results will be available at the conference.

CONCLUSION: We hypothesize that the playful intermittent test will be well suited to the 4 to 7 year-old population. We hypothesize that overall validity and reliability will be good, but influenced by the age of the children, and lower in the youngest age groups. We hypothesize that, at the end of the new test, children will report a level of exhaustion comparable to other tests, but will report a higher fun score.

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**EFFECT OF TRAINING FREQUENCY DURING HEAT ACCLIMATION ON THE PHYSIOLOGICAL ADAPTATION OF THOROUGHBRED HORSES**

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INTRODUCTION: Heat acclimation, the repeated exposure to exercise in a hot environment, induces physiological adaptation with improved thermoregulatory and cardiovascular functions. In humans, daily training regimens in hot environments are recommended for improved adaptation and higher performance. While heat acclimation is also crucial for Thoroughbred horses, research on different training protocols for this species is scarce. This study compared the effects of consecutive and intermittent heat acclimation protocols in Thoroughbred horses.

METHODS: This was a randomized crossover study, including eight trained Thoroughbred horses. The horses were assigned to either a consecutive (CONS, 9 consecutive days) or an intermittent protocol (INT, 3 days/week for 3 weeks), involving 30 min exercise in hot conditions (Wet Bulb Globe Temperature [WBGT] 29.5°C). Both training protocols comprised alternate sessions of high-intensity interval training (3 × 1 min bout at 100% VO2max with 2 min recovery) and moderate-intensity interval training (3 × 1 min bout at 70% VO2max with 2 min recovery). Before and after the heat acclimation period, incremental exercise tests (IETs) were conducted in hot conditions (WBGT 29.5°C), with collection of arterial and venous blood samples to measure blood gases and plasma lactate concentration. Pulmonary artery temperature and heart rate were also recorded. Prior to IETs, muscle biopsy samples were obtained from the middle gluteal muscle for enzyme activity analysis. Data were analyzed using mixed models, and pairwise comparisons were performed using Tukey's test ($P < 0.05$).

RESULTS: Both protocols decreased pulmonary artery temperature after heat acclimation, both at rest (CONS, −0.2°C; INT, −0.3°C) and during submaximal exercise (CONS, −0.3°C; INT, −0.3°C). For IETs, time to exhaustion increased in INT (+11.6%, 8 of 8 horses improved) but not in CONS (+5.7%, 5 of 8 horses improved). For both protocols VO2max remained unchanged (CONS, +7.5%; INT, +3.4%) whereas speed eliciting VO2max increased (CONS, +6.5%; INT, +10.4%). For CONS only, maximal stroke volume increased (CONS, +11.8%; INT, +3.9%) while heart rate during submaximal exercise decreased (CONS, −5.5%; INT, −3.7%). Moreover, weight loss was observed after heat acclimation for CONS only (CONS, −1.8%; INT, −0.6%). Regarding enzyme activity, citrate synthase remained unchanged in both protocols (CONS, +2.0%; INT, −3.6%) whereas 3-hydroxy acyl-CoA dehydrogenase decreased in INT only (CONS, −30.2%; INT, −42.8%).

CONCLUSION: Both protocols elicited physiological adaptation to thermoregulation and aerobic energy metabolism. However, improved performance occurred only in INT, while cardiovascular improvement and weight loss occurred only in CONS. These findings suggest that consecutive heat acclimation training can induce robust physiological adaptations in a short period. However, care should be taken to prevent overreaching in Thoroughbred horses.

**A SIMPLE METHOD TO DETERMINE THE SEVERE-EXTREME INTENSITY EXERCISE DOMAIN BOUNDARY USING THE VO2 KINETIC RESPONSE**

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INTRODUCTION: The boundary separating the severe intensity exercise domain, wherein the maximal O2 uptake (VO2max) can be attained, from the extreme intensity exercise domain, wherein VO2max cannot be attained, is not widely adopted in applied work with athletes due to its labour-intensive nature. The aim of this study was to propose an alternative, practical approach to estimate the severe-extreme boundary using VO2 kinetics.

METHODS: Sixteen physically active males completed an incremental exercise test and a series of constant power output exercise tests on a cycle ergometer. The relationship between time to achieve VO2max and time to task failure during severe-intensity exercise (PUPPERBOUND) was calculated to provide an estimate of the highest power output at which VO2max was momentarily attained just before task failure. Separately, the highest power output that provided a time to task failure that was equal to or greater than four times the time constant (τ) describing the VO2 kinetics during severe-intensity exercise (P4-τ) was calculated.

RESULTS: The PUPPERBOUND and P4-τ occurred at similar power outputs (379±60 vs. 380±57 W, respectively; p=0.62) and were closely related (r: 0.99; bias: 1 W; SEE: 7 W; limits of agreement: -14 W to 16 W).

CONCLUSION: Compared to PUPPERBOUND, the P4-τ method provides a simpler and more time efficient approach to identify the severe-extreme intensity exercise domain boundary.

**THE EPIDEMIOLOGY OF DANCE-RELATED INJURIES AND EFFECTS OF 11+ DANCE NEUROMUSCULAR PROGRAM ON LOWER LIMB FUNCTIONAL PERFORMANCE IN PRE-PROFESSIONAL DANCERS**

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INTRODUCTION: A systematic review shows a high injury rate among pre-professional dancers (17-90%) [1]. Most injuries occur in the lower limbs, with 21-34% in the ankle and 12-21% in the knee [2]. Nevertheless, there is limited research on dance-related injury epidemiology, especially on the type of injuries in non-Western pre-professional dancers. Studies on prevention specific to dancers are lacking. This study includes the epidemiology of dance-related injuries among ballet, contemporary, and Chinese pre-professional dancers in Hong Kong. It also examines the effects of the 11+ Dance neuromuscular program on the functional performance of the lower limbs of pre-professional dancers.

METHODS: Surveys focusing on dance training habits and injury history were distributed to dance students of a professional dance school in Hong Kong. 24 subjects participated in a 6-week non-randomized controlled trial. The intervention group engaged in the 11+ Dance program 3 times a week (hybrid mode of face-to-face and home-based training) for 6 weeks. The control group performed their usual training dance routine. Pre- and post-tests were conducted to assess the functional performance of all participants, including the single-leg hop for distance, side hop test, modified Balance Error Scoring System, and isometric strength (hip abduction and ankle eversion) tests using a hand-held dynamometer.

RESULTS: 49 pre-professional dancers responded to the survey. 83.7% (n=41) had previous dance-related injuries. The most common injured regions were the ankle (31.4%) and the knee (22.9%). The most common injury diagnosis included ankle sprain (37.1%) and plantar fasciitis (31.4%). 25.7% of dancers indicated a pain level of 8 out of 10 would lead to their absence from dance activities. 37.1% of injured dancers indicated a 50% recovery as their return to play threshold. The results also showed the positive effects of 11+ Dance on enhancing lower limb functional performance compared to the control group.

CONCLUSION: Ballet, contemporary, and Chinese pre-professional dancers are prone to lower limb injuries, especially in the ankle region. The 11+ Dance program using the hybrid mode as their warm-up is an effective intervention for improving lower limb functional performance.

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**EFFECT OF TRANSCUTANEOUS VAGUS NERVE STIMULATION ON HEART RATE RECOVERY AFTER INTENSE EXERCISE**

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INTRODUCTION: Heart rate variability (HRV)(1) and recovery (HRR)(2) post-exercise are interesting metrics for understanding autonomic regulation and cardiovascular fitness. Non-invasive tragus stimulation of the vagus nerve (taVNS) has been hypothesized to influence recovery dynamics after an exercise bout by acutely enhancing vagal activity (3). This study aimed to evaluate the effect of tragus stimulation on HRR and HRV, compared to a sham condition, during post-exercise recovery phases.

METHODS: Nine healthy participants (all males; age 23.8±2.0 yrs; weight 75.7±5.7 kg; height 178±5 cm) completed a cycling graded maximal exercise protocol, immediately followed by two conditions: taVNS and sham stimulation (placebo). Heart rate data were recorded using a Faros ECG device (sampling rate: 250 Hz) during the baseline, exercise and recovery phases. Typical HRR short-term indices (HRR30 and T30) and HRV indices, including RMSSD, HF power (indexes of vagal tone), and LF/HF ratio (index of sympathovagal balance), were analysed across different recovery intervals: very short-term (30 s), short-term (2-6 min), mid-term (7-11 min) and long-term (11-16 min). Differences between conditions were assessed using Wilcoxon paired tests and effect size analysis (Cohen's r).

RESULTS: Tragus stimulation exhibited trends of improved vagal recovery only during mid- and long-term recovery phases, as indicated by increased RMSSD and HF power values. While statistical significance was not achieved in all indices, Cohens r suggested medium-to-large effect sizes, favouring vagal dominance during tragus stimulation in the long-term phase. Similarly, sympathovagal balance (LF/HF ratio) displayed a significant shift towards vagal modulation during long-term recovery under taVNS compared to the sham condition ($p < 0.05$, $r > 0.5$). Surprisingly, in the first 30 s recovery HRR30 and T30 worsened under taVNS.

CONCLUSION: Tragus stimulation is a promising non-invasive approach that promotes parasympathetic recovery following exercise, particularly during prolonged recovery phases. It may enhance cardiovascular recovery and autonomic balance, offering potential applications in sports performance and rehabilitation.

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## Conventional Print Poster Presentations

### CP-BM01 Biomechanics and Motor Control - Mixed

**OBSERVATION OF WALKING WITH DIFFERENT LEFT AND RIGHT TREADMILL BELT SPEEDS STRONGLY ACTIVATES THE ACTION OBSERVATION NETWORK COMPARED TO NORMAL WALKING WITH TIED-BELT SPEED**

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INTRODUCTION: Observing others actions activates a brain network known as the action observation network (AON), which includes motor-related brain areas [1]. The AON activity has been reported to be stronger when observing an action that the observer has repeatedly practiced compared to an unexperienced action [2]. However, previous studies have mainly focused on how motor experience affects the AON activity during the observation of voluntary movements (e.g., dancing) and have not examined semi-automatic rhythmic movements such as walking. Therefore, the present study aimed to investigate brain activity induced by observing walking in a split-belt condition (where the left and right treadmill belts move at different speeds), which the observers had not experienced. Initially, walking under the split-belt condition becomes asymmetric, but it gradually approaches more symmetric over several minutes [3]. Using functional magnetic resonance imaging (fMRI), we investigated brain activity, while participants observed both asymmetric and symmetric walking at the initial and late periods of the split-belt condition, respectively.

METHODS: Nineteen healthy adults participated in the study. From the walking video recorded from the actors left side in a tied condition (left and right speed: 1.25 m/s) for 2 minutes and a split-belt condition (left speed: 1.0 m/s, right speed: 1.5 m/s) for 10 minutes, three video clips of the actors lower limb movements were created: 8 seconds during walking in the tied condition, as well as the initial and last 8 seconds (initial and late period, respectively) of split-belt condition. The actors step lengths in the video clips were almost symmetric in the tied condition and late period of the split-belt condition, but were markedly asymmetric in the initial period of the split-belt condition. The participants observed these video clips in a random order to examine brain activity during the observation using fMRI. The differences in brain activity between condi-

tions were analyzed using one-sample t-tests with a voxel-wise threshold of $p < 0.001$ (uncorrected) and a family-wise error rate-corrected extent threshold of $p < 0.05$.

RESULTS: While observing walking video clips, AON areas, including the parietal cortex, cerebellum, and inferior frontal gyrus, were significantly activated, irrespective of the condition. Furthermore, brain regions, including the supramarginal gyrus and inferior frontal gyrus, were strongly activated during the observation of walking in both periods of the split-belt condition compared to the tied condition.

CONCLUSION: Our results suggest that observation of walking under an asymmetric speed condition, which is unfamiliar to the observers, elicits stronger AON activation compared to observation of normal walking in a symmetric speed condition.

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**BALANCING AT THE LIMITS: AGE DIFFERENCES IN POSTURAL CONTROL STRATEGIES**

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INTRODUCTION: Older adults experience more frequent falls due to sensory decline, reduced muscle strength, and other causes. While these risk factors are well-documented, less is known about how aging affects movement behavior near the stability limit. In particular, do older adults adjust their postural control strategies differently than young adults when balance becomes precarious? To investigate this, we instructed volunteers to lean forward as far as possible ("test your limits") from an upright standing position while maintaining a straight body posture. We hypothesized that older individuals would exhibit different characteristics in their corrective movements compared to younger individuals.

METHODS: Twenty young (10 males, 26 ± 3 years) and 21 older (11 males, 70 ± 7 years) healthy volunteers performed eight 30-second trials of forward leaning while their postural movements were recorded (Vicon™, 39 markers, 250 Hz). Postural movement characteristics were analyzed using principal component analysis (PCA), with relative movement variance (rVARk) reported for each principal movement. Depending on normality and variance homogeneity, group differences in rVARk were assessed using independent t-test, Welch's t-test, or the Mann-Whitney U test. Effect sizes were reported as Cohen's d ($d = 0.2–0.5$: small, $d = 0.5–0.8$: moderate, $d > 0.8$: large) or rank biserial correlation ($rbc = 0.1–0.3$: small, $rbc = 0.3–0.5$: moderate, $rbc > 0.5$: large).

RESULTS: PCA revealed no significant differences in the first two principal movements, which accounted for 71% of explained variance. However, older adults exhibited greater lateral sway (rVAR3, $p = .005$, $d = -1.79$), while younger adults showed higher contributions of an ankle strategy with arm movements (rVAR4, $p < .001$, $d = 2.22$), a hip strategy with arm movements (rVAR6, $p = .016$, $d = 1.51$), and elbow flexion, lateral trunk flexion, and ankle movement (rVAR8-12, $p < .038$, $d > 1.21$ / $rbc > .63$).

CONCLUSION: Our findings reveal age-related differences in corrective motor responses near the stability boundary. The lack of differences in the first two principal components, which account for most of the movement variance, suggests that fundamental movement strategies remain similar across age groups (Haid et al., 2018). However, younger adults exhibited greater variance in higher components, indicating more adaptable movement strategies. In contrast, older adults showed increased lateral sway, a pattern associated with a higher fall risk (Rogers & Mille, 2003).

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**THE EFFECT OF COMBINING NEUROMUSCULAR ELECTRICAL STIMULATION WITH TOWEL CURL EXERCISE FOCUSING ON THE ABDUCTOR DIGITI MINIMI MUSCLE ON STANDING BALANCE**

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INTRODUCTION: Foot stabilization for maintaining standing posture has been attributed to intrinsic foot muscles, particularly the abductor hallucis muscle (1). However, our previous study indicated that the towel curl exercise, which activates the abductor digiti minimi (ADM) along with other intrinsic foot muscles, improves balance during single-leg standing (2). Despite this, exercise alone struggles to effectively target ADM, making its role in balance control difficult to evaluate. Therefore, we combined exercise with neuromuscular electrical stimulation (NMES) to selectively activate the ADM and investigate its role in balance control. NMES enhances muscle strength, neural adaptations, and intermuscular coordination (3), with effects further augmented when combined with voluntary exercise (4). This study examined the effects of combining NMES with ADM-focused exercise and hypothesized that it would improve balance and activate extrinsic foot muscles during standing.

METHODS: Twenty-six participants were divided into two groups: NMES combined with towel curl exercise (NMES group) and exercise alone (CON group). They performed single leg standing tasks under eyes-open and eyes-closed conditions before and after intervention. NMES at 20 Hz for 20 minutes was applied to the NMES group before exercise. During the

exercise, they used their little toe side to gather the towel. Balance was assessed using the root mean square (RMS) of CoP displacement in the anteroposterior and mediolateral (ML) directions and rectangular area (RA). Electromyogram of the lower limb was recorded, and the RMS of each muscle were analyzed. They were analyzed by two-way repeated measures ANOVA ($\alpha = 0.05$).

RESULTS: During single leg standing with eyes closed, both groups showed reduced ML-RMS (CON: $p = 0.003$, NMES: $p = 0.003$) and RA (CON: $p = 0.037$, NMES: $p < 0.001$) after the intervention. Additionally, in the NMES group, RMS of the gastrocnemius ($p = 0.033$) and peroneus longus ($p = 0.003$) decreased with eyes open. With eyes closed, RMS of the tibialis anterior ($p = 0.024$) and peroneus longus ($p = 0.004$) decreased in the NMES group.

CONCLUSION: In single leg standing with eyes closed, ML CoP sway decreased in both groups, likely due to ADM activation supporting lateral stability (5). Furthermore, improvements in eyes-closed conditions, where somatosensory input dominates (6), suggest that NMES and exercise enhanced somatosensory function. The NMES group showed reduced extrinsic foot muscles activity, implying ADM activation minimized compensatory extrinsic muscles use (1). These findings indicate that activation of intrinsic muscles enhances stability and reduces reliance on extrinsic muscles. In conclusion, NMES combined with ADM-focused exercise improves standing balance and reduces extrinsic foot muscles activity.

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**BUILDING UP FOR SHORTCOMING: PARALLEL-FIBERED GRACILIS MUSCLE INHERENTLY HAVING LONG FASCICLES BECOMES "THICKER" RATHER THAN LONGER AFTER ECCENTRIC-ONLY STRENGTH TRAINING**

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INTRODUCTION: Muscle hypertrophy by strength training is accompanied by changes in internal architecture (1,2). It is well known that muscle increases fascicle length ($\propto$ speed/excursion potential) rather than physiological cross-sectional area (PCSA, $\propto$ force potential) by eccentric training (3,4), which likely matters in injury prevention and motor performance (5). However, our understanding is strongly biased toward "pennate" muscles with short fascicles and large PCSA. We still poorly understand architectural changes of "parallel" muscles inherently having long fascicles with small PCSA, because of the difficulty in capturing them in vivo. Overcoming this with an MRI-based approach, we tested our hypothesis that parallel muscle hypertrophy is attributed to an increase in PCSA rather than fascicle length after eccentric-only strength training.

METHODS: Eleven healthy males completed a 10-week strength training (3 sessions/week) for eccentric-only knee flexion. Each session included 3 sets of 10 repetitions at 50% of maximal voluntary contraction over 50–100% of the range of motion. Before and after the training, muscle volume/length/PCSA, fascicle length/angle, and aponeurosis length/width were measured for the gracilis (Gra) having the second-longest fascicles in human leg muscles, using diffusion tensor MRI (6). Also, eccentric knee flexion strength was measured with a dynamometer. The paired t-tests and linear regression analyses were performed.

RESULTS: The Gra had long fascicles (21 cm) attached to a small aponeurosis before the training. After the training, the eccentric knee flexion strength (+61%) and Gra volume (+31%) increased greatly ($p<0.01$), but the muscle length did not. Notably, the Gra hypertrophy was mainly attributed to the increase in PCSA (+25%, $p<0.01$) but not fascicle length. This PCSA increase was accompanied by elongation of the aponeurosis length (+11%, $p=0.03$) but not the width or fascicle angle. Also, the PCSA increase tended to be greater in individuals with longer fascicle lengths relative to muscle lengths ($r=0.65$, $p=0.03$).

CONCLUSION: The parallel-fibered Gra became thicker rather than longer through aponeurosis elongation by eccentric training, contrary to the fascicle longitudinal growth of pennate muscle (3,4). Thus, architectural mechanisms underlying muscle hypertrophy and strength gain may differ depending on the inherent architectural type (pennate/parallel); muscles likely make up for their shortcoming (fascicle length/PCSA). Expanding the current understanding beyond pennate muscle, our findings motivate us to rethink muscle architectural/functional plasticity in response to chronic mechanical loading and provide novel insights into the design of training/rehabilitation programs for improving our physical function.

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**DOES STRETCHING IMPACT RUNNING ECONOMY? A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Running Economy (RE), defined as oxygen consumption at a given running pace (1), is influenced by metabolic, cardiovascular, neuromuscular, and biomechanical factors (2). Literature outlines muscle-tendon properties in general and Achilles tendon stiffness in particular as a crucial parameter to increase energy storage and release, potentially lowering muscle activity to improve RE (1). Since stretching is known to decrease tissue stiffness (3), its effects on RE remain controversial. As the effects of stretching on running economy continue to be inconclusive, this meta-analysis aims to provide a comprehensive synthesis of current findings.

METHODS: In adherence with PRISMA 2000 guidelines a systematic search was performed in three databases. Inclusion and exclusion criteria were applied according to the PICOS guidelines. Only controlled acute and chronic studies on young, healthy participants assessing RE ($O_2$/energy consumption at $VO_2$max-relative velocities) were included, while those without controls or metabolic outcomes were excluded. Data were meta-analyzed using robust variance estimation with subgroup analyses for stretching type and a meta regression for running velocity. Risk of bias was assessed via PEDro, and certainty of evidence was classified using GRADE. The protocol was registered on OSF (https://doi.org/10.17605/OSF.IO/MA8D4).

RESULTS: There was low certainty of evidence derived from 14 studies with a total of 169 participants, indicating that stretching did not significantly moderate RE (ES=0.007, p=0.93). This result remained consistent across different stretching types (dynamic, static, and proprioceptive neuromuscular facilitation), with no significant effects observed (p=0.30–0.35). Due to the limited number of chronic studies, long-term effects were assessed qualitatively with both studies indicating no significance effects (effects ES: -0.320 to 0.02, p>0.05).

CONCLUSION: Stretching is often thought to reduce stiffness and impair RE (4,5), but current evidence does not support this. However, flaws in study designs and small sample sizes, varying test speeds, and unrealistic stretching durations limit conclusions and calls for future, well-designed studies with an urgent need for chronic studies.

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**IMPACT OF CHRONIC SLEEP RESTRICTION ON STRENGTH ENDURANCE AND TORQUE VARIABILITY DURING SUSTAINED ISOMETRIC CONTRACTIONS**

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*KU LEUVEN*

INTRODUCTION: Sufficient sleep is essential to achieve peak physical and cognitive performance. While insufficient sleep appears to have no impact on maximal force production, its effects on strength endurance and force control remain inconclusive. Therefore, we will measure these two parameters during sustained isometric contractions following a 4-night sleep restriction protocol. We will hereby focus on the muscles of the ankle, a crucial joint in everyday locomotion.

METHODS: Twenty-two healthy, young male subjects (21.33 ± 1.23 yrs) with a normal sleep pattern underwent two conditions: a sleep restriction condition (SR) and a control condition (CON). All subjects completed both conditions in a randomized order, interspersed by a 1-week wash-out period. In both conditions, subjects' habitual sleep was monitored for 7 nights before the first baseline session in the lab (SR-PRE or CON-PRE). After this first session, subjects in the SR condition were requested to sleep 5 hrs for 4 nights, while subjects in the control condition continued their normal sleep habits. Afterwards, all subjects returned to the lab for a second session (SR-POST or CON-POST). Sleep duration was monitored using wrist actigraphy and a sleep diary. Force control assessments comprised maximal and submaximal dorsiflexion (DF) and plantarflexion (PF) contractions of the ankle on an isokinetic dynamometer. Subjects performed (i) 3 maximal DF and PF contractions, (ii) 6 DF and 6 PF contractions of one minute at 40% of their maximal voluntary contraction (MVC), and (iii) 1 submaximal DF and PF contraction until failure. Force control was assessed by torque variability using both linear (i.e. coefficient of variation) and non-linear methods (i.e. sample entropy and detrended fluctuation analysis). During the contractions, muscle activity of the tibialis anterior and gastrocnemius medialis muscles was measured using electromyography. Additionally, vigilance was assessed using the Psychomotor Vigilance Task (PVT), and subjective workload via NASA-TLX scores. Data were analyzed using a linear mixed model.

RESULTS: After four nights of sleep restriction, time until failure during the submaximal DF contraction decreased significantly (SR-PRE: 242 ± 113, SR-POST: 206 ± 81, CON-PRE: 184 ± 105, CON-POST: 200 ± 97 s, p<0.05). In addition, subjects scored significantly higher on the NASA task load index, with a significant difference on the mental load subscale (SR-PRE: 7.23 ± 4.62, SR-POST: 10.8 ± 6.08, CON-PRE: 7.64 ± 4.28, CON-POST: 7.45 ± 4.52, p<0.01). Vigilance was significantly affected as observed by increased reaction times during the PVT task (SR-PRE: 363 ± 34.9, SR-POST: 408 ± 66.5, CON-PRE: 379 ± 47.3, CON-POST: 373 ± 37.5 ms, p<0.001). No changes were found for torque variability and muscle activity.

CONCLUSION: Four nights of sleep restriction reduces strength endurance of the dorsiflexor muscles, increases mental task load, and reduces vigilance of participants. Torque variability and muscle activity remained unaltered.

**ULTRASOUND STIMULATION ACUTELY DECREASES DEEP MUSCLE STIFFNESS**

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INTRODUCTION: In sports, muscle injuries frequently occur at both the medial gastrocnemius (MG) and soleus (SOL) [1]. Previous research shows that a higher risk of muscle injury is associated with higher muscle stiffness [2]. To decrease muscle stiffness, massage and superficial thermal stimulation are commonly used for the triceps surae in clinical practice [3]. However, applying these stimulations to SOL is difficult because of its deep location. In the present study, we focused on ultrasound stimulation, which has mechanical vibration and heating effects on the deep tissues, possibly leading to a decrease in the stiffness of deep muscles [4]. However, this possibility has not been directly tested yet. Thus, this study aimed to evaluate the effects of ultrasound stimulation on muscle stiffness of the triceps surae.

METHODS: Sixteen healthy adults (9 males) were recruited for this study. Ultrasound stimulation (1 MHz, 2.0 W/cm²) was applied for 10 minutes to the skin over the MG of one leg in the prone position, while the other leg served as the control. The shear wave velocity (SWV) of MG and SOL, which is an index of muscle stiffness, was assessed before and immediately after the stimulation using the shear wave elastography mode of an ultrasound device. The thickness of MG plus its superficial fat (MGF) was measured using B-mode ultrasonography before the stimulation. Two-way ANOVA (legs x time points) and Pearson's correlation analysis were performed.

RESULTS: The SWV of SOL after the ultrasound stimulation was significantly lower than that before the stimulation ($p = 0.005$) and that of the control leg ($p = 0.018$). In contrast, no significant interaction or main effects were observed for SWV of MG. A significant negative correlation was observed between SWV of SOL before ultrasound stimulation and changes in the SWV after the stimulation ($r = -0.742$, $p = 0.001$). However, such a correlation was not significant in MG. In addition, no significant correlations were found between the thickness of MGF and changes in SWV of MG or SOL.

CONCLUSION: This study showed that applying 1 MHz ultrasound stimulation for 10 minutes decreased the stiffness of SOL, but did not affect the stiffness of MG. It has been shown that applying 1 MHz ultrasound stimulation for 10 minutes increases the temperature of tissues 2.5 cm beneath the skin by 4.0°C [5]. In addition, an increase in tissue temperature decreases the stiffness of the tissue [6]. Thus, the heating effect of ultrasound stimulation may lead to a reduction in muscle stiffness of SOL. Notably, the effect of ultrasound stimulation was more significant in individuals with higher baseline muscle stiffness. These findings suggest that ultrasound stimulation is a promising approach to reducing the stiffness of deep muscles, potentially contributing to injury prevention.

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**MOVEMENT COORDINATION PATTERN DIFFERENCES BETWEEN LEFT- AND RIGHT-HANDED VOLLEYBALL SERVES**

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INTRODUCTION: Previous studies have reported lower anticipation accuracy in predicting the spike direction and movement type for left-handed volleyball players (1). Similar tendency was observed in anticipating the tennis serve direction and depth for left-handed serves even they were mirrored from right-handed ones (2). This phenomenon is attributed to lower perceptual familiarity with left-handed movements. However, whether there are movement coordination differences between left- and right-handed players remains unexamined.

METHODS: Three left-handed and three right-handed skilled volleyball players were recruited to perform 3 standing overhead float serves. Two high-speed cameras (240 fps) were used to record their serves, and the best trial from each player was selected for analysis. The trajectories of bilateral shoulders, elbows, wrists, hips, knees, and ankles were digitized using Kwon 3D. The resultant 12 joint angle time-series, along with trunk rotation, were input to Principal Component Analysis (PCA) to examine the movement coordination patterns of each serve.

RESULTS: Compared to right-handed players, left-handed players showed larger dominant ankle angle (130° > 107°) and a smaller non-dominant ankle angle (112° < 128°) at ball contact. The 13 kinematic time-series were effectively represented by 3 components, explaining approximately 80% of the variance. The first component, which included six to nine kinematic time-series, was primarily contributed by bilateral shoulder and knee angles across all serves, highlighting their key role in this type of serve. For two left-handed and one right-handed player, the dominant hip angle, but not the dominant elbow angle, was included in the first component. This suggested that their arm posture remained relatively stable during preparation phase, while changes in the dominant hip angle characterized their movement coordination patterns. Additionally, the trunk rotation was not included in the first component for the two left-handed players. This was due to their shoulder and hip rotating in a similar manner, whereas other players exhibited greater shoulder rotation compared to hip rotation.

CONCLUSION: The findings of this study suggest that bilateral shoulders and knees movements play an important role in standing overhead float serves. The absence of trunk rotation and dominant elbow angle in the first component for the two left-handed players suggested that their movements provided fewer distinguishable cues compared to right-handed players. This may explain why the movements of left-handed players are more difficult to predict.

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**VISUAL REACTION TIME CANNOT DETECT EXPERTISE IN SOCCER GOALKEEPERS VERSUS CONTROLS**

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INTRODUCTION: Visual reaction time (VRT) has been shown to be an expertise factor in some sports, compared to controls without prior sports training.[1]

At the same time, it seems to play a relevant role in injury prevention, and return-to-play contexts.[2]

While VRT evaluation is commonly assessed with computer-based tools, there is a need to develop new methods that better recreate the sport reality.[2]

We investigated the reliability of a VRT test in athletes with high reaction time demands (soccer goalkeepers, GK) and a physically active population; and compared the differences between them.

METHODS: A group of 21 male semi-professional GKs and 19 male students (STUD) practicing sports without a strong VRT component, participated in the study. A subset of 17 GKs and another group of 18 STUD, participated in two different sessions, within a two-week period, for the reliability analysis.

Field VRT Test: Two pairs of two FitLight sensors were placed 160cm apart at 90 & 170 cm height.

Participants had to stand in the middle and "deactivate" a series of 12 visual stimuli (3 per sensor) as fast as possible by passing the side-matching hand <30cm in front of the sensor.

An additional sensor was placed in front of the participant to pace the two-second pauses between stimuli. The mean of all responses was used for analysis.

Computer-based tests: Simple Response Time Task (SRT); Four Choice Visuospatial Response Task (4Cho); and Go/No-Go Response Inhibition Test (GoNoGo). Mean response time and number of errors were used for analysis.

We used Two-Way Mixed ICC for test-retest reliability; Wilcoxon and T-test for group comparisons (for $p < .05$ and $> .05$ Shapiro Tested normality, respectively). Significance was set at $p < .05$.

RESULTS: The reliability of the proposed VRT test was "moderate" (ICC=.74).

GKs were not significantly faster than STUD (657±96 ms vs 680±69 ms, p=.400).

GKs were also non-significantly faster on SRT (317±37 ms vs 329±42 ms, p=.531), 4Cho (455±98 ms vs 460±122 ms, p=.925), GoNoGo (438±42 ms vs 440±3 ms, p=.896); and had fewer errors on GoNoGo (9.6±7 vs 11.6±6, p=.273).

CONCLUSION: Non-significant group differences suggest that VRT is not an expertise factor for GKs.

Practitioners interested in performance assessment or talent identification are advised to prioritize the evaluation of other parameters.

A multifactor use of VRT for these purposes remains to be explored.

In this population, the field test appears to be a reliable measure of VRT. Further studies in injury prevention and return to sport could explore the use of this test to incorporate VRT into common field practices (preseason testing, rehabilitation protocols, etc.).

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## Conventional Print Poster Presentations

### CP-BM04 Muscle and Tendon Mechanics

**ACHILLES TENDON STIFFNESS IN THE PREFERRED AND NON-PREFERRED TAKEOFF LEG OF UNIVERSITY BASKETBALL ATHLETES: RELATION WITH PERFORMANCE, RANGE OF MOTION, AND INJURY**

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INTRODUCTION: Achilles tendon (AT) stiffness is a key factor in athletic performance, particularly in high-impact sports such as basketball. Athletes generally exhibit higher AT stiffness than the general population, which can enhance force transmission and movement efficiency but may also increase injury risk if not balanced with adequate strength and control. Shear-wave elastography (SWE) has been used to assess AT stiffness, yet the relationship between AT stiffness, performance, range of motion (ROM), and injury in university athletes remains unclear. This study aimed to investigate these relationships in male and female university varsity basketball players.

METHODS: Thirty-two university level varsity basketball athletes (12 females, 20 males) participated in this cross-sectional study. SWE was used to assess AT stiffness in both the preferred takeoff leg (PTL) and non-preferred takeoff leg (NPTL). Functional assessments included a single-leg vertical jump, heel raise test, and ankle dorsiflexion ROM. Participants also completed questionnaires on demographics, injury history, and Victorian Institute of Sport Assessment-Achilles (VISA-A) scores. Testing was conducted in a standardized manner pre-training. Paired t-tests compared AT stiffness between PTL and NPTL, while independent t-tests examined differences in AT stiffness and asymmetry between athletes with and without a recent history of lower body injury. Pearson correlations were used to assess relationships between AT stiffness, performance, and ROM.

RESULTS: Mean AT stiffness was 455.4 ± 72.4 kPa in male athletes and 411.7 ± 48.5 kPa in female athletes (p = 0.185). No significant differences in AT stiffness were observed between PTL and NPTL in either males (448.2 ± 83.6 kPa vs. 462.6 ± 84.6 kPa) or females (407.9 ± 40.0 kPa vs. 415.5 ± 77.3 kPa). Male athletes who had sustained a lower body injury in the previous 12 months exhibited significantly lower AT stiffness than non-injured males (p = 0.040), while female athletes with a recent lower body injury displayed lower between-limb stiffness asymmetry compared to their healthy counterparts (p = 0.027). No significant correlations were found between AT stiffness and performance measures or ROM in either sex.

CONCLUSION: This study found no significant differences in AT stiffness between the PTL and NPTL or between male and female basketball athletes. However, male athletes with a recent history of injury demonstrated significantly lower AT stiffness, while female athletes with a recent injury exhibited reduced side-to-side stiffness asymmetry. Our findings suggest that injury history may influence AT stiffness, however, AT stiffness was not associated with functional performance or ROM in our sample of university level basketball players. Further research is warranted to explore the long-term implications of AT stiffness variations on injury risk and athletic performance.

**EFFECT OF VARIOUS FOOTWEAR ON THE VISCOELASTIC PROPERTIES IN THE LOWER LEG SYSTEM THROUGH CHANGE IN MUSCLE FORCE OUTPUT**

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INTRODUCTION: During the contact phase of running, the visco-elastic properties of the muscle-tendon complex (MTC) play a crucial role in functional muscle-tendon interaction and the recycling of elastic energy [1].In recent years, the use of thick-soled shoes in track and field events has led to improvements in running efficiency and competition records, but the effects of these shoes on the mechanical properties of the lower leg system, including MTC, are still unclear in many cases. In addition, the effects of the muscle force exerted by changes in running speed are also unknown. The purpose of this study was to clarify these changes experimentally.

METHODS: Eight male and female subjects participated in the study. The viscoelastic properties of the MTC were measured using the vibration method under multiple load settings (similar to Fukashiro et al. [2]). The subject was placed in a seated position (ankle and knee joints 90deg), with the ball of the foot on a force plate edge. A weight was placed on the knee, and with the posture maintained by isometric contraction (the muscle force exerted was varied), the damped oscillation of the triceps surae muscle was induced. The waveforms were regressed by the least-squares method on the following equation to calculate the unknowns, gamma ($\gamma$), omega($\omega$), $ac$, $as$ and M.

$F(t)$=e^$-\gamma t$ ($ac\cos\omega t + as\sin\omega t$)+Mg

where F is force, t is time, e is Napier number, $\gamma$ is damping factor, a is amplitude, $\omega$ is angular frequency, M is effective mass, and g is gravitational acceleration. Then, after consideration of the moment arm of muscle, the elastic and viscous coefficients (k and b) of MTC were calculated.

k=M($\omega$^2+$\gamma$^2)

b=2M$\gamma$

These measurements were taken in three conditions: barefoot (S0), conventional running shoes (S1), and thick-soled shoes (S2).

RESULTS: Elastic coefficients: k increased significantly with force increment in all shoes. k of S1 was greater than that of S0 in all force application conditions. S2 showed almost the same value as S1 up to 300N, but after that k decreased, and at 600N it was smaller than S0. Viscosity coefficient: b increased significantly with force application up to 300N for all shoes. The change trends for S0 and S1 were similar, but S2 showed much lower b than the other two conditions after 300N. In addition, the individual differences due to different shoes on both coefficients were substantial.

CONCLUSION: It was suggested that the effect of the shoes on the viscoelasticity of the lower leg system was related to the exerted muscle force, or, in other words, the strength of the kick during the contact phase of running. The effect of these shoes could be related to the intrinsic viscoelasticity of MTC in subjects.

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**VELOCITY-DEPENDENT SOLEUS COMPENSATION FOR GASTROCNEMIUS FUNCTION IN KNEE-FLEXED PLANTARFLEXION: EVIDENCE FROM NEUROMECHANICAL AND MORPHOLOGICAL SYNCHRONIZATION**

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INTRODUCTION: When the knee is flexed, during plantarflexion the gastrocnemius muscles contribution to ankle torque is reduced. Literature reports are inconsistent whether soleus (SOL) compensates for this reduced gastrocnemius function. Therefore, the aim of this study was to investigate SOL fascicle behavior during plantarflexion with the knee flexed vs. knee extended. We hypothesize that the compensation of the soleus muscle is evident when the knee joint is flexed. However, we assume that at high angular velocities, the compensation of the soleus muscle is not significantly affected by changes in knee joint angle.

METHODS: Healthy physically active Chinese male university students (n=17) performed knee-flexed (90°) and knee-extended (180°) plantarflexions at 60°·s-1 and 120°·s-1 on an isokinetic dynamometer. During the measurements, electromyographic activity of the medial gastrocnemius (MG) and SOL were recorded with bipolar surface electrodes, and the fascicle behavior of these muscles were obtained by ultrasonography.

RESULTS: Plantarflexion peak torque performed with the knee flexed vs. knee extended was lower by 44% at $60°\cdot s^{-1}$ ($p < 0.001$) and 18% at $120°\cdot s^{-1}$ ($p = 0.0001$). SOL EMG activity was higher in knee-flexed plantarflexion by 44.9% at 60°·s-1 and by 21.6% at 120°·s-1. As expected, MG activity was lower in knee-flexed plantarflexion at both velocities (22.9 ±9.8%at $60°\cdot s^{-1}$ vs 67.6±12.3 %at $120°\cdot s^{-1}$, $p = 0.005$). MG fascicles operated at shorter fascicle length (14.3±0.6% at $60°\cdot s^{-1}$ vs 46.7±0.6% at $120°\cdot s^{-1}$, $p > 0.005$) in knee-flexed vs. knee-extended plantarflexion. Knee joint position did not affect SOL fascicle shortening.

CONCLUSION: Consistent with previous literature, our findings indicate that a flexed knee joint position alters medial gastrocnemius (MG) fascicle behavior and activation patterns. Although the SOL exhibited higher electrical activity at lower contraction velocities in the knee-flexed position, this did not correlate with distinct fascicle behavior, and the differences were minimal at higher contraction velocities. Consequently, we cannot directly confirm that SOL compensates for reduced MG function during knee-flexed plantarflexion. Additionally, while EMG activity demonstrated statistical significance, muscle fiber performance did not, suggesting that changes in knee joint position increase muscle activation without providing definitive evidence of SOL compensation.

**MUSCLE-TENDON MORPHOLOGICAL PROPERTIES IN RUGBY PLAYERS AND MIDDLE-DISTANCE RUNNERS**

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INTRODUCTION: Human knee joint extensor muscle-tendon and ankle joint plantar flexor muscle–tendon units play an important role in producing propulsive force in running and jumping. Muscle and tendon interactions and their biomechanical behaviours depend on their morphological characteristics. Recent research shows that tendon thickness does not correlate with muscle mass, suggesting that resistance training does not increase tendon thickness.

METHODS: This study was conducted to investigate the morphological characteristics of knee extensor muscle-tendon and ankle joint plantar flexor muscle-tendon units in rugby players and middle-distance runners. Furthermore, the maximum voluntary isometric contractions in different tasks were determined. Nineteen athletes of national level (9 rugby players; age: 25.67±4.09 years; stature: 178.11±6.21 cm; body mass: 89.78±16.64 kg; BMI: 28.21±4.39 kg/m2; and 10 middle distance runners; age: 24.80±5.69 years; stature: 178.40±4.30 cm; body mass: 6.90±4.82 kg; BMI: 20.68±0.91 kg/m2) participated in this investigation. The magnetic resonance imagining scan (MRI) was utilized to measure the cross-sectional areas of the Achilles tendon (AT), patellar tendon (PT), plantar flexors (soleus, lateral and medial gastrocnemius) and knee extensors (vastus medialis, vastus lateralis, vastus intermedius, and rectus femoris) on the dominant leg. Maximal isometric voluntary contractions (MVICs) were executed while pushing against a barbell locked in a Smith machine. Before starting the MVICs, the participants assumed a half-squat position and a calf rise. For each task, they conducted three trials, and the highest value was used for analysis.

RESULTS: The CSA of AT and PT was significantly higher in rugby players compared to middle-distance runners (p=0.011). The rugby players demonstrated a higher CSA in their knee extensors muscles compared to the middle-distance runners (p=0.001), but not in their planter flexors (p=0.123). Rugby athletes demonstrated weak correlations between CSA PT and CSA knee extensors (r=-016, p=0.468) and between CSA AT and plantar flexors (r=0.29, p>0.05). Conversely, middle-distance runners showed a strong correlation between CSA PT and CSA knee extensors (r=0.51, p=0.132) and between CSA AT and CSA plantar flexors (r=0.63, p=0.052).

CONCLUSION: The findings of the present study confirm that the morphological characteristics of PT and AT in rugby players do not correlate with their respective muscle sizes. One possible explanation could pertain to the diverse tissue responses to an exercise stimulus. Given the significant variation in tissue responses to the same stimulus, it is plausible that the optimal loading for muscle tissue may be suboptimal for the tendon tissue in rugby players. In this regard, a substantial training volume over a prolonged period may alter the ratio of muscle/tendon cross-sectional area and potentially increase the likelihood of tendinopathy.

**MUSCLE GEARING IS INDEPENDENTLY AFFECTED BY THE FORCE, VELOCITY, AND ACTIVATION OF A MUSCLE.**

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INTRODUCTION: The velocity that muscle fibres shorten affect their potential to generate force and power (1). Fibres in pennate muscle typically shorten at slower velocity than the whole muscle belly, in a process known as belly gearing (2). Previous experimental studies showed that gearing depends on the muscle force (3), and structural models have suggested that gearing is influenced by the properties of connective tissue associated with the muscle (4). However, it has not been clear how the activation state, velocity of the muscle belly itself or properties of the muscle tissue affect this gearing phenomenon. This study aimed to establish a mechanistic link between the muscle tissue properties and the contractile conditions with the belly gearing.

METHODS: Muscle belly gearing was modelled for a block of muscle tissue (18.6 x 6.58 x 6.95 mm with an initial pennation angle of 26.1°) that was represented as a fibre-reinforced composite biomaterial, in a fully-dynamic implementation that was solved using the principles of continuum mechanics. The block was stretched (110%) from its initial length, activated to a set level (0-100%), and allowed to shorten at a prescribed isovelocity rate (0-120 mm s-1) while it was still active. At the moment that the block passed back through its initial length, the mean fibre velocity was determined and related to the prescribed velocity of the block to determine the belly gearing.

RESULTS: When the muscle contraction was simulated, the fibres shortened and also rotated to increase in pennation as the muscle block shortened. The rate of fibre rotation increased with both muscle shortening velocity and increasing activation. The fibre shortening velocity increased with muscle velocity, but this velocity was lessened at higher activations. The muscle belly gearing decreased with muscle force, increased with muscle velocity, and increased with activation.

CONCLUSION: The simulations predicted similar gearing effects that have been reported for maximally activated muscles in animal studies but also now predict the more nuanced effects that occur at submaximal activations as is the case during human movement. All the general features of muscle belly gearing emerged from the physics of the contractile elements and the muscle tissue properties alone, and do not need effects from other tissues to occur (i.e. aponeurosis, ECM or intramuscular fat). Further, this simulation framework shows how force, velocity, and activation independently affect muscle gear. The exact state of the tissue when the measures were probed depends on the energy balance at each condition, which in turn depends on the complex interaction between tissue stiffness, compressibility, and mass as well as the activation state and fibre contractile properties.

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**TOWARD SELECTIVE DECREASE IN MUSCLE STIFFNESS: CAN STATIC STRETCHING COMBINING THREE-DIMENSIONAL HIP JOINT ROTATIONS DECREASE THE STIFFNESS OF TARGET HAMSTRING?**

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INTRODUCTION: High passive muscle stiffness is related to a high risk of hamstring strain injuries [1]. To reduce hamstring stiffness, static stretching is widely used in the sports field. As the susceptibility of individual hamstring muscles to strain injury varies depending on the types of sports [2], selective reduction in stiffness of the target muscle by stretching may be a key to prevention of the injury. Previous studies have mainly tested the effects of static stretching on hamstring stiffness within the sagittal plane, such as hip flexion or knee extension [3,4]. However, the hip joint (a ball-and-socket joint) rotates in three dimensions, and the biarticular hamstring muscles run three-dimensionally across the hip joint. Thus, static stretching with the hip joint position outside the sagittal plane may influence its effects on hamstring stiffness. This study aimed to investigate whether static stretching combining three-dimensional hip joint rotations decreases the stiffness of target hamstring.

METHODS: Fourteen young males participated in three sessions (on separate days) of static stretching (five sets of 90 s), in which the hip joint was passively flexed until their pain onset with 0° knee flexion in different hip abduction and rotation positions: 1) 0° abduction and 0° rotation (N-N), 2) 20° abduction and 30° internal rotation (Abd-In), and 3) 20° abduction and 30° external rotation (Abd-Ex). Before and after the stretching, the maximal knee extension range of motion (ROM), and the shear modulus (an index of muscle stiffness) of right biceps femoris long head (BFlh), semitendinosus (ST), and semimembranosus (SM) were measured with shear wave elastography, and their changes were examined with the Wilcoxon signed-rank test. The Friedman test was used to compare change values in each variable across stretching positions.

RESULTS: The shear modulus of SM was decreased after stretching in the Abd-Ex position (−11.6%, $p < 0.01$), but not in the N-N or Abd-In positions. No significant changes were observed in the shear moduli of BFlh or ST in any positions. The ROM increased after stretching in all positions (all $p < 0.001$); however, no significant differences were found in the extent of ROM increase across positions.

CONCLUSION: The stiffness of SM was selectively decreased after stretching in the Abd-Ex position. As SM is susceptible to strain injury in dancers [2], this finding may help prevent it. The result showed that stretching in the N-N position did not always reduce hamstring stiffness, even though it is widely used in sports and clinical settings. Our findings highlight the necessity of combining three-dimensional hip joint rotations during static stretching to reduce the stiffness of target muscle and contribute to developing preventive programs for hamstring strain injuries.

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**ULTRASONOGRAPHIC ANALYSIS OF THREE SUB-TENDONS WITHIN THE HUMAN ACHILLES TENDON**

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INTRODUCTION: The Achilles tendon (AT) consists of three distinct sub-tendons originating from the medial head of gastrocnemius (MG-AT), lateral head of gastrocnemius (LG-AT), and soleus muscle (SOL-AT). Previous cadaveric studies have classified the twisted structure of these three sub-tendons into three distinct patterns based on their calcaneal insertion sites (Edama et al. 2015; Pękala et al. 2017). Variations in the degree of this AT twisting could affect stress distribution patterns within the tendon. Thus, it is important to monitor the AT twisting in vivo from an injury prevention perspective in sports. AT injuries most commonly occur 2-6 cm proximal to the calcaneal insertion. Therefore, the purpose of the present study was to examine the AT twisting in vivo using ultrasonography and to demonstrate variations in the degree of the AT twisting in vivo and the spatial relationships among sub-tendons at 4 cm proximal to the AT insertion.

METHODS: Twenty healthy adults (age: 27.0 ± 6.6 years, height: 172.6 ± 7.6 cm, body mass: 61.8 ± 13.3 kg) participated in this study. Using high-resolution ultrasonography (ARIETTA 850, Fujifilm Healthcare, Japan), the cross-sectional images of the Achilles tendon from both legs were obtained in a standing position from the gastrocnemius muscle-tendon junction to the AT insertion on the calcaneus. The images were digitally enhanced for optimal visualization. The classification and the spatial relationships among the three sub-tendons (MG-AT, LG-AT and SOL-AT) were examined at 4 cm proximal to the AT insertion.

RESULTS: Analysis of the spatial relationships among the three sub-tendons classified three distinct anatomical arrangements through ultrasonographic imaging. The first type, observed in 6 limbs (15.0%), showed minimal twisting, where LG-AT and MG-AT positioned superficially and SOL-AT was located deep. The second type, found in 30 limbs (75.0%), demonstrated moderate twisting, where MG-AT was positioned superficially while LG-AT and SOL-AT deep. The third type, seen in 4 limbs (10.0%), exhibited pronounced twisting where MG-AT and SOL-AT was positioned superficially, and LG-AT deep. Analysis of bilateral symmetry using weighted Kappa coefficient with quadratic weighting revealed no agreement above chance level ($\kappa$ = -0.010) between the left and right AT twist patterns.

CONCLUSION: Ultrasonographic analyses confirmed three distinct spatial arrangements of the human AT sub-tendons, with the moderate twisting pattern being most prevalent. Notably, more than half of the participants showed asymmetrical twisting patterns between legs. These asymmetrical patterns may have influenced the differences in the stiffness and length of the AT in the left and right legs (Bohm et al. 2015).

**REGION-SPECIFIC PASSIVE STRETCH RESPONSE OF THE BICEPS FEMORIS LONG HEAD USING SHEAR-WAVE ELASTOGRAPHY: AN IN VIVO STUDY**

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INTRODUCTION: Understanding the passive mechanical properties of the biceps femoris long head (BFlh) will contribute to the development of accurate musculoskeletal models that can provide valuable insights into the mechanisms underlying strain injuries. The BFlh has intramuscular variability in fascicle and aponeurosis morphology and architecture (1), suggesting regional heterogeneity in passive mechanical properties during muscle elongation. However, whether passive stretch responses, such as the slack angle, differ regionally within the BFlh, in vivo, remains unclear. Therefore, this study investigated the region-specific stretch response within the BFlh during passive knee extension using ultrasound shear wave elastography.

METHODS: Nine healthy males (mean, 21.7 ± 2.3 years) participated. The shear modulus was measured using shear wave elastography at knee flexion angles ranging from 90° to 0°, in 5° decrements. Measurements were taken at three regions of the right BFlh: proximal (25%), middle (50%), and distal (75%) of the distance between the musculotendinous junctions (0% proximal, 100% distal). A piecewise exponential model was applied to the shear modulus–knee angle data to calculate the passive stretch response characteristics, including the slack angle, slack shear modulus, and the slope of the increase in shear modulus (2). The fit quality of the model was evaluated using the coefficient of determination ($R^2$), and data with $R^2 \geq 0.5$ were included in the statistical analysis. For passive stretch response characteristics, a one-way analysis of variance (sites: proximal, middle, and distal), followed by Tukey's honestly significant difference post hoc test ($p < 0.05$), was performed.

RESULTS: All data had an $R^2$ value ≥ 0.5 (distal: 0.93 ± 0.05, middle: 0.91 ± 0.03, and proximal: 0.86 ± 0.11). A significant main effect of the site ($p < 0.05$) was observed for slack angle (distal: 68.02 ± 15.58°, middle: 59.80 ± 12.18°, and proximal: 50.96 ± 10.83°), with post hoc analysis revealing a significantly larger slack angle at the distal region compared to the middle region ($p < 0.05$). There were no significant main effects of the site for slack shear modulus (distal: 2.91 ± 0.39 kPa, middle: 2.96 ± 0.31 kPa, and proximal: 2.97 ± 0.17 kPa) or the slope of the increase in shear modulus (distal: 0.0110 ± 0.0045, middle: 0.0081 ± 0.0021, and proximal: 0.0087 ± 0.0061).

CONCLUSION: This study investigated regional variability in the passive stretch response within the BFlh, as quantified by the shear modulus–knee angle relationship. The distal region had a significantly larger slack angle than the proximal regions, indicating earlier development of passive tension during knee extension. These findings provide novel insights into the regional passive mechanical properties of the BFlh with implications for developing musculoskeletal models and understanding mechanisms underlying strain injuries.

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**VALIDATING THE MYOTONPRO: COMPARING DYNAMIC AND TENSILE STIFFNESS OF THE ACHILLES TENDON**

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INTRODUCTION: Stiffness is an important property of tendon and often investigated due to its functional relevance to injury and athletic performance. It is traditionally measured as the lengthening that results from tendon loading ('tensile stiffness') and until recently was limited to being obtained in a research setting. The MyotonPRO, a handheld device which imparts a small perturbation to the tissue of interest and measures the responding oscillations, now provides a fast and simple alternative ('dynamic stiffness'). As a result, stiffness obtained from the MyotonPRO is increasingly used as a surrogate for tensile stiffness, however it remains unclear if stiffness obtained using this device is comparable to tensile stiffness. We sought to evaluate the dynamic stiffness measured by the MyotonPRO in relation to tensile stiffness obtained through established methods.

METHODS: Tensile stiffness of the Achilles tendon was obtained from 18 healthy individuals using a combination of 3D motion analysis, passive ankle rotations performed on a dynamometer, and ultrasonography. Dynamic (transverse) stiffness was obtained from a standardized location superficial to the Achilles tendon mid-portion using tissue oscillations produced and recorded by the MyotonPRO. Both methods calculated stiffness estimates from a similar joint angle, under resting conditions (passive tension only). The coefficient of variation for obtaining tensile and dynamic stiffness was 12.6% and 1.47%, respectively.

RESULTS: Regression analysis demonstrated a low correlation (R2 of 0.17) between stiffness values obtained using the two methods. Stiffness was consistently greater using the tensile method than MyotonPRO - mean tensile stiffness was 114 ± 63 N/mm and mean dynamic stiffness was 1.04 ± 0.27 N/mm. Bland-Altman analysis revealed limits of agreement ranging from -11.0 to 236.7 N/mm, indicating individual measurements differed substantially. A highly linear proportional bias (R2 =1) was also found simply because tensile stiffness values dominate the scale of measurement, rather than the difference between methods increasing systematically with measurement magnitude.

CONCLUSION: We found poor agreement between stiffness values obtained from the MyotonPRO and with tensile measurement techniques, indicating that the two methods are not interchangeable. The significant discrepancy in the magnitude of these values likely reflects a fundamental difference in how tendon stiffness is measured (rather than a simple scaling issue) and indicates that different aspects of tendon behavior are captured by each approach. Care must be taken to avoid confusing the reader and when referring to stiffness as an outcome measure using this non-tensile method.

## Conventional Print Poster Presentations

### CP-BM10 Jumping and Squating I

**PELVIC BELT-EQUIPPED GARMENT SUPPRESSES FATIGUE-INDUCED REDUCTIONS IN FORCE PRODUCTION DURING COUNTERMOVEMENT JUMP AND LANDING CUTTING**

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INTRODUCTION: Jump distance and rapid directional changes are crucial for athletic performance; however, fatigue reduces force production during these movements. For instance, fatigue decreases ankle power during countermovement jump (CMJ) push-off and knee extension force (1,2). Maintaining performance under fatigue during jumping and cutting maneuvers can reduce injury risk and improve athletic performance. Although pelvic belts are widely used for lower back support and have been shown to enhance hip energy absorption during landing (3), their effect on jumping and cutting

under fatigue is unclear. This study investigated whether a pelvic belt-equipped garment (PBG) can suppress fatigue-related declines in jumping and cutting performance.

METHODS: Ten male athletes (age: 20 ± 1 years; height: 1.70 ± 0.03 m; weight: 62 ± 8 kg), who participated in sports at least three times per week, performed tasks under two conditions, one with PBG and the other without PBG (CON). Participants performed a CMJ and a landing cutting (LC) maneuver before and after a fatigue protocol, which consisted of the Yo-Yo intermittent endurance test Level 1 and box jumps. Motion data and ground reaction forces were recorded at 100 Hz and 1000 Hz, respectively. We calculated CMJ jump height, concentric phase impulse, and LC peak lateral propulsive force. A two-way ANOVA was used to assess the effects of garment condition (CON vs. PBG) and fatigue (PRE vs. POST), and paired t-tests with Holm correction were performed for post hoc comparisons.

RESULTS: In the CON condition, the CMJ jump height significantly decreased (CON-PRE: 0.38 ± 0.08 m, CON-POST: 0.32 ± 0.07 m, $p < 0.01$), and the impulse during the concentric phase of the CMJ significantly decreased (CON-PRE: 2.83 ± 0.26 N/Body weight, CON-POST: 2.65 ± 0.25 N/Body weight, $p < 0.01$). Similarly, the LC peak lateral propulsive force significantly decreased (CON-PRE: 0.65 ± 0.18 N/Body weight, CON-POST: 0.56 ± 0.16 N/Body weight, $p = 0.04$). In the PBG condition, CMJ jump height, concentric impulse, and LC peak lateral propulsive force did not significantly decrease after fatigue.

CONCLUSION: In the CON condition, fatigue significantly reduced CMJ jump height, concentric impulse, and LC peak lateral propulsive force. However, these reductions were not significant in the PBG condition. These results suggest that the PBG may provide lumbar stabilization during repeated jumping and cutting maneuvers, thereby suppressing fatigue induced declines in force production. Consequently, the PBG could help maintain propulsion force production for CMJ and LC under fatigue.

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**THE DIFFERENCE IN LANDING SOUND AND MOVEMENT DURING SPIKE JUMP BETWEEN EXPERIENCED AND INEXPERIENCED VOLLEYBALL PLAYERS**

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INTRODUCTION: Volleyball players frequently sustain injuries during jump landings. Experienced volleyball players typically achieve higher jump height than inexperienced players. However, no significant differences are observed in vertical ground reaction force (vGRF) in each group. A previous study reported that experienced players mitigate landing impact by increasing the range of motion (ROM) in ankle joint during landing [1]. Furthermore, vGRF is positively correlated with landing sound. The quieter landing is associated with greater lower limb joint movement [2]. This study aimed to compare landing sound during spike jump landing in real-field scenario, and investigate differences in landing mechanics between experienced and inexperienced volleyball players.

METHODS: Twenty male university students (experienced, n=10; inexperienced, n=10) participated in this study. After measuring their maximum spike jump height, participants performed spike jump aiming to reach that height and landed on both feet. Landing sound, as well as knee and ankle joint angles were analyzed. Landing sound was measured using the Sonic Tools SVM app (Rikki systems, Japan), and joint angles were recorded from a lateral view using a smartphone. Initial contact and maximum flexion angles were calculated using Tracker 6.2.0 software (Open Source Physics, US), and ROM was determined as the angular displacement between these points. For statistical analysis, a paired t-test was conducted to compare the jump heights, landing sounds and joint angles between the two groups. In addition, correlations between landing sound and joint angles were analyzed using Pearson's correlation ($p < 0.05$).

RESULTS: Experienced volleyball players had significantly higher jump heights than inexperienced players (55.1±5.6 cm vs. 46.1±7.2 cm, $p = 0.009$), but no significant differences were observed in landing sound and joint angles. In experienced players, landing sound exhibited stronger negative correlations with joint movement, particularly with maximum ankle dorsiflexion ($r = -0.70$, $p = 0.02$), maximum knee flexion ($r = -0.61$, $p=0.06$), and knee joint ROM ($r = -0.59$, $p = 0.07$).

CONCLUSION: While experienced volleyball players demonstrated greater jump heights, no significant differences in landing sound were observed in each group. Although joint angles showed no significant differences, stronger negative correlations observed in experienced players suggest that volleyball experience may influence muscle activity in the ankle and knee joints during landing. These findings suggest that volleyball experience may enhance the ability of joints to absorb landing impact more effectively. Additionally, coaching strategies that emphasize quieter landings may encourage greater joint movement, potentially reducing the risk of injury.

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**THE EFFECT OF REBOUND-JUMP LANDINGS WITH TRUNK ROTATION ON KNEE JOINT ANGLE IN FEMALE BASKETBALL PLAYERS**

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INTRODUCTION: The anterior cruciate ligament (ACL) injuries frequently occur in a slightly flexed and valgus knee position, during jump landings and directional changes. Basketball is characterized by jump landings with trunk rotations (rebound-jump landing) depending on the competitive scene, and especially women athletes have a higher incidence of ACL injuries. Previous study has examined the effect of rebound-jump landing with trunk rotation toward the takeoff leg (TL) and reported that the non-takeoff leg (NTL) exhibited smaller flexion and larger valgus angles of knee joint [1]. However, the direction of rotation was limited. Therefore, this study aimed to investigate the differences in knee joint angles during rebound-jump landings under multiple rotational conditions.

METHODS: In total 11 female basketball players with more than 3 years of experience were participated in this study. The 3-dementional motion analysis was used to calculate the knee joint angles during rebound-jump landings in 3 conditions: (1) front-facing jump (Front), (2) with trunk rotation in 90° toward the TL (TL-side), and (3) with trunk rotation in 90° toward the NTL (NTL-side). The initial contact (IC) was defined as the point when the vertical ground reaction force exceeded 4 N. Measurements were taken at 5 points every 10 ms from IC up to 40 ms. In each condition, a paired t-test or Wilcoxon signed-rank test was used to compare knee angles between the TL and NTL ($p < 0.05$).

RESULTS: In the TL-side condition, the knee flexion angles were significantly smaller in the NTL compared to the TL at all time points ($p < 0.01$). In the NTL-side condition, the TL exhibited significantly larger knee valgus angles than the NTL at the IC, 10ms, and 20ms time points ($p < 0.05$). No significant differences in knee flexion or valgus angles were observed between the TL and NTL in the Front condition.

CONCLUSION: In case of jump landing with directional changes, it has been reported that the decreased knee joint flexion angle on landing in the front leg in relative to the jump direction is involved in deceleration [2]. Consequently, the knee flexion angles of the NTL were smaller in the TL-side condition. Regarding the knee valgus angle of the TL in the NTL-side condition, the centrifugal force which occurred during rotation may affect. The centrifugal force during rotation affected the outer leg (the TL in the NTL-side condition) relative to the direction of rotation, resulting in an increased knee valgus angle [3]. This study suggests that the risk of ACL injuries increases during jump landings with trunk rotation, such as rebound-jumps in basketball, and that differences in rotation direction may be a factor affecting the injured side.

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**NEUROMECHANICAL CONTRIBUTIONS OF SINGLE-JOINT FOCUSED MOVEMENT SYNERGIES TO VERTICAL JUMP PERFORMANCE: IMPLICATIONS FOR TARGETED EXERCISE SELECTION**

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INTRODUCTION: Vertical jump (VJ) performance is a key indicator of explosive lower-body power in sports and an important measure in rehabilitation. Executing an effective VJ requires coordinated lower-limb and trunk extension, posing a complex neuromuscular control challenge. Despite the widespread use of targeted exercises to improve VJ performance, a clear neuromechanical framework for optimal exercise selection remains lacking, limiting the development of evidence-based training and rehabilitation strategies. This study systematically investigates the similarity between the muscle synergies of VJ and key single-joint focused movements (SFM).

METHODS: Fourteen healthy males (mean age: 20 ± 2 years) performed VJ (mean height: 49.0 ± 8.6 cm) and eight SFM—hip extension, abduction, active straight leg raise, knee extension/flexion, ankle plantar flexion, and trunk extension/flexion. EMG data from 16 lower-limb and trunk muscles were recorded wirelessly. Muscle synergies were extracted via non-negative matrix factorization (NMF) and clustered using k-means. SFM contributions to VJ synergies were evaluated using: (1) Similarity between synergy cluster centroids (SP ≥ 0.70 indicating a direct match) and (2) Reconstruction of VJ synergies as linear combinations of multiple SFM synergies via non-negative least squares, requiring at least two synergies (scaling coefficient ≥ 0.2) and an overall SP ≥ 0.70.

RESULTS: Six synergy clusters in the VJ were identified. The push-off module involved co-activation of ankle plantar flexors, knee extensors, and hip extensors. The thrust modules comprised two groups: one with hamstring and abductor activation, the other with the tensor fasciae latae, gluteus maximus, and adductors. The landing control module featured tibialis anterior and back muscle activation, while trunk stability modules corresponded to abdominal and back muscle activation. The thrust and trunk stability modules closely matched SFM synergies related to hip extension, trunk flexion, and trunk extension (SP > 0.7). However, the push-off and landing control modules were best reconstructed by merging multiple synergies: hip extension, knee extension, and ankle plantar flexion for push-off, and knee extension, ankle plantar flexion, and trunk extension for landing control. The thrust module with the tensor fasciae latae, gluteus maximus, and adductors did not correspond to SFM synergies.

CONCLUSION: VJ synergies serve distinct mechanical roles in jumping and landing, with specific SFM exercises contributing to corresponding movement patterns. The direct link between certain SFM synergies and VJ synergies supports the use of SFM exercises to target fundamental movement patterns. However, the push-off and landing control modules required multiple SFM synergies, suggesting that single-joint exercises alone may be insufficient for comprehensive VJ training. Future research should explore multi-joint exercises that integrate multiple SFM synergies to better replicate push-off and landing mechanics.

**A LONGITUDINAL ANALYSIS OF PHASE-SPECIFIC PREDICTORS THAT IMPAIR COUNTERMOVEMENT JUMP PERFORMANCE AFTER A 3 X 12 BACK SQUAT FATIGUING PROTOCOL**

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INTRODUCTION: Residual fatigue following intense exercise is known to impair athletic performance. This study aimed to assess the impairment of phase-specific predictors of vertical jump after a fatiguing resistance exercise protocol.

METHODS: Twenty-two participants underwent a back squat load/velocity profiling test. One week later, participants performed a set of three countermovement jumps (CMJ) at baseline (T0), immediately (T1), 30 minutes (T30min), and 24 hours (T24h) after completing a fatiguing protocol of 3 x 12 full squats at 70% 1RM with maximal intended velocity. A linear encoder measured the displacement velocity of the load, and a force platform recorded the vertical ground reaction force (GRF) of the CMJs. Duration and rates of force development (RFD) were assessed during the unloading, eccentric (yielding and braking), and concentric phases. Minimum position, force at minimum position, jump height, and modified Reactive Strength Index (RSImod) were also recorded.

RESULTS: Fatigue reduced unloading duration (from 0.195±0.06 s at T0 to 0.161±0.03 s at T24h, p=0.008). Although overall eccentric duration remained unchanged, yielding duration decreased (p=0.024) while braking duration increased (p=0.007). Unloading RFD increased (p=0.007) and yielding RFD increased (p=0.002), whereas braking RFD decreased (p=0.003). The minimum position was significantly lower at T1 and T30min (p<0.001) but returned to baseline at T24h, while force at minimum position decreased at T30min (p<0.001) and only partially recovered at T24h (p=0.007). Jump height and RSImod exhibited an acute impairment at T1 and T30min (p=0.003) with recovery at T24h.

CONCLUSION: These findings reveal that a common resistance training protocol (3 x 12 full squats) significantly disrupts phase-specific neuromuscular predictors of CMJ performance. Fatigue induces a compensatory strategy characterized by a reduced minimum position and an altered eccentric phase, specifically through an extended braking duration accompanied by a diminished braking RFD. Such adaptations suggest that the eccentric braking sub-phase is particularly vulnerable to fatigue, potentially compromising performance and increasing injury risk. These results highlight the need for optimized training programs and recovery strategies that specifically target the eccentric phase to mitigate fatigue effects. Future research should further explore the neuromuscular mechanisms underlying these changes and evaluate targeted interventions to enhance resilience during fatiguing conditions.

**DOES A MUSCLE FATIGUE-INDUCING PROTOCOL ALTERS THE MAGNITUDE OF FUNCTIONAL INTER-LIMB ASYMMETRY IN HEALTHY ADOLESCENTS?**

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INTRODUCTION: Inter-limb asymmetry has extensively been studied in the context of sport performance. Research has shown that inter-limb asymmetry is a complex metric influenced by numerous factors (e.g., loading protocol). However, research on inter-limb asymmetry in a fatigued state is scarce. Therefore, the purpose of this study was to assess changes in jump asymmetry magnitudes in healthy adolescents over a 72-hour period following a muscle fatigue-inducing protocol.

METHODS: Twenty-two adolescents (age = 14.6±1.8 years, 32% female) participated in the current study. The fatiguing protocol involved 10 sets of 10 maximal vertical jumps, with a one-minute rest interval between sets. The functional test battery consisted of the Single-leg 10-jump (SL10J), single-leg countermovement jump (SLCMJ), and single-leg hop jump (SLHJ) asymmetry, measured at baseline, immediately post-protocol, and at 24, 48, and 72 hours post- fatiguing protocol. Bioelectrical impedance analysis-derived phase angle was used to assess the level of muscle damage, while muscle soreness was evaluated using the Visual Analog Scale (VAS). Bilateral countermovement jump (BCMJ) and bilateral horizontal jump (BHJ) were used to indicate changes in absolute jump performance across test occasions. Normality was assessed using the Shapiro-Wilk test. A one-way repeated measures mixed design ANOVA was conducted to examine differences in the magnitude of inter-limb asymmetry over time. For non-normally distributed data, Friedman and Wilcoxon tests were applied. Kappa coefficients were calculated to evaluate the consistency of the limb that performed better across tests (i.e., task specificity) and the consistency of the limb that displayed the highest jump performance over time (i.e., time specificity).

RESULTS: A significant increase in SL10J asymmetry was observed 48 hours post-protocol (p<0.001), while no significant changes were detected immediately post-protocol or at 24 and 72 hours post-protocol (p=0.462–0.766). No significant changes were found in SLCMJ (p=0.714) or SLHJ (p=0.468) asymmetry at any time point. BIA did not indicate significant muscle damage, although a significant increase in muscle soreness (VAS) was recorded. Kappa values indicated slight to

moderate agreement for task specificity (κ=-0.123–0.493) and slight to substantial agreement for time specificity (κ=-0.137–0.732).

CONCLUSION: SL10J asymmetry significantly peaked 48 hours after the fatigue-inducing protocol before returning to baseline values. In contrast, no significant changes were observed in SLCMJ and SLHJ asymmetry. Consistent with previous research, our findings indicate that inter-limb asymmetry is both task- and time-specific. However, the results show greater consistency in the direction of asymmetry between 24 and 48 hours post-protocol for both SLCMJ and SL10J. These findings suggests that repeated jump tests, such as the SL10J, may be more sensitive to detecting fatigue-induced changes in asymmetry.

**KNEE TAPING FOR ENHANCED PERFORMANCE: KINETIC AND KINEMATIC COMPARISONS OF DYNAMIC, RIGID, AND KINESIO TAPING**

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INTRODUCTION: The drop jump landing (DJL) evaluates reactive strength and jump performance across six phases: eccentric (0-20%), concentric (20-40%), flight (40-60%), loading (60-75%), attenuation (75-90%), and control (90-100%).(1) Continuous analysis of the full DJL cycle can reveal phase-specific effects of different knee taping types on performance. This study aimed to examine the impact of various knee taping conditions on lower limb kinetics and kinematics during DJL.

METHODS: Twenty-one athletes (age: 22±2.69 years; height: 167.76±7.47 cm; mass: 63.32±10.57 kg) performed a series of 40cm drop jump landings under four taping conditions – no tape (NT), dynamic tape (DT), rigid tape (RT), and kinesiotape (KT). Kinematic and kinetic data were captured using a 10-camera system and multi-axis force plates at 200Hz and 1000Hz, respectively. Discrete biomechanical data were analysed using repeated measures ANOVA ($p<0.05$). Continuous biomechanical data were analysed using spm1d repeated measures ANOVA ($p<0.05$).

RESULTS: Significant differences in GRF occurred at 3–7% ($p=0.001$) between NT vs. RT and NT vs. KT. Ground contact time (GCT) ($p=0.003$) was significantly shorter for NT vs. RT, NT vs. KT, and DT vs. KT. No differences were found in jump height ($p=0.92$), reactive strength index (RSI) ($p=0.69$), or max take-off force ($p=0.21$). Stability metrics (DPSI, VSI, APSI, MLSI) showed no differences ($p=0.2–1.0$). SPM1D analysis revealed significant changes in ankle rotation (1-6%; 17-20%; 67-100%) in NT vs. KT, RT vs. KT, and DT vs. KT, knee abduction (14-16%; 49-51%) in NT vs. DT and NT vs. KT and rotation (1-15%; 17-40%; 51-100%) in NT vs. RT, RT vs. KT, RT vs. DT, and DT vs. KT, and hip rotation (16%; 71-100%) in NT vs. RT and NT vs. KT. Significant changes were seen in peak ankle abduction ($p=0.035$) between DT vs. KT and peak knee flexion ($p=0.004$) between DT vs. KT.

CONCLUSION: While the taping conditions influenced ankle, knee, and hip joint angles, the statistical differences were not substantial enough to observe that one taping condition outperformed the other. However, it can be noted that the DT condition followed a similar movement pattern to KT, and RT to NT. KT, RT, and DT reduced GCT but the overall reactive strength performance was highest in KT, with a significant increase in GRF in the eccentric phase, leading to the highest RSI. While KT did not affect force attenuation at peak GRF, it lowered loading rate, potentially increasing mechanical energy dissipation and reducing joint stress.(2) Given KT's neuromuscular stimulation properties, its performance benefits in DJL may stem from enhanced proprioception, optimising joint positioning sense to minimise energy loss in the eccentric phase and maximise force production in the concentric phase. These results highlight the potential of knee taping, which should form one part of a broader performance enhancement strategy.

1. Harry et al. J Strength Cond Res. 2024;38(2):e62-e71.

2. Maldonado et al. J Sports Sci. 2018;36(22):2551-2557.

**EFFECTS OF ADDITIONAL LOADING AND VIBRATION FREQUENCY ON LOWER LIMB MUSCLE ACTIVITY DURING WHOLE-BODY VIBRATION EXERCISE**

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INTRODUCTION: The effects of whole-body vibration (WBV) training are known to be influenced by multiple parameters. Optimizing these parameters is crucial for maximizing WBV's effectiveness in training and rehabilitation. This study examined how different vibration frequencies and loading conditions affect the electromyographic (EMG) activity of 11 lower limb muscles, providing a more comprehensive understanding of neuromuscular responses to WBV.

METHODS: Twenty-five healthy male participants performed dynamic squats during WBV exercise while EMG activity was recorded from the gluteus maximus, rectus femoris, vastus medialis, vastus lateralis, biceps femoris, semitendinosus, tibialis anterior, peroneus longus, soleus, gastrocnemius medialis, and gastrocnemius lateralis. The additional loading conditions consisted of either no load or a weighted vest equivalent to 20% of body weight. Vibration frequencies of 0Hz, 10Hz, 20Hz, 30Hz, 40Hz, and 50Hz were applied. EMG root mean square (EMGrms) values were statistically analyzed using a 2 (Loading)×6 (Frequency) repeated-measures ANOVA.

RESULTS: No significant interaction effects between loading and frequency were observed. The gluteus maximus exhibited significant main effects for both loading ($p<0.001$) and frequency ($p<0.001$), with higher EMGrms under additional loading. EMGrms values at 10Hz, 20Hz, and 30Hz were significantly higher than at 0Hz. In the quadriceps (rectus femoris, vastus

medialis, vastus lateralis), only loading had a significant effect (p<0.001), with higher EMGrms in the additional loading condition. The hamstrings (semitendinosus, biceps femoris) showed significant effects of both loading (p<0.001) and frequency (semitendinosus: p=0.008; biceps femoris: p<0.001), with higher EMGrms in the additional loading condition. The semitendinosus showed significantly higher EMGrms at 10Hz than at 0Hz, while the biceps femoris exhibited significantly higher EMGrms at 10Hz and 20Hz than at 0Hz. The soleus demonstrated a significant loading effect (p<0.001), with higher EMGrms in the additional loading condition. The gastrocnemius lateralis showed a significant frequency effect (p=0.016), with EMGrms at 20Hz being significantly higher than at 50Hz. No significant effects of loading and frequency were observed in the gastrocnemius medialis, tibialis anterior, and peroneus longus.

CONCLUSION: Additional loading and vibration frequencies in the range of 10–30Hz significantly enhanced lower limb muscle activation during WBV exercise. This study provides a more comprehensive understanding of how these factors influence neuromuscular responses by examining a wider range of lower limb muscles. These findings highlight the importance of optimizing loading and frequency parameters to maximize the efficacy of WBV in both training and rehabilitation settings.

## Conventional Print Poster Presentations

### CP-BM14 Kinematics

**THE EFFECTS OF CHRONIC ANKLE INSTABILITY ON JOINT KINEMATICS DURING A SIDE-CUTTING JUMP: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: Lateral ankle sprains (LAS) are a common musculoskeletal injury, particularly in sports that involve jump landings and rapid changes in direction [1]. Chronic ankle instability (CAI) affects the biomechanics and neuromuscular patterns of the ankle as well as the knee and hip, and these findings suggest that the mechanics of CAI may be multifactorial [2]. Consequently, this study aimed to investigate these factors by expanding the analysis to the upper limbs.

METHODS: Subjects who scored less than 25 on the CAIT and greater than 10 on the identification of functional ankle instability (IdFAI) were classified into the CAI group (n=11), and those who did not qualify the criteria were included in the control group (n=12). Participants performed a forward horizontal jump from a starting position set at 40 % of their height, landing with their right foot on the force plate, and then immediately jumping to the left with their right foot and landing. Kinematic data defined initial contact (IC) as the point when the ground reaction force (GRF) exceeded 10 N, toe-off as the point when the GRF fell below 10 N, and landing as the point when the ankle angle returned to neutral position. The interval from IC to one second after landing was normalized to 100 %. To evaluate the magnitude of the difference between groups, Cohens D effect sizes (d) were computed as the absolute mean difference between groups divided by the pooled standard deviation (SD). A frame-by-frame two-sample t-test using Statistical Parametric Mapping (SPM1D) was conducted in MATLAB (Math Works Inc., MA, USA) to analyze the group differences in mean values from IC (0%) to 1 second after Landing (100%). To address the issue of multiple comparisons, a Bonferroni correction was applied, and the statistical significance level was set to α = 0.05 / 100 (number of frames).

RESULTS: The significant differences between the two groups primarily occurred from IC (0%) to Toe off (26.72%). Based on the CAI group, Neck left oblique (p <.0005), Neck anterior tilt (p <.0005), Neck left rotation (p <.0005), Pelvic left oblique (p <.0005), Pelvic left rotation (p <.0005), Right knee valgus (p <.0005), Right knee internal rotation (p < 0.0005) were small. While Trunk left oblique (p <.0005), Trunk anterior tilt (p <.0005), Trunk left rotation (p <.0005), Pelvic anterior tilt (p <.0005), Right Hip flexion (p <.0005), Right hip internal rotation (p <.0005), Right knee flexion (p <.0005), Right ankle external rotation (p <.0005), and Right ankle eversion (p <.0005) were large.

CONCLUSION: The results of this study suggest that CAI movements involving rapid changes in direction may influence the kinematics of both the lower and upper extremity joints. This indicates that the upper extremity may be a contributing factor in the CAI mechanism.

**THE EFFECT OF UNSTABLE LOADS ON SCAPULAR KINEMATICS DURING SHOULDER PRESS: A PILOT STUDY**

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INTRODUCTION: Unstable load is widely used in the fitness field, and the load is often made unstable by using flexible barbells. More unstable movements are generally believed to increase stabilizer muscle activation and strengthen these muscles more effectively than stable loads. Previous studies have mainly focused on investigating muscle activation during unstable and stable shoulder press exercises [1]. The differences in scapular kinematics between unstable and stable shoulder presses have not yet been studied. This pilot study aimed to analyze the differences in scapular kinematics during unstable and stable shoulder presses in recreationally active people.

METHODS: This pilot study recruited six recreationally active men with currently regular resistance training. The participants performed both unstable and stable shoulder press exercises in a randomized order. The unstable load was applied

using a Bandbell Bar with weight plates suspended by resistance bands on the bar. Unstable and stable shoulder presses each used their respective 15-repetition maximum (RM). During these movements, the electromagnetic motion capture system was used to analyze the scapular upward/downward rotation, anterior/posterior tilt, and external/internal rotation. The scapular kinematics were analyzed at 30°, 60°, 90°, and 120° of shoulder presses during both raising and lowering phases. Both types of shoulder press were tested five times, and the average value was calculated. The Mann-Whitney U test was used to compare differences between the two conditions.

RESULTS: The 15 RM of stable and unstable loads in six participants were 28.75 ± 2.09 and 22.47 ± 3.01 kilograms, respectively. The results indicated that shoulder press with unstable loads exhibited a significantly greater upward rotation at 120° of the raising phase compared to stable loads ($p = 0.020$). No statistically significant differences were observed in the other scapular kinematics.

CONCLUSION: Shoulder presses with unstable loads may exhibit greater scapular upward rotation at 120° of the raising phase compared to stable loads. Shoulder presses with unstable loads may be an effective re-education exercise for people with insufficient scapular upward rotation. More participants should be recruited to confirm the findings.

**A COMPARISON OF BAR AND CENTRE OF PRESSURE HORIZONTAL PLANE MOTION DURING THE CONCENTRIC PHASE OF THE BACK SQUAT**

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INTRODUCTION: Quantifying barbell motion during the back squat is a valid and reliable approach to monitor training performance[1]. When contrasted with force-velocity metrics obtained via integration of vertical ground reaction force (vGRF) from a force plate, the bar trajectory demonstrates a strong positive correlation in the vertical plane[2]. Whilst movement of the centre of pressure (COP), the point of application of the vGRF in the horizontal plane, is reflective of stability[3], there is a paucity of research considering the insight horizontal plane motion of the bar may afford. This study evaluated the similarity between the bar and COP to quantify horizontal plane motion during the back squat.

METHODS: Ten participants (age = 31.0 ± 10.1 years; mass = 82.7 ± 12.2 kg; height = 173.5 ± 7.82 cm; 1RM = 116.98 ± 18.32 kg) completed 3 sets of 8 full-depth back squat repetitions at 80%1RM emphasising maximal intent and velocity[1]. COP was derived from a Kistler 9281EA force plate sampling at 1000Hz synchronised to 8 Oqus 300 Qualisys cameras at 100Hz to quantify motion of the bar trajectory, defined as the midpoint between markers positioned on the bar ends. A 10Hz lowpass filter was applied to the bar trajectory with a bandpass filter applied to the COP within Visual3D. The concentric phase of each repetition[4] was extracted for analysis within Python 3.12, with horizontal plane motion defined by the range in the anterior/posterior (AP-Range) and medial/lateral (ML-Range) directions. Procrustes analysis[5] using Scipy.spatial assessed the similarity of horizontal plane motion between the bar and COP trajectories. Procrustes analysis applies an optimised transformation to minimise the distance between datasets with the associated dissimilarity measure implying the degree of similarity (0) or dissimilarity (1). Following exclusion of outliers (mean ± 3SD), statistical analysis was undertaken using descriptive statistics and Student's t-tests ($p=0.05$) using Scipy.stats.

RESULTS: From 234 back squat repetitions analysed, significant ($p<0.001$) differences with small-medium (AP-Range: bar = 8.87 ± 3.15cm, COP = 7.92 ± 2.57cm; $d=0.337$) and large effect (ML-Range: bar = 1.83 ± 0.97cm, COP = 6.52 ± 2.85cm; $d= -1.816$) were identified. Bar and COP trajectories had a dissimilarity score of 0.54 ± 0.24.

CONCLUSION: Horizontal plane motion was significantly different for both AP-Range and ML-Range with Procrustes analysis establishing a lack of similarity between the bar and COP trajectories during the concentric phase of the back squat. Whilst the practical suitability of vertical plane motion of the bar to monitor training performance during the back squat is accepted [1], further research is required to elucidate horizontal plane contributions with results identifying that such motion should not be considered reflective of the COP or therefore stability during a back squat.

1.Thompson et al (2020) 2.Rahmani et al (2000) 3.Kohn et al (2021) 4.McMahon et al. (2018) 5.Krzanowski, W (2000)

**EVALUATION OF KINEMATICS IN TENNIS FOREHAND DRIVES USING OPENCAP AND MARKER-BASED MOTION CAPTURE**

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INTRODUCTION: Biomechanical metrics derived from the analysis of 3D joint angles can provide relevant insights on tennis performance. Such methods have been extensively used to investigate tennis serve [1], but only a few studies focused on tennis forehand drives and the effect of stances [2]. One of the obstacles is that 3D biomechanical studies mostly rely on marker-based motion capture systems, that are difficult to use in ecological situations. The development of markerless tools like OpenCap [3] looks promising for democratizing 3D kinematic analysis directly on the court. The objective of our study was then to evaluate the accuracy of the OpenCap system for the assessment of kinematics during tennis forehand drives.

METHODS: Six tennis players (1 woman and 5 men), at the regional to national level, were recruited for this study. In lab conditions, they performed series of tennis forehand strokes, with open or square stances, aiming at a target integrated into the projection of a tennis court image. They also performed series of squats to have a baseline evaluation for a movement involving only flexion.

Trajectories of anatomical landmarks were collected with 3 iOS devices (OpenCap, Stanford University, USA) concurrently with a marker-based optoelectronic system (41 markers, 14 cameras, Qualisys, Sweden). Joint angles were computed with the OpenCap pipeline, and compared with the same angles inferred from 3D marker trajectories, using scaling and multi-body kinematics optimization tools from OpenSim.

RESULTS: For squat motions, differences in peak flexion angles between the two systems reached 12.3°± 6.1° for the hip and 6.8°± 3.9° for the knee. As expected, our preliminary analyses showed that differences between the two systems were higher for tennis strokes (24.5° ± 15.3° for arm flexion), with large errors occurring for rotations around the longitudinal axis (31.1° ± 23.7° for arm internal rotation).

CONCLUSION: Markerless motion capture tools like OpenCap allow to measure 3D kinematics on the tennis court, with the advantage of providing hands-on results. However, as reported in the literature [4], users should be aware that depending on the task and joint angles investigated, the magnitude of errors in comparison with marker-based motion capture can be high. In our case, the errors for squat movement were consistent with values reported in the literature [4] and drastically increased when investigating tennis strokes. This may be due to the specific movement of the tennis forehand, inducing upper and lower body dissociation and combinations of flexion, internal rotation, and adduction. Further investigations are required to compare this system to other embedded measurement tools like IMUs and OpenSense, in order to find the most suitable tool for 3D kinematics evaluation on the tennis court.

[1] Lambrich and Muehlbauer (2023)

[2] Martin et al. (2020)

[3] Uhlrich et al. (2023)

[4] Lima et al. (2024)

**THE CONFLICT BETWEEN HORIZONTAL DECELERATION PERFORMANCE AND NON-CONTACT ACL INJURY**

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INTRODUCTION: Horizontal deceleration at high velocity imposes potentially hazardous knee mechanical loading, which may rapture the ACL. However, it is unclear whether horizontal deceleration performance concurrently increase knee joint loading and potential ACL injury risk.

METHODS: Thirty-eight males were recruited to participated in the study. Reflective markers were placed on the following bony landmarks: right and left shoulder top, anterior superior iliac spine, posterior superior iliac spine, medial and lateral epicondyles, medial and lateral malleolus, the first and fifth metatarsal head, and heel of the shoe. During the horizontal deceleration test, all athletes were instructed to perform a maximal horizontal deceleration following a 15 m linear sprint. To collect the velocity-time-distance profile, a radar device was positioned 5 m behind the start line at a height of 90 cm and sampling at 47 Hz as per manufacturer recommendations. All participants were instructed not to decelerate until passing the 15 m line, and any 15 m completion time which was 5% greater than the best 15 m sprint time recorded during the linear sprint test was discarded. Motion capture data and ground reaction force data of the first braking step were collected using an 8-camara set-up at 240 Hz. Ground reaction force data were recorded from two 40 cm × 60 cm Kistler force platforms sampling at 1200 Hz. Pearson's (parametric data) and Spearman's (non-parametric data) correlations were used to assess the correlations between horizontal deceleration performance and deceleration biomechanics, and non-contact ACL injury risk surrogates. The motion data and force data were low-pass filtered at 15 and 25 Hz, respectively [4]. Initial contact was defined as the instant when the vertical ground reaction force signal exceeded 20 N, and toe-off was defined as the frame where the vertical ground reactive force was less than 20 N [5]. For kinetic data, mean and peak multi-planar braking GRF (anterior-posterior, AP; medio-lateral, ML; vertical: V), horizontal braking GRF (horizontal $=AP2 + ML2$) [5].

RESULTS: Greater peak deceleration was significantly ($p < 0.05$) and moderately correlated with greater mean anterior-posterior braking GRF ($\rho = 0.39$ and 0.40) and greater horizontal braking GRF ratio ($\rho = 0.44$ and 0.46). Greater peak horizontal deceleration was significantly ($p < 0.05$) and moderately correlated with greater horizontal braking GRF ($\rho = 0.38$). There were non-significant correlations between deceleration performance (mean and peak deceleration) and KFM, KAM, and KRM ($\rho = 0.02$-$0.20$, $p > 0.05$).

CONCLUSION: Therefore, there is no conflict between horizontal deceleration performance based on the first braking step, and non-contact ACL injury risk. As such, deceleration strategies which emphasize greater horizontal and posteriorly orientated forces during the first braking foot contact of deceleration appear effective for facilitating more effective deceleration, without concomitant increases in injury risk.

**EVALUATING THE IMPACT OF STEP FREQUENCY MANIPULATION AND FEEDBACK MODALITIES ON RUNNING KINEMATICS AND STABILITY**

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INTRODUCTION: Running kinematics and stability are critical components of athletic performance and injury prevention. Step frequency is a key variable that influences these aspects. Adjusting step frequency can alter running mechanics, potentially improving efficiency. This study explores the impact of step frequency manipulation on running kinematics and

stability, with a focus on different feedback modalities (auditory and visual). The Goal Equivalent Manifold (GEM) method is employed to assess running stability. GEM analysis provides a framework for understanding how runners maintain stability by allowing for variability in certain dimensions while constraining others. This method is particularly useful for analyzing complex motor tasks like running, where stability is maintained through dynamic adjustments rather than rigid control.

METHODS: Twenty trained and recreational runners (10 male, 10 female) took part in 13 treadmill trials, each lasting 2 minutes at a speed of 12 km/h with a 1% incline. Baseline kinematics were established from two initial runs without any feedback. Participants then completed trials with auditory (metronome) and visual (on-screen) feedback, adjusting their step frequency to predetermined targets of ±3% and ±6% from their baseline. The feedback was specific to the right leg, and participants were not informed of the frequency adjustments. Running kinematics, including step length and time, were recorded using the OptoJump Next system, and heart rate was continuously monitored. Stability was assessed using the Goal Equivalent Manifold (GEM) method, while kinematic variability and physiological responses were analyzed using descriptive and inferential statistics.

RESULTS: Preliminary analysis using repeated-measures ANOVA revealed significant differences in kinematic variability and stability between baseline and manipulated step frequencies. Visual feedback trials exhibited greater variability compared to auditory feedback, with more pronounced deviations at ±6% frequencies. Heart rate responses were correlated with step frequency deviations, indicating increased physiological effort with larger frequency changes. These results highlight also the importance of feedback modality.

CONCLUSION: The findings indicate that step frequency manipulation significantly impacts running stability and kinematics. The distinct responses to auditory and visual feedback modalities suggest that visual feedback may introduce greater variability in running mechanics. The correlation between heart rate and step frequency deviations highlights the increased physiological effort required for larger frequency adjustments. This suggests potential applications in training and rehabilitation. These insights can inform strategies for optimizing running mechanics, feedback methods, and physiological efficiency.

## Conventional Print Poster Presentations

### CP-BM16 Biomechanics - Mixed

**EXPLORING THE TORQUE-VELOCITY RELATIONSHIP FOR LOWER LIMBS IN POSTMENOPAUSAL WOMEN: COMPARING THE GOODNESS OF FIT OF LINEAR AND NON-LINEAR MODELS AND ADDRESSING DATA PROCESSING ISSUES**

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INTRODUCTION: Middle-aged women experience a decline in circulating estrogen levels, which affects muscle strength (1). Torque-velocity analysis allows us to monitor these strength alterations. The main aims of this study were to compare the goodness of fit and derived parameters of linear and non-linear models of fitting the torque-velocity (TV) relationship in postmenopausal women and to contrast the results using target or real maximum velocities as independent variable.

METHODS: 16 physically active postmenopausal women participated in a study funded by the Spanish Ministry of Science, Innovation and University (PID2021-124277OB). Knee extensors (KE) muscle strength was evaluated in the dominant limb using an isokinetic dynamometer. Range of motion was: 80º(knee flexed) to 0º(knee full extended). Isokinetic test was completed at 30, 60, 120, 180, 240, 300 and 400°/s. Peak torque was selected where >90% of the maximum target velocity was reached. Linear, polynomic and Hill regression models (2) were used to fit the TV data. Since the dynamometer reported a torque value even though the target velocity has not been reached, we obtained the TV relationship considering both real (i.e., the velocity achieved; TVR) and target velocity (i.e., the velocity preset on the dynamometer; TVT). The coefficient of determination (R2), mean square error (MSE) and all the TV parameters derived from each model were obtained considering TVR and TVT relationships.

RESULTS: The isokinetic dynamometer failed to apply the preset target velocity, particularly at velocities >240º/s. In those cases, the automatic report included a peak torque reached at a velocity much lower than the target velocity but indicating that it was achieved at the target velocity. The goodness of fit of linear, polynomic and Hill models for fitting TVR and TVT data was excellent (R2>0.915). However, there were significant variations in both goodness of fit values and parameters derived from the linear and polynomial model, indicating that TVR and TVT were not similar ($p<0.05$). No variations in those variables were detected using Hill model ($p>0.056$). Considering TVR data, the best adjustment was obtained using Hill model (R2=0.991;MSE=3.72±1.63N2·m2) and the worst with linear model. However, the theoretical maximum velocity (V0) obtained from Hills model resulted physiologically incorrect (6764.69°/s). The theoretical maximum torque (T0) and velocity (V0) obtained from Hill model resulted higher compared with the values obtained from linear and polynomial models.

CONCLUSION: Caution should be exercised when performing isokinetic assessment at high velocities in a population with low strength levels. Obtained data should be meticulously reviewed since TVR and TVT cannot be used interchangeably. The model choice can influence the parameters value. We recommend the polynomial model to fit the TV data for KE in postmenopausal women.

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**EFFECT ON STRENGTH PERFORMANCE AND MUSCLE ACTIVATION OF A PASSIVE EXOSKELETON DURING A MAXIMAL ISOMETRIC DEADLIFT TASK**

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INTRODUCTION: Low back pain is the most reported work-related musculoskeletal disorder (WMSD), accounting for 21.8M disability adjusted life years (Fan & Straube, 2016). Exoskeletons designed for occupational use have the potential to reduce the risk associated with several work-related risk factors, including awkward postures and handling of heavy loads. Passive exoskeletons don't require an external power supply and are often lighter and less cumbersome but have been reported to provide less support (Schwartz et al., 2023). Therefore, the aim of this study was to investigate the efficacy of a commercially available back-support passive exoskeleton during a maximal effort lifting task.

METHODS: The exoskeleton adopted for this study was the Laevo V2.6 (Laevo Exoskeletons, Schiedam, Netherlands). Adult workers with experience in manual handling and with no history of low back pain in the last year were recruited for the study. After a short warm-up, the participants performed three trials of maximal isometric deadlift each with and without the exoskeleton, using a load cell to measure strength performance. EMG data were collected bilaterally for the iliocostalis, multifidus, biceps femoris and external obliques. RMS and envelope activation peak were computed for each acquired signal.

RESULTS: The sample consisted of 10 participants (23,6 ± 3.4 years old), 1RM without the exoskeleton was 173,7 ± 27,4 kg, and 173,3 ± 40,2 with the exoskeleton (p-value = 0.95). No significant differences were found for any muscle's EMG after applying Holm-Bonferroni correction.

CONCLUSION: The exoskeleton provided no support during the selected task, with 6 participants performing worse than without the device. It is possible that the additional torque provided by the exoskeleton was offset by the non-familiarity with the instrument and was masked by the relatively high level of maximal strength expressed by the participants sampled. Future studies could further explore the differences between passive and active exoskeletons.

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**ATTENTION TO WIND STRENGTH ENHANCES THE SKILL ADJUSTMENT IN RECURVE ARCHERS**

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INTRODUCTION: The influence of wind on archery performance remains underexplored (1). Research suggests that external and holistic attention improves performance over internal focus in experienced athletes (2). However, it remans unclear which types of external focus attention-skill-related (Ext-skill) or environment (Ext-env)-is as beneficial as holistic attention (H). Therefore, this study aimed to investigate the effects of these attentional foci on skilled archers.

METHODS: Eight recurve bow archers (4 females; 18.6-21.2 years; 5.5-11.2 years of experience; weekly training 15-25 hours; personal best: 625-662) were recruited. Each archer completed 12 ends of 6 arrows in a simulated competition across 2 sessions per attention condition (144 arrows per condition per archer). After each shot, archers rated wind strength, performance outcome, and overall feeling of the shooting movement (all on a 1-10 scale), corresponding to Ext-env, Ext-skill, and H condition, respectively. For data anlysis, a generalized estimation equation (GEE) model was used to compare across attnetion conditions, with sex as a factor. Furthermore, actual wind strength, phase durations (setup, drawing, aiming, clicker reaction time [CRT]), aiming trjectory in the X and Y axes 0.5 s before and after clicker fall of each shot, and sex were input into separate GEE models to examine respective effects on score for each attention condition.

RESULTS: The first GEE model revealed no significant effects of attention condition (p=.426) and sex (p=.400) on score. However, separate analyses on each condition showed better model fit for Ext-env (QIC=1218) compared to Ext-skill (QIC=1389) and H (QIC=1551). All three models revealed that stronger wind negatively affected score (beta = -0.062 to -0.128, p = .033 to <.001). Specifically, in the Ext-env condition, CRT (beta = -0.002, p=.015), aiming trajectory in the Y axis before (beta = -0.017, p=.017) and after clicker fall (beta = -0.038, p=.003), and sex (males > females, p = .02) had effects on score. These results suggested that when archers focused on wind strength, they adjusted their release timing and aiming trajectory in the Y axis. Such adjustments were not found in the Ext-skill or H conditions.

CONCLUSION: This study provided evidence that wind strength affects outdoor recurve archery performance. Focusing on wind conditions facilitated adjustments in release timing and vertical aiming, while focusing on skill or movement did not. These findings highlight the potential importance of attentional strategies in optimizing performance under varying environmental conditions in archery.

**THE CURRENT STATE OF KNOWLEDGE ON PASSIVE BACK-SUPPORT EXOSKELETONS: A SYSTEMATIC REVIEW**

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INTRODUCTION: Back pain and musculoskeletal disorders are leading causes of disability among workers performing manual task. Passive back-support exoskeletons have been developed to reduce physical strain without relying on external power sources. Unlike active exoskeletons, which use motors or actuators, passive exosuits use mechanical elements such as springs and elastic elements to provide support. Although promising, the efficacy of these devices is still under investigation. This review aims to assess the current state of knowledge on passive back-support exoskeletons, focusing on their biomechanical impact and practical applications.

METHODS: A systematic literature search was conducted using databases such as PubMed, Scopus, and Embase. The following research search string was used on pubmed and adapted for the other search tools ("Exoskeleton Device"[mesh] OR "exoskeleton" OR "exoskeletons" OR "hybrid assisted limb" OR "wearable device" OR "wearable devices" OR "wearable robot" OR "exosuit" OR "ergoskeleton") AND (passive OR mechanical OR elastic OR "potential energy" OR "unpowered") AND ("back"[Mesh] OR "Shear Forces" OR "Compression Forces" OR "Back Muscles" OR "Lumbar" OR "multifidus" OR "longissimus dorsi" OR "iliocostalis" OR "spinalis" OR "low back" OR "lower back" OR "back support"). Inclusion criteria comprised peer-reviewed articles in english published in the last decade that examined passive back-support exoskeletons in any setting. Exclusion criteria included studies focusing exclusively on active exoskeletons or rehabilitation / medical applications.

RESULTS: Studies have consistently reported reductions in erector spinae muscle activity when using passive exosuits, particularly during lifting and sustained bending tasks. The most widely adopted devices (Laevo and HeroWear Apex) demonstrated significant reductions in lower back muscle activation across multiple tasks, although its effectiveness varied by task type and posture. User perception of exosuits is mixed, with most studies reporting positive feedback regarding reduced effort and fatigue. However, some users experienced discomfort due to fitment issues, increased heat, and restrictions on natural movement. Long-term usability studies are needed to assess adaptation and compliance in real-world settings.

CONCLUSION: Passive exosuits show promise in reducing muscle strain and perceived effort. However, their effectiveness depends on the task, and real-world adoption remains challenging due to user acceptance, comfort, and workplace integration. Future studies should explore long-term use, worker acceptance, and cross-industry applicability. While the biomechanical benefits are clear, optimizing the design for comfort and usability will be crucial for widespread adoption. With further research, passive exosuits could become valuable tools for injury prevention and ergonomic support in physically demanding occupations.

**COMPARISON OF BICYCLE POSITIONING METHODS USING STATIC SIMULATION: TRADITIONAL FITTING TECHNIQUES VERSUS INDIVIDUALISED ADJUSTMENT**

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INTRODUCTION: Bicycle positioning significantly impacts cycling performance, injury prevention, and musculoskeletal health [1]. Traditional bike-fitting methods rely on standard anthropometric formulas or established procedures, whereas individualised adjustments using dynamic biofeedback aim to optimise biomechanics, muscular efficiency, and comfort [2]. This study compares these two approaches, assessing their impact on muscle activity, internal forces, and performance, with implications for sports medicine, physiotherapy, and injury prevention.

METHODS: A cohort of 35 healthy urban cyclists (19.5 ± 1.2 years, 15 female, 20 male) underwent bicycle fitting across five handlebar-saddle positions: (1) low handlebar & low saddle, (2) high handlebar & low saddle, (3) low handlebar & high saddle, (4) high handlebar & high saddle, and (5) a personalised position (P5). Key kinematic and kinetic parameters, including joint angles, saddle and pedal forces, and muscle activation patterns (EMG), were analysed using the Ultium Motion inertial system across all tested conditions. Anybody modelling system estimated reaction forces at L5-S1 and the lower limbs during four pedalling phases (0°, 90°, 180°, 270°). Noraxon insole force sensors and saddle pressure mapping provided additional reaction force data. Static optimisation identified muscle forces using a cost function that minimised the sum of cubes of the ratio of muscle forces to their maximum possible values. Muscle fatigue was assessed through a normalised muscle force ratio-based objective function. Statistical t-tests and statistical parametric mapping (SPM) analyses assessed differences in biomechanical efficiency, comfort, and performance outcomes between methods.

RESULTS: The experiment demonstrated optimised joint angles and reduced deviations in knee and hip alignment for the personalised position (P5) compared to traditional fitting (P1-P4). The lowest reaction force at L5-S1 was recorded in P5, with the highest forces at the start of the pedalling cycle (0°) and the lowest at 180°. P4 showed the highest L5-S1 force variability (177.5 ± 57.7 N), while P2 had the lowest (44.4 ± 4.4 N). Muscle fatigue, expressed as the normalised muscle load index, was lowest in the P5 position, averaging 0.56 ± 0.05 across all pedal stroke phases, suggesting reduced muscular strain and enhanced efficiency.

CONCLUSION: The findings suggest that dynamic simulation-based fitting results in lower spinal and muscular loads, reinforcing its superiority over traditional methods. The personalised position minimised muscle fatigue and spinal stress, emphasising the need for individualised bike-fitting in sports medicine and physiotherapy. These results support the inte-

gration of biomechanical modelling in bike-fitting practices to enhance performance and reduce injury risk. Future research should validate long-term effects in diverse cycling populations.

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**MEASUREMENT METHODS AND EVALUATION INDICATORS FOR TECHNICAL PERFORMANCE IN CLEAN SWIMMING: A SYSTEMATIC REVIEW**

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INTRODUCTION: Swimming is an aquatic sport where race outcomes are determined solely by speed. During swimming, the swimmer technical performance is influenced by biomechanical and energetic factors. Overcoming hydrodynamic resistance while generating effective propulsion is critical for enhancing performance. Consequently, researchers require specialized measurement methods and biomechanical indicators to evaluate mid-race technical performance. With increasing demand for precise monitoring, advanced measurement tools have been integrated into training and competition. This study aims to comprehensively assess common measurement methods and evaluation indicators for technical performance during swimming, providing theoretical references for technical analysis.

METHODS: Literature review and expert interviews were employed to collate and analyze prevalent measurement methods and evaluation indicators in recent swimming research.

RESULTS: Common measurement methods for mid-race technical performance include video analysis, active drag systems, tethered swimming, and wearable devices. Biomechanical evaluation indicators are divided into kinematic and kinetic categories. Kinematic indicators encompass velocity, stroke rate (SR), stroke length (SL), coordination index (IdC), and joint range of motion (ROM). Kinetic indicators include propulsion and drag metrics. Propulsion metrics comprise average force, peak force, impulse, and rate of force development, while drag metrics focus on active drag coefficients.

CONCLUSION: Video-based analysis remains the primary method for swimming technical assessment. Current evaluations predominantly focus on upper limb and trunk movements. and limited studies on kicking dynamics. Measurement protocols should align with training and competition demands, simplifying data output and procedures. Future research should emphasize interdisciplinary integration to develop composite evaluation models, advancing swimming training practices.

**DOES THE TRAJECTORY OF THE CENTER OF GRAVITY DURING THE BACK SOMERSAULT ANALYZED BY THE JUDGING SUPPORT SYSTEM (JSS) AGREE WITH THE 3D MOTION ANALYSIS?**

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INTRODUCTION: In international artistic gymnastics competitions, the AI-based judging support system (JSS, Fujitsu Ltd., Japan) has been introduced to assist in skill recognition. This system utilizes markerless motion capture technology to estimate the three-dimensional posture of athletes in real-time, supporting judges decisions. In addition to its role in judging, JSS has the potential to contribute to biomechanical research by offering kinematic data. However, its accuracy in providing positional data has not been thoroughly validated. To address this, we compared the Center Of Gravity (COG) trajectory obtained from JSS with that obtained from VICON, a widely recognized motion capture system for high-precision 3D motion analysis.

This study aimed to assess the accuracy of the COG trajectory obtained from JSS during back somersaults. We evaluated the similarity between JSS and VICON COG trajectories and analyzed estimation errors. The findings of this study provide fundamental insights into the applicability of JSS for biomechanical research in artistic gymnastics and its potential for advancing AI-based motion analysis.

METHODS: Five female gymnasts, all active competitors at the national level, participated in this study. Each performed a back somersault on a low balance beam. Four video cameras (30 Hz) were used, while VICON used 14 infrared cameras (250 Hz). COG was calculated using the body model for Japanese athletes proposed by Ae et al. (1992). The similarity between COG trajectories estimated by JSS and VICON was evaluated using Dynamic Time Warping (DTW) as trajectory similarity measures.

RESULTS: The results of this study indicate that JSS demonstrated high agreement with VICON in stable phases, with over 80% of the trials exhibiting a high level of agreement.

Time-series comparisons were performed using DTW and its derivative (DDTW) to assess trajectory similarity. Trials with lower agreement showed an error of 376 mm, while trials with higher agreement exhibited closer alignment with a baseline, indicating stronger consistency between JSS and VICON COG time series. The maximum error in trials with high agreement was 220 mm. Discrepancies increased after landing, suggesting greater estimation error in dynamic phases.

CONCLUSION: The results of this study indicate that JSS demonstrated high consistency with VICON in stable phases. However, larger discrepancies were particularly evident in the landing phase, indicating potential limitations in capturing rapid posture changes. Additionally, trials with lower agreement were performed by a single participant, suggesting that the AI's skeletal recognition may be influenced by individual physical characteristics as well as recording conditions.

In conclusion, this study demonstrated that the AI system exhibited a high level of agreement with VICON in back somersault trials. Further validation is needed to enhance the accuracy and reliability of AI-based motion analysis in artistic gymnastics.

**INFLUENCE OF RIDER EXPERTISE ON MOVEMENT VARIABILITY AND STRIDE REGULARITY IN SHOW JUMPING**

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INTRODUCTION: Movement variability is a key factor in the analysis of sports movements and motor skills, particularly in relation to expertise level [1]. In show jumping, such analyses can provide valuable insights into the underlying regulatory mechanisms of movement under different task constraints (i.e., the various zones of the jump). While coordination variability has been previously studied in show jumping [2], no research has examined variability in terms of both movement smoothness and inter-stride variability. This study investigates, under ecological conditions, how riders expertise level influences movement variability (rider's head and pelvis, horse) and stride regularity across different zones of the jump.

METHODS: 16 horse-rider dyads participated in a jumping task at a canter with Inertial Measurement Units (XSens MVN, The Netherlands) on the feet, shanks, thighs, pelvis, sternum, head, scapulae, upper arms, forearms, hands and horse's sternum. Participants were divided into 2 groups according to their expertise level: professional riders (PRO) and amateur riders (AMA). Stride regularity measured by the coefficient of variation (CV) [3] during approach zone and reception zone of jump. Jerk Cost (JC) [4] was computed stride by stride for head, pelvis and horse to assess the smoothness between kinematics of rider and horse. A repeated-measures ANOVA was conducted to compare the aforementioned variables for PRO and AMA riders on approach zone and reception zone. Significance was set at $p<0.05$.

RESULTS: No significant results were observed between the PRO group and the AMA group for CV in the approach zone and in the reception zone, but a significant difference was observed between the two zones (approach 3.97 +1.68; reception 6.95+3.13; p=0.008). Regarding JC for the horse, no significant difference was noted between the PROs and the AMAs across strides, but the JC was lower for the approach strides in comparison with the reception strides (approach: 163 +32.5 m²/s5; reception 198+39.3 m²/s5; p=0.001). For pelvis and head JC, no difference was identified between the two groups between each stride, but JCs were higher in the approach zone than in the reception zone (JCHead approach: 327+139 m²/s5; reception: 188+65.7 m²/s5; $p<0.001$ / JCPelvis approach: 361+111 m²/s5; reception: 292+71.6 m²/s5; p=0.024).

CONCLUSION: The present results did not allow to discriminate the level of riders according to the CV of the horses stride or with JC on the horses overall movement or the riders head and pelvic movements. However, the results provide differences in terms of the change in the riders movement smoothness and stride regularity between the approach zone and the reception zone.

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**A SYSTEMATIC REVIEW OF AGE-SPECIFIC BIOMECHANICAL DIFFERENCES IN RUGBY TACKLING: IMPLICATIONS FOR SAFETY AND PERFORMANCE**

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INTRODUCTION: Tackling is a critical skill in rugby, integral to both performance and injury risk. With tackling accounting for up to 72% of head impacts in rugby, including concussions and cervical injuries, the biomechanical execution of tackle techniques is essential for player safety(1). This study systematically evaluates tackle biomechanics across age groups to identify differences in technique, injury mechanisms, and developmental opportunities, emphasising the importance of tailored coaching strategies for improving safety and performance.

METHODS: This systematic review adhered to PRISMA guidelines, utilising PubMed, SPORTDiscus, Web of Science, ScienceDirect, and Google Scholar databases. Studies analysing tackle biomechanics, injury prevention, and performance metrics in youth and adult players were included. Biomechanical data, including joint angles, kinematics, and head positioning, were extracted alongside injury rates and technical performance outcomes. Video analyses, motion capture systems, and accelerometer data were synthesised to compare tackle execution across age groups. The risk of bias was assessed using the Downs and Black checklist to evaluate the quality of included studies.

RESULTS: Youth rugby players exhibited higher rates of improper head positioning, increasing head and cervical injury risk (69.4 vs. 2.7 per 1,000 tackles)(2). Youth players often performed high-risk tackles due to limited biomechanical control and experience. Adults showed better technique but faced higher injury rates from increased tackle volumes and forces. Though perceived as safer, low tackles increased head-to-knee impacts, while midsection tackles reduced risks. Age-specific training significantly improved technical proficiency, especially in the pre-contact and impact phases.

CONCLUSION: This review underscores the necessity of age-specific coaching strategies to optimise tackle safety and performance. Emphasising proper head positioning, pre-impact stabilisation, and midsection targeting can mitigate injury risks while enhancing skill acquisition. These findings support evidence-based training protocols to bridge the gap between safety and technical development, particularly in youth rugby.

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**RELIABILITY OF AN OPPONENT-INITIATED STIMULUS-RESPONSE SETUP FOR CHANGE-OF-DIRECTION MOVEMENTS IN FOOTBALL**

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INTRODUCTION: Change-of-direction (COD) movements play a key role in injury research and are often analyzed in stimulus-response situations, such as a light signal indicating the change of direction. To enhance ecological validity, attempts have been made to use real opponents instead of artificial stimuli [1]. Yet, control parameters, including approach speed and reaction time, are crucial factors to be considered [2]. Thus, ensuring reliable test conditions in opponent-initiated stimulus-response setups is essential for biomechanical research. Therefore, this study aimed to evaluate the reliability of a football-specific COD test setup using opponent-initiated stimuli under conditions with increasing task complexity.

METHODS: Twenty-nine female football players performed 90° CODs after an approach run targeted at 4.0±0.3 m/s. COD directions were triggered by an experienced player (opponent) who kicked the ball in the targeted direction in four experimental conditions: anticipated COD, unanticipated COD with two options, unanticipated COD with three options including stopping, and unanticipated COD with four options including stopping or feinting. Kinematic data of the participants, the opponent and the ball were recorded via 3D motion capture. Variables of interest included approach speed, the position of the participant at the initiation of ball movement (PosBall), and the available time to react from initial ball movement (ATRBall) and from opponent movement (ATROpp) to force plate contact. Relative and absolute reliability were computed using intraclass correlation coefficients (ICCs) between conditions and coefficients of variation (CVs) within participants in each condition.

RESULTS: Approach speed showed excellent absolute reliability (CV=2.2%–3.0%) and high-to-excellent relative reliability (ICC=0.89 [0.82, 0.94]), with no significant main condition effect (p=0.11). For PosBall, we observed moderate-to-high relative (ICC=0.73 [0.59, 0.85]) and high absolute reliability (CV=5.8%–7.5%), without reaching the significance level for the factor condition (p=0.71). ATRBall and ATROpponent exhibited moderate-to-high absolute reliability (CV=11.6%–15.7%; 6.5%–8.9%) and high relative reliability (ICC=0.79 and 0.76), also with no significant condition effect (p>0.05).

CONCLUSION: Our findings confirm that an opponent-initiated stimulus-response COD setup in football demonstrated moderate-to-excellent reliability for all analyzed spatio-temporal parameters. Furthermore, we did not find significant condition effects, which supports the robustness of the setup and underscores its potential for use in ecologically valid test scenarios. Findings suggest that the test setup can be implemented in performance and/or injury-risk monitoring. Future studies should examine its applicability across male and youth players and different expertise levels to further establish the practical relevance.

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## Conventional Print Poster Presentations

### CP-MH01 Health and Fitness I - Mixed

**YOUTH SPORT SPECIALIZATION, TRAINING VOLUME, AND INJURY HISTORY: ASSOCIATIONS WITH BALANCE, STRENGTH, AND MOVEMENT PATTERNS**

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INTRODUCTION: Physical activity declines from adolescence to young adulthood, potentially due to lifestyle changes or life transitions. This decline may be further exacerbated by youth sport specialization (YSS), which has been linked to an increased risk of injury and sports burnout. Moreover, YSS is often pursued as a pathway to elite athletic success and better sport performance. This study investigated the impact of YSS, training volume, and injury history on dynamic balance, isometric strength, and functional movement patterns in young athletes.

METHODS: A cross-sectional study of youth athletes in northern Poland adhered to STROBE guidelines, was approved by the Independent Bioethics Committee, and was registered on clinicaltrials.gov. Participants were classified into low, moderate, and high specialization. Data were collected through face-to-face questionnaires and interviews, anthropometric measurements, and performance tests, including the Y-Balance Test (YBT), Functional Movement Screen (FMS), and lower-limb isometric strength assessments using a handheld dynamometer.

RESULTS: Of the 373 participants initially enrolled, 235 young athletes (40% girls; 12.3 ± 1.8 yrs) met inclusion criteria, with 31% classified as highly, 53% moderately, 16% low specialized, and 37% reporting an injury history within the past year. No significant differences were observed in YBT, isometric muscle strength, or FMS scores across specialization levels (p<.05). Additionally, asymmetry analysis revealed a significant difference in anterior reach YBT scores between high (3.2 ± 10.5) and moderate (-1.9 ± 8.4) (p = .0485) and low (-1.03 ± 9.8)(p = .0387) specialization groups. Other asymmetry indices showed no significant differences (p<.05).Training volume correlated positively with isometric strength in knee flexors (r = 0.16–0.21) and hip abductors (r = 0.21, p = .005) and with FMS scores (r = 0.21–0.22, p < .05). Athletes training beyond their age showed higher strength in hip abductors, knee flexors, and ankle plantarflexors (p < .05) and better FMS scores (17.3 ± 1.66 vs. 16.2 ± 2.4, p = .027). No significant differences were observed in sports performance between athletes with and without a history of injury (p > 0.05).

CONCLUSION: Contrary to common perceptions, higher specialization did not confer advantages in dynamic balance, isometric strength, or functional movement. Furthermore, it may be related to an asymmetry of dynamic balance in the anterior direction. Increased training volume was associated with strength improvements, particularly when exceeding age-related thresholds, but its impact on balance remained inconclusive, highlighting the need for balanced training approaches. Injury history was unrelated to sports performance. Given the increasing emphasis on evidence-based practice in youth sports, these findings provide valuable insights for coaches, parents, and sports scientists seeking to promote safe and effective training strategies for young athletes.

**HIGH-INTENSITY RESISTANCE EXERCISE TRAINING AND PROTEIN SUPPLEMENTATION RESULT IN GREATER STRENGTH GAINS WHEN COMPARED TO STANDARD REHABILITATION IN PATIENTS RECOVERING FROM TOTAL KNEE ARTHROPLASTY**

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INTRODUCTION: Despite successful surgery and standard rehabilitation practices, patients often remain with long-term deficits in muscle mass, strength, and physical functioning following total knee arthroplasty (TKA). We hypothesized that an optimized, combined exercise and nutritional intervention program would induce greater improvements in muscle outcomes than standard rehabilitation following TKA. We compared the effects of 12 weeks of high-intensity resistance exercise training (RET) with protein supplementation with 12 weeks of standard rehabilitation (SR) on muscle mass, strength, and physical functioning in older adults recovering from TKA.

METHODS: Thirty-three patients (70±6 y; 28.7±3.1 kg/m2) were randomized to the RET (n=18) or SR group (n=15). Starting 8 weeks after TKA, the RET group performed 12 weeks of supervised, high-intensity, whole-body resistance exercise training on standard exercise machines, 3x/week, progressing from 50% to 80% one-repetition maximum (1RM), and ingested a daily whey protein-based nutritional supplement (45g protein). The SR group underwent standard rehabilitation following individualized procedures from their own physiotherapist. Before and after the 12 weeks, muscle strength (1RM) was assessed on the leg press and leg extension, body composition and quadriceps cross-sectional area (CSA) were assessed using DEXA and CT-scan, respectively, and physical functioning was assessed with the short physical performance battery (SPPB), six-minute walk test (6MWT), chair-stand test (5CST) and timed-up-and-go test (TUG). Data were analyzed with 2-way repeated measures ANOVA (α=0.05) and expressed as mean±SD.

RESULTS: Leg press 1RM increased to a greater extent (P-interaction=0.026) in the RET vs SR group (RET: from 131±38 to 174±56 kg, P<0.001; SR: from 124±36 to 143±49 kg, P=0.018). Similar findings were observed for 1RM leg extension, with a tendency for greater improvements in RET vs SR (P-interaction= 0.074). Appendicular lean mass increased from 23.7±5.0 to 24.2±5.1 kg in the RET and from 23.4±5.1 to 23.6±5.4 kg in the SR group, with no differences between groups (P-time=0.009; P-interaction=0.390). Similarly, quadriceps CSA increased in both the operated and non-operated leg in both groups (RET: +6.7±7.2% and +4.7±4.4%; SR: +7.3±5.5% and +3.0±3.0%; P-time<0.001), with no differences between groups. While the SPPB significantly improved in the RET group (from 9.2±1.5 to 10.4±1.1, P<0.001), the SR group showed no changes (from 10.1±1.3 to 10.5±1.4, P=0.150; P-interaction=0.045). In contrast, improvements in the 6MWT were greater in the SR vs RET group (P-interaction=0.034), and both groups showed similar improvements on the TUG and 5CST.

CONCLUSION: High-intensity resistance exercise training with protein supplementation induces greater strength gains when compared to standard rehabilitation during recovery from TKA, but does not further augment gains in muscle mass and improvements in physical functioning.

**INJURY EPIDEMIOLOGY: A SYSTEMATIC REVIEW OF REPORTING METHODS IN BASKETBALL**

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INTRODUCTION: The international governing body of basketball (FIBA) reports nearly half a billion people play globally each year (1). The physical demands mean that injuries occur frequently (2). However, the injury epidemiological profile is largely unknown. This is attributed to a variety in reporting methods, making comparisons of injury rates between sports and contexts difficult (3). This review aims to summarise injury epidemiology and reporting methods in the literature to provide guidance for accurate reporting that aligns with IOC recommendations on injury surveillance.

METHODS: This review was conducted as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines and registered with PROSPERO (CRD42023487335). PubMed, SportDiscus, and Scopus were system-

atically searched up to December 2024 with no restrictions in place. Inclusion criteria specified peer-reviewed articles reporting injury rates (of any definition) per an exposure denominator, not intervention-based, in traditional 5v5 basketball of all age groups, sexes, levels or contexts in English. The abstract screening was completed by two pairs following calibration with raw agreement >0.80. A single author conducted data extraction, focusing on injury definitions, types of exposure, and the corresponding denominators. The quality of articles eligible for inclusion was assessed using the modified Downs and Black (DB) checklist (4).

RESULTS: A total of 2,879 articles were retrieved after the initial database search, of which 118 full-text articles were included. DB scores varied between 5 and 14 (mean 8.3). Key reporting methods included: injury definition, exposure type, and denominators. The majority of articles assessed injuries in North America (78%), with sparse data available for other continents. There were 12 different types of injury definitions. A total of 9 different exposure denominators were found, with athlete exposures being the most adopted (70%) followed by player-hours (17%). However, multiple different denominators were used, complicating any direct comparisons. Approximately one-third (36%) of articles reported no injury severity measures, limiting the understanding of an injurys impact.

CONCLUSION: This systematic review and the subsequent metanalysis in progress, provides a comprehensive overview of basketball injury epidemiology and highlights extensive heterogeneity across methods (injury definitions and reporting methods) making comparisons between studies difficult. These findings underscore the necessity for a consensus statement outlining standardised basketball injury surveillance protocols to advance research and promote player safety.

[1] FIBA, 2024

[2] Bullock, 2021

[3]Ekegren et al, 2016

[4] Downs & Black, 1998

**REGIONAL, SOCIO-ECONOMIC, AND HEALTH DETERMINANTS OF PHYSICAL FITNESS IN SCHOOL-AGED CHILDREN**

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INTRODUCTION: The purpose of this study was to investigate the impact of critical predictors, such as school infrastructure, socio-economic factors, and health-related variables, on regional differences in physical fitness among school-aged children in Slovakia.

METHODS: Data were obtained from the Slovak Olympic and Sports Committee's National Physical Fitness Project. The study included 42,741 students in grades 6–9. Physical fitness was assessed using the EUROFIT test battery. Predictors included regional socio-economic indicators, health determinants, and school infrastructure variables. Four separate multiple linear regression models were developed, stratified by gender and age group.

RESULTS: BMI was identified as a significant negative predictor of physical fitness, while average life expectancy had a positive influence. Higher knowledge capital was associated with lower physical fitness, especially in younger students. Social vulnerability and gender equality had a strong negative effect on girls fitness, whereas insufficient school infrastructure notably diminished fitness levels in boys. The regression models explained 58% to 71% of the variance in physical fitness.

CONCLUSION: This study highlights the complex relationship between regional socio-economic, health, and environmental factors influencing physical fitness in school-aged children in Slovakia. The results emphasize the importance of targeted interventions to address systemic inequalities and enhance physical fitness and health equity among school-aged children.

Funding: This study was supported by the Slovak Research under Grant No. APVV-23-0062 , APVV-22-0047 and by the Development Agency, under Grant No. VEGA 1/0313/25.

**BLOOD PRESSURE RESPONSE IN SPINAL CORD INJURY ATHLETES DURING STRESS TEST**

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INTRODUCTION: Spinal cord injuries (SCI) disrupt the nervous system's ability to regulate cardiovascular functions, leading to complications such as autonomic dysreflexia, orthostatic hypotension, and increased cardiovascular risk. These alterations increase the complexity of assessing cardiovascular health and exercise capacity in athletes with SCI, particularly in the context of sports eligibility evaluations. The unique cardiovascular challenges faced by SCI athletes need careful monitoring during exercise to prevent complications and ensure safety.

This study aimed to analyse blood pressure (BP) responses during stress test in SCI athletes, examining how factors such as lesion level, lesion completeness, and sport typology influence BP variations. A key aspect of the study was to assess whether recovery BP ratio (>0.9) could be used as an indicator of cardiovascular risk in SCI athletes, in line with findings from the general population.

METHODS: The study included 40 athletes with SCI, 27 paraplegic (23 males, 85%; 4 females, 15%) and 13 tetraplegic (10 males, 76%; 3 females, 24%), with lesion levels ranging from C5 to L3. The mean age was 43.3 ± 12.5 years for paraplegic

athletes and 43.4 ± 11.2 years for tetraplegic athletes. All athletes underwent sports eligibility evaluations, which included arm ergometry testing. During these tests, BP was measured at rest, peak exercise, and at recovery intervals. Data on lesion characteristics, sport type, and comorbidities were collected. The recovery BP ratio was calculated by dividing systolic BP at 3 minutes post-exercise by peak systolic BP. Delayed recovery (ratio >0.9) was considered an abnormal response and a potential marker of cardiovascular risk.

RESULTS: BP responses during exercise varied significantly depending on the level and completeness of the lesion. Athletes with tetraplegia or high thoracic injuries exhibited a reduced BP increase, with an average rise of 11.3% from baseline, and some even experienced a BP drop during exertion. In contrast, paraplegic athletes with lesions below T6 displayed a more typical BP response, with an average systolic BP increase of 23% and peak values reaching up to 210 mmHg.

The delayed BP recovery ratio was abnormal in 47% of SCI athletes (> 0.9), indicating a slower BP decline post-exercise.

In our data, a delayed BP recovery ratio (>0.9) was strongly associated with the presence of cardiovascular comorbidities, suggesting that a slow decline in BP after exercise may be a reliable indicator of elevated cardiovascular risk in SCI athletes, similar to the general population.

CONCLUSION: Lesion-specific cardiovascular assessments are essential to ensure the safety and effectiveness of sports participation for SCI athletes. Monitoring BP recovery dynamics during exercise testing provides valuable insights into cardiovascular risk, helping to identify athletes at higher risk and implement tailored management strategies to optimize health outcomes.

**BIOMARKER VARIABILITY IN UNIVERSITY ATHLETES FOLLOWING CONCUSSION: INSIGHTS FROM NFL AND GFAP ACROSS THE RETURN-TO-PLAY PROTOCOL**

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INTRODUCTION: Mild traumatic brain injury (mTBI) is one of the most common injuries in contact sports, with strong links to long-term neurological conditions such as post-concussion syndrome and an increased risk of Alzheimer's disease (1, 2). Despite its prevalence and severe consequences, mTBI diagnosis remains challenging, relying heavily on subjective assessments like the SCAT6, making diagnosis challenging. Previous research has highlighted promise in the ability of specific biomarkers to monitor brain injury (3). However, further research is required to better understand the relationships between these biomarkers and how they can be used together to advise return to play (RTP).

METHODS: This study investigated the changes in mTBI-related blood biomarkers across the RTP protocol. At initial concussion assessment (≤7 days post-injury) and RTP clearance, blood samples were collected from 34 university athletes (26 female) at the University of Birmingham Concussion Clinic. Biomarker levels were analyzed with Single Molecular Array (SIMOA) technology (Neuro 4Plex A assay) to assess changes in neurofilament light chain (NfL), glial fibrillary acidic protein (GFAP), ubiquitin c-terminal hydrolase L1 (UCH-L1), and total Tau levels across mTBI recovery. RESULTS: Between initial and RTP assessment, GFAP, UCH-L1 and Tau levels showed little to no change (all p>0.05), although NfL decrease was near-significant (p=0.051). There was marked variability among the athletes across all these outcomes (nested variability p<0.001). Interestingly, a positive correlation was observed between NfL and GFAP levels (R2=0.286, p=0.008), suggesting a potential relationship between these biomarkers in mTBI recovery.

CONCLUSION: These findings highlight the potential link between neuronal damage (as indicated by NfL) and brain inflammation (GFAP release), given that ~29% of the variation in NfL levels were explained by changes in GFAP. However, the variability of individual biomarkers highlights the need for further investigation, particularly around the optimal timing of initial sampling in amateur sporting settings. Future research should aim to compare normative variability across a season, considering factors such as menstrual cycle phase and symptom severity during sampling, to improve the understanding of how blood-based biomarkers can have clinical application in the diagnosis and management of mTBI.

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**ARE SUPERVISED EXERCISE AND PSYCHOEDUCATION EFFECTIVE TO REDUCE CATASTROPHIC THOUGHTS IN INDIVIDUALS WITH CHRONIC PRIMARY LOW BACK PAIN? THE BACKFIT PROJECT.**

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INTRODUCTION: Catastrophic thoughts such as pain magnification, rumination and pessimism are highly prevalent in individuals with chronic primary low back pain (CPLBP). A combination of supervised exercise and psychoeducational

program might be effective to reduce catastrophic thinking in these individuals. The aim of this study was to compare the effectiveness of a supervised exercise and a multimodal approach (supervised exercise+mindfulness) compared to a usual rehabilitation care group on catastrophic thoughts in individuals with CPLBP.

METHODS: 105 participants were recruited and randomized. A total of 53 individuals with CPLBP aged 52±9 years attended >65% of the program: control group (CG, n=20), exercise group (EG, n=14) and exercise+mindfulness group (EMG, n=20). All groups received an 8-week intervention program twice a week for 45 minutes/session. The CG followed usual rehabilitation care (stretching, breathing and motor control exercises in different positions). The EG and EMG received a supervised exercise intervention focused on muscle strengthening exercises. Additionally, the EMG attended a mindfulness program once a week for 2.5 hours/session. Catastrophic thoughts were assessed with the pain catastrophizing scale divided into magnification, rumination and helplessness subscales. A total score of these subscales was calculated. Participants completed three assessments before (pre) and after (post) the intervention program and after a detraining period (re) of 3 months.

RESULTS: Repeated measures analysis of variance (ANOVA) showed that the EMG exhibited a reduction in catastrophic thoughts, rumination, magnification and helplessness following the intervention (post-pre mean difference (MD)=-7.3; 95% confidence interval (CI)=-12.16,-2.3; p=0.06; -0.4; -3.8, -0.95; p=0.02; -1.8; -3.1, -0.52; p=0.09 and -3.1; -6.1, -0.14; p=0.41, respectively). After the detraining period, the CG showed a reduction in catastrophic thoughts, rumination and helplessness (-6.60; -11.1, -2.1; p=0.006; -2.20; -3.9, -0.43 p=0.17 and -3.2; -5.39, -0.91; p=0.08, respectively). No significant differences were detected between groups for the remaining outcomes (all, p>0.05). Analysis of the covariance (ANCOVA) showed no significant differences between groups for catastrophic thoughts (all, p>0.05).

CONCLUSION: The multimodal approach effectively reduced catastrophic thoughts immediately after the intervention in individuals with CPLBP. Although no significant differences were found between groups, this was likely due to the small sample size and the consequently low statistical power. Future studies with larger samples are warranted.

**A FEASIBILITY STUDY INVESTIGATING QUANTITATIVE AND QUALITATIVE EFFECTS OF EXERCISE IN THE WORKPLACE DURING WORK TIME FOR MENOPAUSAL WOMEN**

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INTRODUCTION: The menopause is associated with many physical (eg, hot flushes) and psychological (eg, anxiety) symptoms [1]. Physical exercise has some benefits to reduce these symptoms, however lack of time is cited as the main barrier to take part in physical exercise in this population [3]. Therefore our objective was to investigate the feasibility of exercise classes undertaken in the workplace during work time in healthy menopausal women, and to study the potential benefits of this intervention.

METHODS: Twenty-eight women (54.3±6.5 years old; 162.6±7.6 cm; 65.6±12.5 kg) performed two testing sessions before and immediately after a 12-week exercise intervention including two exercise classes and two independent exercise sessions weekly. Feasibility outcomes were measured during the intervention, and semi-structured interviews were conducted post-intervention. Psychological (Menopause Rating Scale (MRS), 12-item Short- Form Health Survey (SF-12), Patient Health Questionnaire (PHQ-9), Generalised Anxiety Disorder (GAD-7) questionnaire, Self-efficacy for exercise (SEE) questionnaire, Behavioural Regulations in Exercise Questionnaire (BREQ-3) and the International Physical Activity Questionnaire (IPAQ)) and physical outcomes (body composition, balance, 30-s sit-to-stand (STS) test, and 6-min walk test (6MW) were measured before and immediately after the intervention.

RESULTS: Participants' drop-out, retention and compliance were 14.3%, 78.6% and 70±32%, respectively. The exercise programme had a positive effect on the four main themes identified: positive organisation work culture, impact on menopausal physiological outcomes, impact on menopausal psychological outcomes, and improvements and growth for the program. Finally, significant improvements between pre- and post-intervention were observed in some MRS items (p=0.007 to 0.038), BREQ-3 (p=0.001 to 0.041), SF-12 (p=0.028), IPAQ (p=0.039), while body fat was significantly decreased (p=0.026) and STS (0.047) and 6MWT (p<0.001) were significantly improved.

CONCLUSION: A workplace physical activity intervention during work time for menopausal women is feasible and induces significant psychological and physical benefits after 12 weeks.

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**PHYSICAL ACTIVITY LEVEL MORE THAN MATURITY STATUS IS A KEY PARAMETER TO IMPROVING FATIGABILITY AND MUSCULAR FITNESS FOR HEALTH IN PREADOLESCENTS AND ADOLESCENTS**

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INTRODUCTION: Muscular fitness is a valuable indicator for monitoring the health of preadolescents (pre-peak height velocity (PHV)) and adolescents (post-PHV) [1]. To promote physical activity (PA) for health, it is essential to consider and understand how to develop the ability to resist fatigability and maintain muscular fitness during adolescence. This study aimed to assess the interaction effect between PA status (with regular and without regular PA) and maturity status (pre- and post-PHV) on fatigability and muscular fitness in preadolescents and adolescents.

METHODS: Fifteen pre-PHV boys (preadolescents) and seventeen post-PHV boys (adolescents) with regular PA, as well as thirteen pre-PHV boys (preadolescents) and twelve post-PHV boys (adolescents) without regular PA, participated in this study. Regular PA was defined as involvement for more than 4 hours a week (excluding physical education classes) and participation in organised systematic training. Each group performed a high-intensity intermittent protocol with 7 blocks (blocks 1 to 7) each comprising 1 x 30-m sprint and 5 min of high-intensity intermittent exercise with 1 min of passive recovery. Fatigability and short-term power output were measured. Linear mixed-effects models were used to analyse the interaction between PA status and maturity status on these parameters.

RESULTS: Fatigability increased significantly for all groups after the high-intensity intermittent protocol, but significantly more in preadolescents and adolescents without regular PA (blocks 4 to 7; CI 95% [-5.6;-0.2]; CI 95% [-5.6;-0.4]); CI 95% [-6.6;-1.4]); CI 95% [-6.7;-1.3], respectively). In addition, sprint time (block 4; CI 95% [0.8;18.8]; block 6; CI 95% [3.6;21.0]) and maximum velocity (block 6; CI 95% [-16.7;-3.2]) decreased significantly more during intense short-term exercises in preadolescents and adolescents without regular PA. Linear mixed-effects models showed no maturity status effect during the high-intensity intermittent protocol for all variables.

CONCLUSION: Independent of maturity status, preadolescents and adolescents who did not regularly take part in PA exhibited significantly greater fatigability than preadolescents and adolescents who did engage in regular PA during intense short-term exercises. This study confirms the importance of participating in regular PA from preadolescence and continuing through adolescence to improve resistance to fatigability and muscular fitness for health. When the level of PA is below the World Health Organizations recommendations (at least 60 min of moderate-to-vigorous intensity PA per day), greater exercise fatigability and poorer physical capacity are observed.

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**THE FEASIBILITY OF EXISTING GROSS MOTOR TESTS IN PRIMARY SCHOOL SETTINGS IN HONG KONG**

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INTRODUCTION: School physical education (PE) is important in assessing and promoting students' motor skills. In Hong Kong, a PE teacher typically manages dozens of students in class. Young students may struggle to understand complex instructions or have no prior experience in compound movements. This study evaluated the feasibility of some common gross motor tests of various areas in students aged 5–7 years in group settings.

METHODS: Thirty-nine typically developing children (1 withdrawal, 15 males and 23 females; grades: primary 1–3; age: mean ± SD: 6.70 ± 0.58) from two schools were recruited to perform physical tests in after-school sessions. Handgrip strength and eight tests selected from the Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT-2), which assesses the developmental issues of those aged 4 to 21 years individually, were conducted with groups of 8 to 10 students. The data collection was video-recorded. The feasibility and performance of the tests were evaluated based on observations performed by the first author and two trained associates.

RESULTS: The feasibility index [percentage of participants who successfully completed the test out of the total number of participants (n = 38)] ranged from 94.74 to 100%. The sum of the maximum values obtained from three trials for each hand was 19.59 ± 5.70, similar to previous data collected from the same population. The raw scores of the BOT-2 items were converted to point scores. The students attained the highest scores in jumping in place–same sides synchronised (point score: 3.00 of maximal point 3) and walking forward on a line (4.00 of 4). Nearly the highest scores were achieved in standing on one leg on a balance beam–eyes open (3.82 ± 0.61 of 4), one-legged stationary hop (8.47 ± 1.27 of 10), and dropping and catching a ball–both hands (4.37 ± 1.08 of 5). A fair score was scored in dribbling a ball–alternating hands (3.11 ± 1.96 of 7). Notably, extremely poor scores were scored in knee push-ups (0.19 ± 1.17 of 9) and sit-ups (0.78 ± 1.46 of 9).

CONCLUSION: The test items appear highly feasible for group assessments using a video camera. Most participants in the current study could not perform knee push-ups (35 of 38 students) and sit-ups (27 of 38), suggesting two possibilities. Firstly, push-ups and sit-ups may exhibit floor effects for young participants. These exercises necessitate more than simply muscle force generation, a complexity that could hinder the differentiation of strength capabilities. Consequently, less skill-dependent test items, e.g. handgrip strength, could be more suitable for these participants. Secondly, the current typically developing participants exhibited underdeveloped muscle strengths, potentially due to the focus of the PE curriculum for

these grade levels in Hong Kong. In conclusion, the test items adopted in this study were highly practicable but are subject to floor effects when applied to groups of typically developing children.

## Conventional Print Poster Presentations

### CP-MH02 Sports Medicine and Rehabilitation - Mixed

**WHAT CHARACTERIZES RESPONDERS TO AN EXERCISE INTERVENTION FOR LOW BACK PAIN?: FINDINGS FROM THE REVIEEW RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Exercise is one of the most effective interventions for low back pain (LBP). However, its effects vary, and not all patients experience improvement. Identifying factors that distinguish responders from non-responders could enhance therapeutic decision-making. Therefore, this study aimed to analyze differences between responders and non-responders to an exercise intervention for LBP addressed to eldercare workers, a population with high LBP prevalence.

METHODS: This study analyzed data from the ReViEEW randomized controlled trial, which was effective for reducing LBP (ClinicalTrials.gov: NCT05050526). Participants from the experimental group and the waiting-list control group were assessed. Inclusion criteria were having ≥2 average LBP intensity at baseline on the numerical rating scale (NRS, 0-10) and completing pre-post assessments after participation in a 12-week videoconference-supervised exercise intervention. The intervention consisted of two weekly 45-minute group sessions including whole-body resistance exercises performed with bodyweight and elastic bands at moderate-high intensity. Response was defined taking into consideration a clinically significant reduction of ≥2 points on the NRS [1]. Responders vs. non-responders were compared based on adherence to the intervention, sociodemographic data, and several baseline measures of muscle performance, psychological health, work-related parameters and musculoskeletal pain (including low back, neck, shoulder and hand/wrist pain). First, between-group comparisons were done with independent samples t-tests or Mann-Whitney U tests (depending on normality) for continuous variables and chi-squared tests for categorical variables. Later, variables with $p<0.05$ in these analyses were entered into a binary logistic regression model, with response status as the dependent variable. Analyses were conducted using IBM SPSS Statistics 30.0.0.

RESULTS: 77 participants were included (39 responders, 38 non-responders). Between-group comparisons showed that responders had higher baseline LBP intensity (4.7±1.8 vs 3.9±1.7 in 0-10 NRS; p=0.045) and lower anxious symptomatology (3.9±2.4 vs 5.1±2.4 in 0-9 Goldberg's scale; p=0.040). Other comparisons were non-significant (p>0.05). In the logistic regression model, higher LBP intensity (OR 1.37; 95%CI 1.03-1.81) and lower anxious symptomatology (OR 0.79; 95%CI 0.64-0.97) at baseline remained significant predictors of being responders.

CONCLUSION: This study highlights that baseline LBP intensity and levels of anxiety are significant predictors of response to a videoconference-supervised exercise intervention for LBP in eldercare workers. These findings suggest that tailoring interventions based on baseline characteristics could improve outcomes and enhance therapeutic decision-making for this high-risk population.

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**NECK STRENGTH IN ADOLESCENT ATHLETES: A COMPARISON OF NORMATIVE VALUES BY SEX AND SPORT**

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INTRODUCTION: Neck strength has been purported to be a modifiable risk factor in reducing the risk of sports related concussion. However, literature is sparse with most studies focusing on professional male athletes. Concussions are frequent across all playing levels and sports, particularly in adolescent and female cohorts. The neck strength profiles of these athletes are largely unknown. This study aims to describe and compare neck strength in high-school athletes across various sports.

METHODS: Male and female athletes participating in rugby, football and basketball academies, were recruited from an elite sports college in England, UK. All athletes completed a standardised warm-up followed by maximal isometric neck strength testing (VALD ForceFrame). In a randomised order, participants completed one submaximal practice attempt followed by three maximal isometric contractions (3 second push with 10 second rest) in a quadrupled position for neck flexion (FLEX), extension (EXT) and side flexion (SFLEX; rugby only), with a minimum of 10 minutes between directions. Absolute peak force values (Newtons (N)) and peak force normalised to body weight (N per kilogram of bodyweight) were gathered. EXT:FLEX and left:right SFLEX ratios were calculated to describe strength for opposing musculature. Significant

differences (significance p<0.05) between sexes were analysed using an independent t-test, with a one-way ANOVA used to compare sex-specific sports academies.

RESULTS: 174 participants (125 males (81.0 ± 13.6 kg), 49 females (68.0 ± 13.5 kg)) from football (male n=44, female n=20), rugby (male n=49, female n=29) and basketball (male n=32) were included. Absolute and relative EXT values were greater than FLEX for both sexes and sports, with EXT:FLEX ratios of 1.39 ± 0.3N for females and 1.34 ± 0.3N for males. Males had significantly greater absolute force scores for each of the four movements compared to females as well as significantly greater normalised peak force FLEX and EXT scores (p<0.001). Both male and female rugby athletes had significantly stronger FLEX and EXT scores (absolute and normalised) compared to their football counterparts (p<0.001). In males, no differences were observed between basketball athletes and those from rugby or football for any absolute or normalised scores (p>0.05).

CONCLUSION: Males had significantly stronger neck strength profiles compared to females, both with absolute and normalised force production. Lower neck strength could be one reason female athletes are at increased risk of concussion compared to male counterparts. Footballers had the lowest neck strength values across all sports, especially for neck flexion. This is interesting given football is the only sport with the involvement of intentional head movements through heading a ball, predominately stressing the neck flexors. Further work needs to focus on interventions to improve neck strength to aid performance and reduce concussion risk.

**DOES INTERNAL OR EXTERNAL SHOULDER TORQUE RELATE TO SHIRT DRESSING SPEED IN COLLEGE-AGED WOMEN?**

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INTRODUCTION: The ability to dress a buttoned shirt is considered an Activity of Daily Living (ADL). These daily basic skills are considered necessary to maintain quality of life which include bathing and eating [1]. When one is unable to perform ADL's, their quality of life decreases which negatively affects their overall health [2]. The action of dressing oneself with a buttoned shirt requires flexibility and torque of the internal and external rotators of the shoulder joint. Previous research showed that peak torque of shoulder abduction was lower in older adults than compared to younger adults when performing ADLs [3]. However, there have not been studies demonstrating a relationship between internal and external torque of the dominant shoulder rotators and shirt dressing speed in either population. Therefore, the purpose of this investigation was to determine if dominant internal or external torque had a relationship with shirt dressing speed in college-aged women.

METHODS: 15 college-aged females with no history of shoulder injury (age:19.5 ±1.3 years; height: 169.7 ± 8.6 cm; weight: 69.8 ± 16.1 kgs) were selected for this study. The subjects were given a specific protocol on how to dress the button shirt sleeves using both arms without buttoning, starting with both hands on the chest. Two trials were provided for their best time in seconds using a hand-held timer. A Biodex III isokinetic dynamometer was then used to assess internal and external torque of the dominant shoulder in the standing position. Two trials of six maximal repetitions followed by one maximal repetition at 120 degrees/second was assessed. Peak torque for internal and external rotation were recorded for each trial.

RESULTS: Mean values of torque were analyzed (internal rotation 29.1 + 12.01 ft-lb; external rotation 15.6 + 6.99 ft-lb.). The average shirt dressing time for all subjects was 2.60 + 0.50 seconds. Pearson correlations between external torque of dominant shoulder and shirt dressing speed was (r = - 0.19; p = 0.58) compared to internal torque of the dominant shoulder (r = -0.3; p = 0.14).

CONCLUSION: Our results did not determine a significant relationship between the internal or external rotators and shirt dressing speed, but internal torque values and dressing speed were moderately related. A possible explanation could be due to participants lack of consistent effort, based on the specific shirt dressing protocol that all subjects were adhered to. If subjects were given adequate practice of the shirt dressing protocol, this potentially would have resulted in a stronger significant relationship. Utilizing an older population for future studies could result in consistency of scores.

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**MAXIMUM-SPEED SINGLE-LEG BRIDGE: A NOVEL APPROACH FOR ASSESSING AND REHABILITATING RECURRENT HAMSTRING INJURIES – A SINGLE CASE STUDY**

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INTRODUCTION: The high recurrence rate of hamstring strain injuries (HSI) suggests that using only muscle strength and flexibility differences between the injured and uninjured sides may be insufficient. Recurrences are frequent during high-speed movements; however, no assessment method currently exists to evaluate high-speed functional performance. This case report aimed to highlight the use of the Maximum-Speed Single-Leg Bridge Test (MS-SLBT)1 in a rugby player with a

fourth recurrence of HSI to identify functional impairments that are not detectable with conventional assessments, and to demonstrate that these impairments can be improved by utilizing the test as an intervention.

METHODS: A 21-year-old university rugby player with a history of three prior HSI experienced a fourth recurrence in the semitendinosus. Magnetic resonance imaging (MRI) confirmed a Grade I injury (BAMIC 1a) 2, and musculoskeletal ultrasound imaging showed scarring and tenderness of the muscle fibers. At 1-month post-injury, the patient reported no pain during hamstring stretching, isometric or eccentric contractions, or sprinting. The patient was unable to complete the MS-SLBT because of severe pain and fear. After 2 months, the pain during the test decreased, but the buttock-raising speed and height remained limited. The patient then performed the MS-SLBT exercise as a daily intervention for 2 months and the effects of training and detraining were evaluated.

RESULTS: After the intervention, the buttock-raising height increased from 0.19 m to 0.35 m, and the buttock-raising speed improved from 0.83 to 1.46m/s during the MS-SLBT. The isometric knee flexor torque increased from 1.5 to 2.0 Nm/BW, and the flexibility, as measured by the active knee extension test, improved from 16.5 to 0.5°. These improvements were maintained even after a 1.5-month of detraining period. Ultrasound imaging showed reduced muscle fiber irregularities, improved centralization of muscle contractions, and increased contraction speed.

CONCLUSION: The MS-SLBT provides a specific and valuable tool to assess concentric contraction deficits in the hamstrings during high-speed movements in rugby athletes with HSI, even when conventional assessments such as muscle strength tests, flexibility measures, and Nordic hamstring exercises show no abnormalities. Additionally, using MS-SLBT as an intervention resulted in improvements in high-speed movement performance, muscle strength, and flexibility, along with a reduction in muscle fiber irregularities and enhanced coordination and centralization of muscle contraction during isometric hamstring contractions.

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**DYNAMIC KNEE VALGUS IN YOUTH SOCCER PLAYERS AFTER A FUNCTIONAL TRAINING PROGRAM. PILOT STUDY.**

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INTRODUCTION: Knee injuries are very common in athletes, especially soccer players and often take a long time to recover [1]. High loads on the knee during landing or changes of direction during soccer matches or training can lead to a valgus shift of the knee, known as dynamic knee valgus (DKV) [2]. Many studies have shown that a low dynamic knee valgus is a predisposing factor for knee injuries and disease, such as anterior cruciate ligament injury, patellofemoral pain syndrome or osteoarthritis [2;3;4;5;6]. Functional training based on dynamic stretching, balance, proprioceptive and stability exercises, has been developed to reduce the DKV.

METHODS: Nine male youth soccer players (mean age: 16.4 ± 0.2 years) from the same soccer team took part in six weeks of functional training program. DKV was measured in pre- and post-measurements during single leg squats using a three-dimensional Kinect Azure camera in combination with DynaKnee software [6]. In addition, maximal voluntary muscle contraction (MVC) was measured using a dynamometer and muscle activation amplitude (MAA) was measured using electromyography. Data were analysed using a non-parametric Wilcoxon signed rank test to assess differences in DKV, MAA and MVC at a 5% significance level.

RESULTS: Data showed a small improvement of DKV in dominant leg. MVC increased slightly in all measured muscle groups. MAA of the involved muscles in the single-leg squat had inconsistent results, but rather a decreasing trend. Nevertheless, none of the analyses showed significant changes.

CONCLUSION: Results showed influence on dominant leg on DKV. The small number of participants and the short duration of the training might have been a limiting factor. Further studies should repeat the procedure with a larger group of participants and a longer training period.

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**ANKLE STABILITY IN HIGH-SPEED RUNNING: FOOT PLANTAR PRESSURE, KINEMATIC, AND MUSCLE ACTIVATION CHARACTERISTICS IN ATHLETES WITH ANKLE INSTABILITY UNDER DIFFERENT TAPING**

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INTRODUCTION: Sports taping provides support and stabilization for the ankle during the rehabilitation phase while enhancing ankle stability to prevent re-injuries [1]. However, there is limited research on the effects of sports taping on ankle stability during high-speed running, and scientific validation remains insufficient. Therefore, this study compares the differences in joint kinematics and foot plantar pressure under different taping conditions during high-speed running.

METHODS: This study recruited nine athletes with chronic ankle instability (CAI) to perform a 20-seconds high-speed running test at 15 km/h of three conditions: no taping (NT), athletic taping (AT), and dynamic taping (DT). A quasar foot plantar pressure treadmill, nine EMG sensors, and nine IMUs were used to collect foot plantar pressure, muscle activation, and gait parameters. The analysis focused on different phases of running gait cycle, including the stance phase, swing phase, initial swing, mid-swing, and terminal swing. One-way ANOVA repeated measurement was conducted to compare the kinematic and kinetic and foot plantar pressure distribution across different taping.

RESULTS: The results of this study showed no significant differences between AT and DT across different stance phases during high-speed running. However, both AT and DT resulted in significantly greater ankle dorsiflexion during the stance phase compared to NT (p=.014). Additionally, during the swing phase (p=.042) and mid-swing phase (p=.044), the ankle dorsiflexion were significantly lower with AT and DT than with NT. No significant differences were observed in lower limb muscle activation, gait parameters, or foot plantar pressure across different taping during the various stance phases.

CONCLUSION: The findings of this study indicate that both athletic taping and dynamic taping effectively restrict the range of motion (ROM) of the ankle joint without affecting muscle activation or max foot plantar pressure. Additionally, CAI often exhibit excessive plantarflexion and limited dorsiflexion [2]. The findings suggest that DT is more effective than NT and AT in increasing the stance phase and reducing the swing phase of the ankle joint dorsiflexion angle. This modulation may facilitate shock absorption during initia; contact of stance phase and promote a more neutral ankle position during the swing phase, optimizing landing preparation and potentially reducing the risk of repetitive high-speed running-related ankle injuries. Furthermore, when the ankle joint is in dorsiflexion, the elastic recoil effect of DT increases the storage of elastic energy, thereby reducing lower limb load [3]. Therefore, it is recommended that athletes with CAI in high-speed running-related activities consider using DT for injury prevention when athletic taping is necessary.

1.Yang et al. (2022) 2. Li et al. (2024) 3. Mcneill et al. (2016)

**NEUROCOGNITIVE PERTURBATIONS IN NON-CONTACT ACL INJURIES IN ELITE FOOTBALL PLAYERS**

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INTRODUCTION: Anterior cruciate ligament (ACL) injury is a severe concern in professional football, with persistently high incidence rates. While previous research focused on biomechanical aspects, a model incorporating playing situations and opponent interactions offers a more comprehensive understanding (1). Lower cognitive function has been linked to higher non-contact knee injury risk (2), highlighting the value of including neurocognition in ACL injury studies. This study aims to investigate neurocognitive perturbations preceding non-contact ACL injuries in professional football players through video analysis.

METHODS: An established video analysis framework was adopted. Cases met the following inclusion criteria: (i) documented ACL injuries (2010-11 onwards) in (ii) top national and international competitions; (iii) available video coverage; (iv) non-contact ACL injury with (v) neurocognitive perturbations preceding the injury. Videos were analyzed using Kinovea to gather contextual factors: game situation, match score, minute, action preceding injury, body orientation, pitch location, playing position and opponent pressure. A gross biomechanical analysis was conducted using a custom form to extract data on injury mechanism, situational pattern, and biomechanics. Distributions homogeneity was tested with Chi-squared tests.

RESULTS: Preliminary data from 35 players were considered. Injuries predominantly occurred in defensive situations (66%), mainly during pressing (54%) and with a sidestep biomechanics (57%). A deceiving action preceded 51% of injuries, 94% of which were defensive. Time from the deceiving action to initial contact (IC) averaged 258 ms (range 34-490 ms). In offensive situations, injuries mainly occurred under tight opponent pressure (83%). At IC, the area around the injured player included the ball (86%), no teammates (89%), one opponent (83%) and no spatial constraints (63%). Scanning activity was present (68%) before the injury occurred but remained minimal (39% performed zero and 39% one scan in 3 s, and 50% and 19% in 5 s prior, respectively). Additionally, at perturbation, the visual focus was directed toward the ball (97%) rather than the motor task required.

CONCLUSION: This study describes neurocognitive perturbations, scanning activity and contextual factors associated with non-contact ACL injuries in elite football. Data align with existing literature indicating a high incidence of ACL injuries following a deceiving action. Results support the importance of efficient and rapid decision-making processes in unplanned

actions. Moreover, limited scanning activity may increase the risk of unexpected and subsequently altered movements. Findings highlight the role of neurocognitive errors and visual behaviours in the complex nature of ACL injuries, emphasizing the need for preventive strategies to include both biomechanical and neurocognitive aspects.

## Conventional Print Poster Presentations

### CP-MH03 Sports Medicine

**IS ACCELERATIONS DURING THE MARATHON PART OF A FULL DISTANCE IRONMAN ASSOCIATED WITH SKELETAL AND HEART MUSCLE DAMAGE?**

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INTRODUCTION: It is well known that ultra-endurance races such as a full distance ironman triathlon causes damage to skeletal and cardiac muscles. However, the underlying factors causing these disturbances are less investigated. In this study we investigated if there is an association between ground reaction forces, measured with accelerometry, during the marathon part of an Ironman triathlon and markers of skeletal and cardiac muscle damage. Our hypothesis was that higher ground reaction forces are positively associated with skeletal and heart muscle damage with no gender differences.The overall results of the race have been reported previously [1, 2].

1. Danielsson T, Schreyer H, Woksepp H, et al. BMJ Open Sport Exercc Med 2019;5:e000486

2. Danielsson T, Carlsson J, Bergman P, et al. Scientiffic Reports 2020;10:901

METHODS: Twenty (8 women) participants completed a full distance ironman triathlon (3.8 km swimming, 180 km cycling and 42 km running) and provided a full set of data and were included in the analysis. As markers for skeletal muscle damage, creatine kinase (CK) and myoglobin was analysed. As markers for cardiac muscle damage cardiac troponin t (cTnT), the N-terminal of the prohormone brain natriuretic peptide (NT-proBNP) was analysed. Ground reaction forces were estimated using an accelerometer (ActiGraph GT3x). Based on the official transition times we sliced out the raw accelerations for the marathon part of the race and calculated the mean vector magnitude (VM) expressed in milliG per second (mG/s). Due to outliers among the dependent variables, Spearman rank correlations (rho) stratified by sex was calculated.

RESULTS: No significant association between the biomarkers and mechanical stress was observed (all $p>0.05$).

CONCLUSION: We did not find any support for our hypothesis of a positive association between ground reaction forces and markers of skeletal and heart muscle damage. The small sample size in the groups and the fact that we did not adjust for any potential confounder in this study warrants caution in the interpretation of the results.

**VAGAL SUPPRESSION AND REACTIVATION IN THE ITALIAN MEDICAL CERTIFICATE: A FIRST APPROACH**

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INTRODUCTION: In incremental exercise tests, a significant decrease in vagal activity occurs as exercise intensity rises. This reduction in vagal tone results from the autonomic nervous systems (ANS) response to increased physical demands. As individuals move from rest to higher exertion levels, the sympathetic nervous system becomes more dominant, leading to an elevated heart rate (HR) and reduced heart rate variability (HRV). This shift in autonomic balance highlights the bodys need to deliver more oxygen and nutrients to active muscles, showcasing the complex interaction between the cardiovascular and nervous systems during exercise. Despite this understanding, insights into HRV behavior during sports medical tests for issuing exercise certificates are limited. Thus, we aimed to assess the timing of vagal suppression and its recovery during maximal tests in the Italian clinical context.

METHODS: Following the Italian Ministry of Healths suggestion, the ECGs of twenty-three healthy men who underwent an incremental test on the cycle ergometer were recorded. The protocol involves a consistent load increase of 25 W every 30 seconds until reaching 85% of the theoretical maximum heart rate (HR85%theory). Tests were preceded by a 1-minute resting period and a 30-second warm-up at a fixed intensity of 50 W. The following recovery phase was divided into 30 seconds of pedaling without load and 2 minutes of rest. At each phase of the protocol, the root mean square of successive beats (RMSSD) and the HR were calculated.

RESULTS: A repeated measures Friedman test confirmed that RMSSD decreased along with the increased workload required (-42% from the rest phase to the end of the test, $p < 0.001$). However, the RMSSD at the final stage of recovery did not differ from the rest phase ($p = 0.85$), nor did the RMSSD observed during the first step of the test vary from that recorded at the beginning of recovery ($p = 0.08$). Moreover, the RMSSD during the resting phase also showed a significant correlation with its counterpart at the end of the test ($rho = 0.47$; $p = 0.025$). In parallel, a paired t-test demonstrated that the maximal HR achieved at the end of the test presented values similar to those of the HR85%theory ($p > 0.05$).

CONCLUSION: The lower RMSSD value observed during the incremental step test confirms that this protocol is sufficiently stressful for the ANS without compromising the cardiovascular system. As mandated by Italian authorities, this protocol aims to determine whether the participant is suitable for competitive sports, considering the underestimation of the actual maximal HR. From the ANS perspective, it was confirmed that there was greater reactivity at the end of the recovery,

demonstrating a similar autonomic balance to the results in the resting phase. Furthermore, participants with higher RMSSD values at rest maintained elevated RMSSD levels at the end of the test, reaffirming previous findings regarding the extent of vagal suppression in maximal tests based on resting values.

**DECLINE IN LEFT ATRIAL BOOSTER FUNCTION DURING A MULTI-STAGE ULTRAMARATHON RACE**

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INTRODUCTION: The atria make a significant contribution to ventricular filling and thus to cardiac output.

Due to regular exercise-induced volume and pressure overload endurance athletes may develop atrial dilation, leading to a reduction in atrial reservoir and booster function. This reduction of atrial function can already be observed after 16 weeks of endurance training.1 To investigate whether changes in atrial function may also occur during a single ultra-endurance event we analysed the atrial adaptions during the 64-day TransEuropeFootRace.

METHODS: 20 athletes (18 men, 2 women, age 26-65 (50.3 ± 10.0) years) ran 4,487 km at an average of 70.1 km/day. Cardiac magnetic resonance imaging (cMRI) was obtained at three time points: T1 after 294.3 ± 134.7 km, T2 after 1735.3 ± 85.7 km and T3 after 3369.8 ± 89.7 km. 8 months after the race (Tpost) 10 athletes returned for a follow-up scan. Atrial function was analysed by longitudinal strain analysis. Since atrial function is substantially influenced by ventricular filling pressures, we also analysed left ventricular diastolic function using the ratio of mitral peak early to late diastolic filling velocity (MV E/A). We fitted linear mixed models for all strain parameters. Means of the parameters were compared pair-wise by Tukey test at all time points. Multiple imputation was used to account for uncertainty due to missing data.

RESULTS: Left and right atrial reservoir strain and right atrial booster strain remained unchanged over the course of the race. MV E/A also remained unchanged. However, we found evidence for a significant change in left atrial booster strain in both 4- ($F(3; 45.83) = 3.99$, $p = 0.013$) and 2-chamber views ($F(3; 45.74) = 3.77$, $p = 0.017$). In the 2-chamber view, left atrial booster strain decreased significantly between T2 and T3 (20.15 ± 4.41%, 15.55 ± 6.63%, $p = 0.045$). In the 4-chamber view, there was a significant increase in left atrial booster strain between time points T2 and Tpost (10.19 ± 4.76%, 17.07 ± 11.03%, $p = 0.039$).

CONCLUSION: Cardiac imaging provides evidence of partial decline in left atria booster strain after approximately 45 days of the TransEuropeFootRace. As the left ventricular diastolic function remained stable this decline might be intrinsic to the left atrium. A possible regeneration of left atrial booster strain is suggested by the follow-up cMRI (Tpost) of a sub-sample.

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**AN INTERNATIONAL DELPHI STUDY OF CLINICAL AND EXERCISE PROFESSIONALS' OPINION OF EXERCISE PRE-SCREENING AND CONTRAINDICATIONS FOR PARTICIPATING IN POSTPARTUM PHYSICAL ACTIVITY.**

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INTRODUCTION: To establish expert consensus on contraindications to moderate-to-vigorous intensity physical activity (MVPA) during the first year postpartum.

METHODS: A Delphi survey (up to three rounds) of clinical and exercise professionals working with postpartum women and individuals was conducted until consensus was reached (≥75% agreement). Round I consisted of questions about relative and absolute contraindications to MVPA. Rounds II and III included additional questions based on the thematic coding of open-ended responses from the previous rounds. Before conducting the Delphi study, a scoping review was performed.

RESULTS: 120 participants completed Round I, 105 completed Round II, and 95 completed Round III. Consensus was reached in 46/49 (94%) statements. Twenty-four relative contraindications to MVPA were identified (loss of consciousness; neurological symptoms; renal or kidney disease; calf pain or swelling suggestive of deep vein thrombosis; severe abdominal pain; vaginal bleeding not associated with menses; postpartum cardiomyopathy; caesarean section with symptoms that worsen with MVPA; unstable hypertension; an eating disorder; malnutrition; anemia; excessive fatigue; fractures or other significant musculoskeletal injuries; hemodynamic instability; breathing difficulties; acute systemic infection accompanied by fever, body aches, or swollen lymph glands; the new onset of chest pain, discomfort, and other angina-like symptoms with exertion; dizziness or lightheadedness during MVPA; new symptoms of heart disease, stroke; and other medical or physical conditions that may affect the ability to be physically active).

CONCLUSION: This Delphi study recommends relative contraindications to MVPA for the first year postpartum, as well as biopsychosocial screening to assess readiness to engage in MVPA.

**ARTIFICIAL INTELLIGENCE-PREDICTED ELECTROCARDIOGRAPHIC AGE IN ATHLETES: PRELIMINARY FINDINGS**

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INTRODUCTION: Estimation of biological age using neural networks applied to electrocardiograms (AI-ECG) has been studied as a potential biomarker of accelerated aging, but studies assessing AI-ECG in athletes are lacking. This preliminary study aimed to estimate AI-ECG in athletes and compare it to chronological age.

METHODS: Cross-sectional study including athletes aged 18 years or older. A questionnaire was applied to assess demographic data, sports modality, weekly training volume, sleep and sports practice time, comorbidities, lifestyle and the Portuguese-adapted version of the "Depression, Anxiety and Stress Scale-21", in addition to recording a 12-lead digital ECG. An ECG-AI was estimated by the neural network. The Δage was calculated as the difference between ECG-AI and chronological age. Data were presented descriptively as median and interquartile range (IQR). The multivariable linear regression model included as environmental variations predictors of Δage: practice time, weekly training time, daily hours of sleep and DASS-2 score, obtained by adding the total score of the 14 items of the aforementioned scale. A p-value <0.05 was considered statistically significant

RESULTS: Forty-six athletes were recruited, with a median age of 27.8 years (IQR 24.5–35.5), 65.2% men, median time of sports practice of 13.0 years (IQR 10.0–17.0), median weekly training time of 20.0 hours (IQR 12.0–25.0), median daily sleep time of 7.0 hours (IQR 7.0–8.0). The median AI-ECG was 27.2 years (IQR 26.0–31.3), with no significant difference in relation to chronological age (p=0.656). Δage was 0.32 years (IQR -4.35–4.66) and the median DASS-21 score was 5.50 (IQR 1.75–12.0). The multivariate regression model presented $R^2$ of 0.179, with a sample power of 55.2%. The time of sports practice (B = -0.282, p = 0.085) and the DASS score (B = 0.215, p = 0.095) presented associations close to significance, while the other variables were not statistically significant (p > 0.05).

CONCLUSION: This preliminary study suggests that sports practice may contribute to healthy biological aging, although variations in Δage are observed depending on the sport modality and training intensity. However, the preliminary nature of the data highlights the importance of studies with larger samples and longitudinal methodologies.

**THE IMPACT OF REPEATED TBIS ON THE HEALTH OF PROFESSIONAL RUGBY PLAYERS, WITH A FOCUS ON THE ROLE OF CIRCULATING MTDNA.**

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INTRODUCTION: Rugby is a high-contact sport with repeated traumatic brain injuries (TBIs), more in matches than in training, especially among forwards (FWD) players. Rugby players also experience contusions, muscular, and joint injuries, contributing to systemic inflammation. In this context, mitochondrial DNA (mtDNA) can be released into circulation as a damage-associated molecular pattern, regulating the inflammatory cascade. Since the biological role of mtDNA in contact sports remains unclear, we analyzed three mtDNA forms: within mitochondria (Fraction 1), bound to protein (Fraction 2), and naked (Fraction 3). Correlations between circulating mtDNA, soluble factors, blood parameters, and TBIs suffered were investigated.

METHODS: Thirteen male professional rugby players were monitored over two matches during the 2023-24 season. Venous blood samples were collected before (T0, T2), immediately after (T1, T3) each match, and one month post-season (T4). Fifty-two hematochemical parameters were analyzed, and plasma and PBMCs were isolated. Total DNA was extracted from 200 uL of plasma, and mtDNA was quantified using Droplet Digital PCR (ddPCR). Neurofilament light chain (NFL) and several cytokines (IL-6, IL-8, TNF-alpha) were quantified using ELLA technology. Flow cytometry was performed to assess immune receptor expression (CD200R, CD36, CD11a) and monocyte subset distribution (classical, intermediate, non-classical). Correlations between circulating mtDNA, soluble factors, and blood parameters were evaluated using the Spearman correlation test and linear regression analysis.

RESULTS: MtDNA levels progressively increased from T0 to T4, in both the total population and the FWD players group. Data showed higher mtDNA levels after each match in both Fraction 2 and 3, and at T4 compared to T0. IL-6 and IL-8 levels significantly increased after each match, while TNF-alpha increased only at T3. NFL levels were significantly higher post-match in both the total population and the FWD players group but returned to pre-match values. Baseline mtDNA levels correlated with mean corpuscular hemoglobin, somatotropin, uric acid, triglycerides, LDL, glucose, cortisol, and key immune cells involved in the inflammatory response at T1 and T3. GPS data indicated that mtDNA levels at T2 (p=0.0046, $R^2$=0.7061) and T3 (p=0.0291, $R^2$=0.4682) correlated with the number of high-powered actions during the first match in the total cohort. In FWD players, mtDNA levels at T1 correlated with total contact involvement post-match (p=0.0446, $R^2$=0.6761).

CONCLUSION: Circulating mtDNA increased after each match and progressively over the season, suggesting a cumulative effect. The observed correlations between baseline mtDNA levels, blood parameters, and soluble factors depending on TBIs indicate that mtDNA, with other inflammatory markers, could serve as an early marker of cell damage, inflammation, and brain injury. This may be crucial for preventing the onset and progression of sports-related neurodegenerative diseases.

**MISPERCEPTION OF OPPONENT SPATIAL INTERACTIONS AS A RISK FACTOR FOR DECISION ERRORS LEADING TO NON-CONTACT ACL INJURIES IN TEAM SPORTS**

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INTRODUCTION: Non-contact anterior cruciate ligament (ACL) injury is one of the most severe sports injuries. Although previous studies have quantified the mechanism of ACL injuries in biomechanical terms, the contribution of unquantifiable factors, such as the association between an athlete's ongoing cognition and eventual biomechanical risks, remains unexplored. This study aimed to identify the cognitive risks underlying non-contact ACL injuries in team sports through detailed video analyses conducted by experts, combined with semi-structured interviews.

METHODS: Six elite handball players (M:F = 3:3) and one elite female rugby player with a history of non-contact ACL injuries participated in this study. They provided videos capturing their injury events. Two experts—coaches of the Japan national handball team, each with over ten years of experience and biomechanics professional —reviewed these videos. In addition to analyzing biomechanical features (contact type: direct/indirect/non-contact, foot strike pattern, knee kinematics, and torso orientation) at the moment of ACL injury, the experts qualitatively assessed whether unreasonable decision-making (such as inappropriate strategic choices and associated body movements) based on their professional sports-specific knowledge. Additionally, semi-structured interviews were conducted to explore the athletes' reasoning for executing the final movement that led to their injuries.

RESULTS: In video reviews, the experts identified clear instances of unreasonable decision-making in six out of the seven cases. The most common decision error was attempting a one-on-one maneuver despite being positioned either too close to or too far from an opponent (six cases), followed by an attempt to break through a narrow space surrounded by opponents (two cases). In both scenarios, the space created by the opponents indirectly interfered with the athletes body configurations, leading to risky biomechanics, such as loss of torso balance, and rapid heel strikes. The experts concluded that misperception of spatial interactions with opponents may predispose athletes to unreasonable decision-making, increasing the risk of ACL injury. During the interviews, the athletes were able to clearly describe their injury situations. They reported that, at the moment of the ACL injury, their attentional focus was entirely devoted to achieving game-specific success, such as scoring a goal with a preferred shooting style or evading opponents using quick change-of-direction techniques. However, video evidence did not always support the rationality of these decisions, as the spatial interactions with opponents suggested a mismatch between their situational perception and actual physical constraints.

CONCLUSION: This study aimed to explore cognitive risks underlying non-contact ACL injuries in team sports. The discrepancy between perceived spatial interaction with opponents and actual situation may have led to suboptimal movement choices, ultimately contributing to their injuries.

**A SURVEY ON LIFESTYLE HABITS, GYNECOLOGICAL VISITS, AND MEDICATION USE IN FEMALE UNIVERSITY STUDENT-ATHLETES WITH DYSMENORRHEA**

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*JUNTENDO UNIVERSITY*

INTRODUCTION: Dysmenorrhea is associated with lifestyle habits. However, the relationship between dysmenorrhea and lifestyle habits in female university student-athletes, as well as the actual measures taken to manage it, remains unclear.

Purpose: This study aims to clarify the relationship between dysmenorrhea and lifestyle habits (skipping meals, sleep duration, and exercise habits) in female university student-athletes, as well as the actual conditions of gynecological consultations and the use of medication.

METHODS: A survey was conducted using Google Forms targeting female university student-athletes participating in competitive sports. The survey examined the relationship between dysmenorrhea and lifestyle habits (meal skipping, sleep duration and exercise time), as well as gynecological visit history, oral medication use, and the impact of dysmenorrhea on daily life. Dysmenorrhea was evaluated based on whether individuals experienced symptoms such as lower abdominal pain or lower back pain that interfered with daily life. Participants who reported experiencing symptoms that affected their daily activities were classified as having dysmenorrhea.

RESULTS: A total of 316 responses were collected (age: 19.0 ± 1.0 years). The prevalence of dysmenorrhea was 23.4% (74/316). Comparisons based on the presence or absence of dysmenorrhea showed no significant differences in lifestyle habits (skipping meals: p=0.127, sleep duration: p=0.544) or exercise time (p=0.601). Among individuals with dysmenorrhea, 21.6% (16/74) had a history of visiting a gynecologist, and 85.1% (63/74) used oral medication. While 74.3% (55/74) of symptomatic individuals experienced no disruptions in daily life due to medication use, 25.7% (19/74) still faced difficulties despite using oral medication or because they were not using it.

CONCLUSION: 23.4% of female university student-athletes had dysmenorrhea, and there was no association between dysmenorrhea and lifestyle habits or exercise time. While about 75% of those with dysmenorrhea experienced no disruption in daily life due to medication use, approximately 25% experienced disruptions.

Conventional Print Poster Presentations

CP-MH04 Ageing I

**EFFECT OF PROGRESSIVE MULTICOMPONENT EXERCISE PROGRAM ON PHYSICAL FITNESS, COGNITION AND QUALITY OF LIFE IN FRAIL ELDERLY**

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INTRODUCTION: Frailty is a complex and age-related syndrome which leads to an increased risk of falls or other adverse events in the old adult. The characteristics of frailty include unintentional weight loss, self-reported exhaustion, weakness, slow walking speed, and low physical activity, which are highly associated with physical fitness. In addition, the physical decline of the frail elderly is frequently linked to cognitive impairments. Multicomponent exercise intervention is an effective strategy for improving both the physical function and cognitive ability. However, there is still a lack of best exercise prescription which is specific and implementable for frail elderly.

METHODS: A total of 130 enrolled frail elderly were randomly divided into the control group (CG, n = 68) and the exercise group (EG, n = 62) according to gender, age, Sports Self-Efficacy (SSE) and Short Physical Performance Battery (SPPB) by the matched group design. A 3-month progressive multicomponent exercise program which covering aspects such as gait training, aerobic exercise, resistance and flexibility training, balance, and cognitive training were conducted in the EG group while regular health education and care was conducted in the CG group. The SPPB and Senior Fitness Test (SFT), Chinese version of Montreal Cognitive Assessment-Basic (MoCA-BC), and the 36-Item Short Form Health Survey (SF-36) were adopted to assess the physical fitness, cognitive ability and quality of life respectively. Chi-square test was used to compare categorical variables. Independent sample t test was used for comparison between the two groups, and paired sample t test was used before and after intervention comparison.

RESULTS: After 3-month progressive multicomponent exercise intervention, the scores of gait speed, chair stand test and the total scores of SPPB, the walked distance, walking speed and step size of 6MWT, back scratch, chair sit and reach, 30s arm curl, 30s sit to stand and TUG test of SFT, the total score and the delayed recall domain of MoCA-BC, and the physical function (PF), vitality (VT), role emotional (RE) and mental health (MH) domains of SF-36 in the EG group were significantly improved both compared with baseline and CG group; the verbal fluency domain of MoCA-BC in EG group was significantly improved compared with CG group; the scores of balance test of SPPB in both the CG group and EG group, the 30s sit to stand and TUG test of SFT, the conceptual thinking domain of MoCA-BC in the CG group, and the role physical (RP), general health (GH) domains of SF-36 in EG group were significantly improved compared with baseline; while the verbal fluency of MoCA-BC in the CG group was significantly weakened compared with baseline.

CONCLUSION: The progressive multicomponent exercise program designed in this study increases the physical fitness, cognition ability and the quality of life in the frail elderly, which may provide a feasible program for the health management of local frail communities.

**DEMONSTRATING THE EFFECTS ON FUNCTIONALITY AFTER 10-WEEKS OF TRAINING WITH BLOOD FLOW RESTRICTION COMBINED WITH LOW INTENSITY RESISTANCE TRAINING ON OLDER ADULTS.**

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INTRODUCTION: Blood Flow Restriction (BFR) training entails limiting perfusion to specific body areas, allowing low-intensity exercise to simulate the effects of high-intensity workouts. Combining BFR and online exercise classes is a novel approach of potentially improving both effectiveness and accessibility of training to an older population. It is essential to maintain strength as we age to avoid or manage physiological conditions like sarcopenia and osteoporosis. The goal of this study is to investigate if ten weeks of online low-intensity resistance training, will lead to greater improvements in functionality among older adults using BFR straps compared to those who do not.

METHODS: Men and women (N=25) with a mean age of 70 ± 5.6 were recruited in the Montreal area. They performed ten weeks of online, low-intensity resistance training twice a week using the Zoom platform. The study design was a randomized control trial with a pre, mid and post- testing session. Functionality was measured by: 30-seocond sit to stand (STS), 8ft timed up and go (TUG) and the calf raise senior (CRS) test

RESULTS: Both BFR and CON improved significantly at all intervals for the 30-second STS (BFR: pre-mid $p<0.001$, mid-post $p=0.023$, pre-post $p<0.001$; CON: pre-mid $p=0.028$, mid-post $p<0.001$, pre-post $p<0.001$). The CRS showed both groups improving significantly at all intervals (BFR: pre-mid $p<0.001$, mid-post $p<0.001$, pre-post $p<0.001$; CON: pre-mid $p=0.002$, mid-post $p=0.003$, pre-post $p<0.001$). The TUG revealed the BFR improved from mid-post ($p=0.017$) and pre-post ($p=0.003$), with no change in CON ($p>0.315$). BFR showed no significant change pre-mid ($p=0.096$).

CONCLUSION: The BFR group demonstrated significantly greater improvements in functionality compared to the control group, particularly in the TUG test, indicating enhanced mobility. These findings suggest that BFR training is an effective method for improving strength and functionality in older adults, offering a promising strategy to maintain independence and quality of life in aging populations

**ENHANCING EXERCISE ADHERENCE AND PHYSICAL FUNCTION IN FRAIL OLDER ADULTS THROUGH A SMARTWATCH AND ISOKINETIC STRENGTH TRAINING**

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INTRODUCTION: Regular exercise is essential for preventing and alleviating disability-related symptoms by preserving muscle strength and mobility in older adults. This study assessed frailty risk through evaluations of daily life function, the Otassha 21-item questionnaire, and physical activity monitoring. Participants underwent physical fitness testing and gait analysis to establish baseline physical function. A whole-body isokinetic strength training program was implemented to enhance muscle strength and mobility in frail older adults.

METHODS: Individuals aged 65 and older with declining physical function were recruited through health screenings and questionnaires. Subjects were assigned to either a control group (CON, n=7) or a training group (TR, n=14) based on willingness and mobility levels. The CON group completed pre- and post-tests without training, while the TR group underwent a supervised 12-week isokinetic strength training program, followed by post-training assessments. A 12-week follow-up period without further intervention was conducted, culminating in a final assessment. The subjects heart rate (HR), steps and physical activity were recorded daily for 24 hours by a smartwatch for 24 weeks.

RESULTS: The TR group showed significant improvements in physical function. Among subjects with high fall risk decreased from 5 to 0 post-training ($p < 0.05$). Additionally, the number of subjects classified as low-risk for frailty increased from 0 to 10 after training and follow-up ($p < 0.05$). Muscle strength and mobility assessments revealed significant gains in single-leg stance duration, two-minute step test performance, and 6-minute walking distance in the TR group compared to the CON group ($p < 0.05$). However, these improvements were not sustained at the 12-week follow-up ($p > 0.05$). Heel-to-toe walking performance remained significantly better in the TR group post-training and at follow-up ($p < 0.05$), while the CON group showed a decline in step count. Daily step counts were consistently higher in the TR group at weeks 1, 4, 6, 8, and 18 ($p < 0.05$). Gait analysis showed that after training, the TR group had increased hip flexion and reduced hip joint torque ($p < 0.05$), indicating improved lower limb elevation and walking ability. HR monitoring revealed a downward trend in the average HR between 6:00-7:00 AM post-training and follow-up in the TR group but not in the CON group. This decrease may be linked to improved walking efficiency and reduced exertion levels during daily activities.

CONCLUSION: A 12-week isokinetic strength training program significantly improved walking ability and balance in older adults, preventing and delaying disability. These findings suggest that smartwatches are beneficial in maintaining exercise adherence and promoting long-term health in elderly populations.

**GAIT ABILITY AND STRIDE LENGTH IN OLDER ADULTS: FOCUS ON HEEL CONTACT AND TOE-OFF**

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INTRODUCTION: Falls and stumbling are major causes of reduced quality of life among older adults, which may be a result of a decline in physical function due to aging, disease, and the effects of medications. To prevent stumbling and falls, it is necessary to reduce the decline in physical functions such as walking ability, balance, and muscle strength. However, few studies have clarified the extent of such prevention. Therefore, this study focused on stride length as a measure of gait ability and examined the characteristics of the feet at contact and liftoff as a function of the difference in stride length.

METHODS: The participants were 31 men and women aged 65 years or older. Prior to the study, the participants were informed of the details of the study and protection of their personal information, and their consent was obtained. A simple gait analysis system (RehaGait) was attached to the dorsal surfaces of both feet. After calibrating the device, the participants performed two trials each of walking with stride lengths of 0 cm (stepping in place), 10 cm, 20 cm, 30 cm, 40 cm, 50 cm, 60 cm, and 70 cm, as well as normal walking and maximum walking, in random order on the floor. During the trials, the moving distance, stride length, speed, cadence, walking cycle, foot-to-floor angle with the heel as the axis of rotation at heel-strike, and foot-to-floor angle with the toe as the axis of rotation at toe-off (in both sagittal planes) were measured. The average of two trials was evaluated. In addition, a tape was placed on the floor to calculate stride length; however, trials in which the foot landed on the tape were invalidated. Kruskal-Wallis test and Bonferroni multiple comparisons were used to compare the conditions. Statistical analyses were performed using IBM SPSS Statistics version 26.0, and statistical significance was set at 5%.

RESULTS: Significant differences were observed in the plantar floor angle at the time of contact and lift-off when the stride length was less than 40 cm compared with normal walking. This suggests that as the stride length increases, the heel comes in contact with the ground, and at the time of liftoff, the heel can be lifted off the ground and the toes can contact the ground to kick off. The height of the raised foot was less than 10 cm, except in the 0 cm trial. In addition, the height of the raised foot in the 10 and 20 cm trials was lower than that during normal walking ($p < 0.05$).

CONCLUSION: In this study, individuals with a stride length of 50 cm showed that heel contact occurred and the ground could be kicked off. This highlights the importance of ensuring an appropriate stride length for gait assistance and fall prevention among older adults. In the future, more comprehensive knowledge can be gained by studying individuals with a wide range of characteristics, including those with impaired physical function, and by studying their relationships with physical functions other than walking in different regions.

**RELATIONSHIP BETWEEN A REACTION STEP TEST AND HISTORY OR FEAR OF FALL IN THE ELDERLY**

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INTRODUCTION: To prevent falls, it is necessary to recognize obstacles, react to them, and apply appropriate strategies in relation to the concrete situation. A stepping strategy serves as the final measure for avoiding falls, and proper stepping movements can help reduce fall risk in older adults. Two abilities are essential for fall avoidance movements: agility, enabling a quick reaction to disturbances, and equilibrium, which later controls its posture. Previous studies have separately examined the relationship between falls and agility or equilibrium, but they have only considered individual abilities. To avoid falls, it is crucial to comprehensively evaluate movements, as fall prevention involves both rapid physical reactions and appropriate strategies of posture control. We developed a reaction step test that integrates agility and equilibrium and confirmed its reliability and validity. However, its relationship with falls has not yet been examined. This study is intended to investigate the relationship between the reaction step test and the history or fear of fall.

METHODS: A total of 57 elderly participants (24 men, 33 women; mean age 76.4±6.1 years) performed the reaction step test. In this test, the participants stood upright on a pressure-sensitive mat in an upright position and were instructed to take a quick step forward onto a stabilometer following the onset of a visual stimulus. After stepping forward, they were required to stand on both legs for 10 s. The time from stimulus onset to foot-off was evaluated as agility, while the post-step center of pressure sway while standing on both legs was evaluated as equilibrium. An independent t-test was conducted to compare the results of the reaction step between groups based on history or fear of fall.

RESULTS: Both agility and equilibrium were significantly decreased in the group that had a history of falls. On the other hand, the group with fear of fall had significantly less agility, although it showed no difference in equilibrium.

CONCLUSION: The reaction step test, which evaluates agility and equilibrium in a series of movements, may be an effective method of assessing fall risk. In particular, agility and equilibrium were both lower in the group that had a history of falls, which indicates a decreased ability to avoid falls. In addition, only agility was decreased in the group with a fear of fall, suggesting that fall anxiety could influence the delay in the initiation of movement.

**PHYSICAL ACTIVITY OF ANY INTENSITY PER DAY AS A PREDICTOR OF MORTALITY AND LONG-TERM CARE NEEDS AMONG COMMUNITY-LIVING OLDER PEOPLE IN JAPAN: A 7-YEAR FOLLOW-UP STUDY**

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INTRODUCTION: Physical activity is a crucial component of healthy aging. The WHO guidelines (2020) recommend regular physical activity and replacing sedentary time with physical activity of any intensity for older adults. However, research is still limited in demonstrating the association of physical activity engagement with mortality and long-term care needs as indicators of healthy life expectancy. The purpose of the present study was to assess different definitions of physical activity engagement and determine whether these physical activities predict mortality and long-term care needs over a 7-year period among community-living older people in Japan.

METHODS: Participants included 322 randomly selected men and women (aged 65 to 80 years at baseline) from a city in Hokkaido, the northern part of Japan. The participants had taken part in the baseline survey and had not relocated during the 7-year follow-up period. The incidence of death, long-term care needs and hospitalization was confirmed by city officials. Physical activity was assessed using a questionnaire, which included the following definitions: engagement in a local exercise class (multicomponent activities, once a week), exercise habits (moderate-intensity: at least 30 mins per session, twice a week; light-intensity: at least 5 mins per session, 4 times a week), and daily physical activity (moderate-intensity: at least 60 mins per week, every week; any-intensity: at least 40 mins per day, every day). Multiple logistic regression models were used to estimate odds ratio (OR) and 95% confidence interval (CI) for the incidence of death or long-term care needs. The study was approved by the Ethical Committee of Hokusho University, and all participants provided written informed consent.

RESULTS: During the follow-up period, 68 participants (21.1%) either died or required long-term care. Participants who engaged in at least 40 mins of physical activity of any-intensity per day had significantly lower incidence of death or long-term care needs compared to those who did not (40.0% vs. 54.8%, p=.034). The OR (95%CI) for developing long-term care or death among those who did not engage in at least 40 mins of physical activity of any-intensity per day were 1.82 (1.04-3.16, p=.035). After controlling for age and sex, the association was slightly attenuated but remained a trend [the adjusted OR (95%CI); 1.71 (0.96-3.04), p=.067]. No significant associations were found between other physical activity engagement and the incidence of mortality or long-term care needs.

CONCLUSION: Our findings suggested that engaging in at least 40 minutes of physical activity of any-intensity per day is more likely to prolong a healthy lifespan among community-living older people in Japan.

**THE ACUTE RESPONSE OF BRAIN-DERIVED NEUROTROPHIC FACTOR IN PLASMA DURING EXERCISE AND RECOVERY IN DIFFERENT ENVIRONMENTS IN OLDER ADULTS**

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INTRODUCTION: Brain-derived neurotrophic factor (BDNF) is a protein which has been described as a marker of brain health, cognitive functioning, and neuronal plasticity. Physical activity promotes several aspects of health and upregulates expression of BDNF. Evidence also indicates positive effects on health measures from exposure to outdoors environments which sparks the question whether exercising outdoors have greater effects on BDNF than exercising indoors.

METHODS: A randomised clinical cross-over trial was conducted with 42 healthy participants over the age of 65 years who underwent 20 minutes of standardised ergometer cycling in three different settings (indoors, simulated outdoors, outdoors). BDNF was measured in plasma in advance of, immediately following exercise and at 60 and 120 minutes of recovery.

RESULTS: Levels of BDNF are elevated and thereafter reduced below baseline after exercising. BDNF-levels did not vary significantly between the three environments. No interaction between the two factors (environment, exercise) were found.

CONCLUSION: Our results suggests that brain health, cognitive functioning, and neuronal plasticity, measured as levels of plasma BDNF, may benefit from exercise. We could not detect any environmental effect on BDNF in this experiment, however, it is possible that BDNF may be influenced by environment but not measurable adjacent to physical acitivity.

**THE RELATIONSHIP OF MUSCLE QUALITY WITH MUSCLE STRENGTH AND WALKING SPEED IN OLDER INDIVIDUALS.**

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INTRODUCTION: Muscle quality, which is determined by the content of adipose and connective tissues within skeletal muscle and muscle stiffness, has been assessed using ultrasound echo intensity and shear modulus. Recent studies have reported that aging is one of the factors that affect muscle quality negatively, implying that muscle echo intensity increases and muscle shear modulus decreases with aging. Therefore, in order for older individuals to live a healthy life with a high physical function, it is necessary to maintain and manage not only muscle quantity, but also muscle quality. However, few studies have investigated the relationship between muscle quality and physical function in older individuals using both muscle echo intensity and shear modulus. Thus, the purpose of this study was to investigate which of the two muscle quality indicators, muscle echo intensity and muscle shear modulus, is more strongly related to physical function, such as muscle strength and walking ability.

METHODS: Twenty-six men and women, aged 60 to 81 years, participated in this study. We focused on the thigh and lower-leg muscles and measured muscle thickness as the parameter of muscle quantity, and echo intensity and muscle shear modulus as the parameters of muscle quality using B-mode ultrasound image and ultrasound shear wave elastography. Knee extension peak torque and maximum walking speed were measured as the parameters of physical function. Stepwise multiple regression analysis was performed with knee extension peak torque and maximum walking speed as dependent variables, and muscle quantity and quality as independent variables.

RESULTS: For knee extension peak torque, muscle thickness of the vastus intermedius and the shear modulus of the rectus femoris were selected as independent variables ($R2 = 0.309$). For maximum walking speed, only the echo intensity of the vastus intermedius was selected as an independent variable ($R2 = 0.352$).

CONCLUSION: We showed that the higher muscle shear modulus was related to greater force exertion. As shown in previous studies, a higher shear modulus indicated a lower amount of adipose and connective tissues within the skeletal muscle. Although muscle thickness was not selected as an independent variable for maximum walking speed, echo intensity is negatively related to walking speed, implying that higher echo intensity indicated lower walking function. These results suggest that physical function is better explained by considering not only muscle quantity but also quality in the assessment of physical function. In conclusion, this study suggests that echo intensity and shear modulus contribute to physical function in older individuals; however, their relative contribution varies depending on the specific physical functions we assessed.

**WATCH YOUR STEP! OLDER ADULTS INCREASE RELATIVE MUSCLE ACTIVITY DURING WALKING TASKS.**

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INTRODUCTION: Age-related changes in walking performance are established risk factors for reduced independence and mortality (White et al., 2013). This study investigated age-related differences in muscle activation during walking tasks to highlight potential targets for future intervention.

METHODS: 31 young (18-29), 17 middle aged (40-59) and 35 older (60+) adults carried out 4-minute walking trials over a flat surface and separately over an uneven surface. A 10 m track was used with turns included, and triangular prisms placed at random under the mat to simulate an uneven surface. Surface electromyography (Biopac Systems Inc, Goleta US) was recorded during the trials on vastus lateralis (VL) and tibialis anterior (TA) muscles of the right leg.

RESULTS: There was a significant main effect of age for the TA during the loading phase (F(2,77)=6.19, p<0.01, ?p2= 0.467), with post-hoc testing showing older adults having greater activation during this phase vs. young (t(77)=2.98, p=0.012) and middle-aged (t(77)=2.86, p=0.017) adults. During the mid-stance phase, there were significant main effects of age for the VL (F(2,77)=5.09, p<0.01, ?p2=0.478), with older adults displaying greater activation compared to young adults (t(77)=2.87, p=0.016). This was also the case in the TA, with a main effect of age (F(2,77)=3.82, p=0.026, ?p2=0.507) reflecting greater activation in older compared to young adults (t(77)=2.50, p=0.044). A significant interaction was observed in the TA (F(2,77)=4.74, p=0.011, ?p2=0.110), with older adults expressing a greater activation on the uneven surface than young adults (t(154)=2.83).

CONCLUSION: These findings highlight a greater muscle activation of knee extensors and dorsiflexors in older adults during normal gait cycles over a flat surface. Greater muscle activity during walking relates to increased muscular demand (Hortobágyi et al., 2011), in turn linked to decreased daily stepping time and sit-to-stand transitions in older adults (LaRoche et al., 2018). To combat this, muscle strengthening interventions are warranted to improve functional capacity to ensure prolonged mobility and crucially, independent living, in older age.

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## Conventional Print Poster Presentations

### CP-MH05 Cancer I

**CARDIOPULMONARY EXERCISE TEST AND FATIGUE OF CANCER PATIENTS RECEIVING IMMUNOTHERAPY**

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*SCIENCE AND RESEARCH CENTRE KOPER*

INTRODUCTION: Cancer is acknowledged as the second greatest cause of death globally [1] and has enormous economic and societal impacts. Its treatments significantly impact patients physical and mental health, but it remains unclear how the novel treatment – immunotherapy, influences cardiorespiratory function and perceived levels of fatigue in cancer populations. Studies have shown that cancer-related fatigue (CRF) is associated with decreased cardiopulmonary performance, especially VO2 peak [2]. Understanding the relationship between them can be beneficial for future exercise interventions for cancer patients undergoing immunotherapy.

METHODS: We conducted a cross-sectional study involving three age-matched groups: immunotherapy cancer patients (IMMU) (n=11; 36.36% females), cancer survivors (SUR) (n=12; 50% females), and healthy controls (HC) (n=16; 37.5% females). Cardiopulmonary exercise testing (CPET) was used to assess VO2 peak, VCO2, VE, maximal heart rate (HRmax), peak power output (PPO), and respiratory exchange ratio (RER). Self-reported fatigue was evaluated using the Multidimensional Fatigue Inventory (MFI-20). This study aimed to compare the CPET performance and fatigue levels among IMMU, SUR, and HC and search for possible correlations between fatigue and CPET parameters.

RESULTS: Significant differences ($p < 0.05$) were found between the IMMU and HC and SUR and HC when comparing the values of CPET (VO2 peak, VCO2, VE, PPO) and fatigue levels (general and physical fatigue, reduced activity). IMMU exhibited descriptively higher VO2 peak values (mean: 31.09 ± 4.81 mL·kg−1·min−1) than SUR (mean: 28.33 ± 5.43 mL·kg−1·min−1) but lower than HC (mean: 39.75 ± 7.11 mL·kg−1·min−1). The highest fatigue levels were observed in IMMU compared to SUR, which showed fatigue levels comparable to HC. Increased VO2 correlated with higher generalized fatigue ($\rho = 0.636$; $p = 0.048$), while VCO2 ($\rho = 0.793$; $p = 0.006$), VE ($\rho = 0.652$; $p = 0.041$), and RER ($\rho = 0.688$; $p = 0.028$) correlated with higher mental fatigue in IMMU. Lower reduced activity was correlated to a higher VO2 peak ($\rho = 0.590$; $p = 0.044$) in the SUR group.

CONCLUSION: The IMMU group showed tendencies of better CPET performance but significantly higher levels of fatigue than the SUR group, even though they were still receiving ongoing anticancer treatment. These findings indicate that CPET is not the only indicator of chronic fatigue development in cancer-affected populations, especially under immunotherapy treatment.

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**RESPONSE OF MYOKINES IN BREAST CANCER PATIENTS IS DEPENDENT ON THE MODALITY OF ACUTE EXERCISE**

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INTRODUCTION: Physical activity influences anticancer effects (ACE) indirectly by reducing cancer risk factors like sex hormones, body fat, and inflammation (doi:10.1038/nrc2325). Preclinical studies show direct effects on cancer cells, such as reduced proliferation (doi:10.1016/j.cmet.2017.09.015). These effects may be mediated by myokines like IL-6, which can inhibit proliferation and induce apoptosis in breast cancer (BC) (doi:10.1515/tjb-2020-0508) and colon cancer cells (doi:10.1002/ijc.33982). Oncostatin M (OSM) and SPARC can suppress or promote cancer growth depending on the type of cancer. Exercise also stimulates release of BDNF, and FGF21, which have systemic or direct ACE effects (doi:10.1016/j.bbcan.2022.188761). This pilot study examined effect of acute exercise on serum myokine levels in BC survivors. The focus was on markers associated with cancer progression, immune response, and metabolism, including cytokines.

METHODS: Seven women (age 44.7±7.76 years, BMI 24.4 (23.1; 30.3), 6-12 months post-BC treatment). Modified Bruce protocol was used to assess HRpeak and VO2peak (UNCCRI Treadmill Protocol). VO2peak attainment was determined based on modified Borg scale (fatigue rating ≥8), and/or RER ≥1.1, and tester's confirmation of protocol termination. In the following weeks subjects completed three high-intensity exercise protocols (85–95% heart rate reserve) with different modalities: interval, continuous, and incremental. Blood samples were obtained before and immediately after each exercise session. Levels of IL-6, OSM, FGF-21, SPARC, and BDNF were analyzed using the Human Myokine Magnetic Bead Panel (HMYOMAG-56K, Millipore, Billerica, MA, USA) on a Magpix analyzer (Austin, TX, USA). After checking normality mixed-design ANOVA and Post-hoc comparisons were used for data analysis.

RESULTS: During VO2peak estimation RER reached 1.14±0.0698, ventilation (VE) was 77±7.47 L/min and VO2peak 29.1±2.93 ml/kg/min. Data analysis revealed no significant interaction between intervention and time for any of the evaluated biomarkers ($p>0.05$). Furthermore, post-hoc comparisons showed no significant differences between interventions or time points for any biomarker (all $p > 0.05$). However, each patient showed a different intra-individual response to various high-intensity exercise modalities, with varying trends and magnitudes of change. For example, BDNF values before vs after the training session for one of the patients were as follows: interval training - 18,914.8 vs 6,689.3 pg/mL; continuous exercise - 13,551.4 vs 14,891.5 pg/mL; incremental exercise - 6,813.5 vs 11,788.1 pg/mL, correspondingly.

CONCLUSION: None of the high-intensity exercise modalities resulted in significant systemic changes of myokines in breast cancer patients. However, intra- and inter- individual variability in response to different exercise modalities should be considered for development of proper research design and for personalized interventions in this patient population.

**ASSESSING THE RELATIONSHIP BETWEEN BALANCE AND GAIT VARIABILITY IN CHILDREN WITH CANCER**

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INTRODUCTION: The ability to walk safely and engage in daily activities and social interactions without restrictions relies on the coordinated interplay of sufficient muscle strength, ankle flexibility, and the effective acquisition and utilisation of sensory information essential for motor control and balance during walking. It is well-documented that cancer and its associated treatments can have a detrimental effect on physical performance, potentially resulting in limitations in parameters needed for normal gait, including balance. Therefore, this study hypothesises that balance impairments significantly influence gait variability in children with cancer, a factor recognised as a crucial contributor to increased fall risk in children. The present research aims to examine the relationship between balance and gait variability in children and adolescents with cancer.

METHODS: A total of 62 patients aged 4 to 20 years (mean age: 9.68 ± 4.02 years) during and after cancer treatment participated in the study. Spatio-temporal gait parameters (step length, base of support, step duration, velocity, step frequency) were measured using a 10 m OPTOGait walkway (Microgate S.r.l., Bolzano) and intra-individual gait variability was calculated using the coefficient of variance (CV). Balance was measured using the static stand test according to Bös et al. (2009), a balance test in which subjects maintain a one-legged stance on a thin T-bar for one minute and ground contacts are counted. Correlations between balance and gait variability were analysed using Spearmans correlation. The significance level was set at $p < 0.05$ and Spearman correlation coefficients were interpreted according to Cohen ($\rho = 0.1$ - 0.3: small correlation, $\rho = 0.3$ - 0.5: moderate correlation, $\rho > 0.5$: strong correlation).

RESULTS: The findings indicate moderate to strong significant correlations between balance performance and intra-individual variability in all gait parameters assessed, except for step frequency where only small significant correlations can be observed. Children with poorer balance ability in the static stand test had significantly greater variability in step length ($\rho = .402$, $p = .002$), base of support ($\rho = .305$, $p = .022$), step duration ($\rho = .375$, $p = .004$), velocity ($\rho = .353$, $p = .008$) and step frequency ($\rho = .263$, $p = .05$).

CONCLUSION: The findings of this study highlight the significant relationship between balance ability and gait variability in children and adolescents with cancer. Given the critical role of balance in maintaining stable and efficient gait, targeted interventions aimed at improving balance may help reduce gait variability. Future research should further explore the underlying mechanisms of balance deficits in childhood cancer patients and assess the effectiveness of tailored rehabilitation strategies to enhance mobility and overall quality of life.

**PHYSICAL ACTIVITY, SLEEP QUALITY, FATIGUE AND QUALITY OF LIFE IN CHILDHOOD CANCER: THE IMPACT OF THE FIRST MONTH AFTER DIAGNOSIS**

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INTRODUCTION: Childhood cancer is a growing global issue, with increasing cases in recent years (1). Physical activity (PA) is an effective strategy to improve cardiorespiratory fitness and muscle strength, often impaired by cancer or bed rest in the hospital. Exercise programs also offer emotional and social benefits (2). Chemotherapy side effects, like fatigue and sleep disturbances, further limit participation in PA programs (3). The aim of this study is to assess physical activity (PA), sleep quality (SQ), fatigue (CRF), and quality of life (QoL) within the first month after pediatric cancer diagnosis.

METHODS: 12 patients with solid tumors (females=58%, median age=16.8 ± 1.6 years, range 14-19) were enrolled at Fondazione IRCCS Istituto Nazionale dei Tumori in Milan. They completed the Physical Activity Questionnaire for Adolescents (PAQ-A), Pittsburgh Sleep Quality Index (PSQI), Multidimensional Fatigue Scale, and Pediatric Quality of Life Inventory™ (PedsQL) at diagnosis (T0) and 30 days later (T1), when chemotherapy or radiation treatments begin. Data were analyzed using Prism GraphPad.

RESULTS: In the comparison between T0 and T1, significant reductions in PA ($p<.04$), SQ ($p<.0001$), parents CRF ($p<.03$), and adolescents CRF ($p<.002$) were observed. No significant changes were found in parents QoL ($p=.14$) or adolescents QoL ($p=.06$). SQ worsening, measured by the PSQI, was associated with changes in sleep ($r^2=0.45$, $p<.02$), fatigue ($r^2=0.69$, $p<.008$), and cognitive aspects ($r^2=0.44$, $p<.02$) as measured by the CRF questionnaire.

CONCLUSION: Levels of PA, SQ, CRF, and QoL underwent changes soon after cancer diagnosis in pediatric patients. Creating programs focused on the improvement of these aspects could be a useful strategy to improve outcomes in childhood cancer.

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**FITNESS AND QUALITY OF LIFE ASSESSMENTS AFTER DIFFERENT BREAST CANCER SURGERIES: WHICH TYPE OF TAILORED EXERCISE SHOULD BE PRESCRIBED?**

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INTRODUCTION: Although innovations in breast cancer (BC) treatments improved patients' outcomes, surgery often leads to physical and psychological challenges that can worsen over time. Exercise emerged as a promising intervention to mitigate these effects, but little is known about the optimal exercise interventions for BC patients immediately after surgery.

METHODS: The study aimed to assess and compare parameters, such as body composition, physical function (i.e. upper and lower limb strength), and health-related quality of life (QoL) in 50 BC patients (aged 45–65 years) who underwent mastectomy (MAST, n=13), quadrantectomy (QUAD, n=21), or tumorectomy (TUM, n=16)immediately after surgery. Moreover, potential correlations among these variables were identified to provide tailored exercise program recommendations.

RESULTS: Significant difference in PhA between the TUM and QUAD groups ($p < 0.000$) and between the QUAD and MAST groups ($p = 0.015$) were evidenced. FM difference was observed between TUM and QUAD ($p = 0.003$) and TUM and MAST ($p = 0.008$). The correlation analysis showed that Handgrip strength was positively correlated with emotional functioning ($r=0.294$, $p=0.038$) and with cognitive fatigue ($r=-0.284$, $p=0.046$). Lower limb strength correlated with interference with daily life ($r=-0.367$, $p=0.009$) and global health ($r=0.292$, $p=0.040$). Global health showed positive correlations with FFM ($r=0.295$, $p=0.037$) and BCM ($r=0.327$, $p=0.021$).

CONCLUSION: These results emphasize the importance of improving fitness parameters despite the type of surgery. Although aerobic training remains the most studied and commonly prescribed approach in cancer, strength training seems the most promising in improving those functional parameters related to health related QoL in BC patients.

**DESIGN AND IMPLEMENTATION OF A PERSONALIZED EXERCISE PROGRAM FOR IMPROVING PHYSICAL FUNCTION IN CANCER SURVIVORS.**

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INTRODUCTION: Cancer survivors suffer from long-term side effects of treatment which significantly reduces their functional capacity and quality of life (QoL). Exercise can improve functional capacity and can prevent long-term illness. Previous research and our preliminary study helped us to understand the patients' perspective on long-term illness following can-

cer treatment. A myriad of side-effects was identified of which chronic fatigue and loss of physical function (reduced cardiorespiratory capacity, flexibility, and muscle strength) was identified as the most debilitating effect that impacted the QoL of many patients. The severity and type of symptoms experienced by patients varied significantly. It was highlighted by the patients that the exercise intervention developed to address these issues needed to be tailored to the individual's symptoms and capacity. The intervention needed to be multi-modal targeting all the symptoms experienced by the patient. The current study aimed to develop a personalized, multimodal exercise- based rehabilitation program that will help to improve physical function amongst cancer survivors and reduce fatigue.

Purpose: To design, implement and evaluate the effectiveness of a "personalized" exercise program to improve physical function and reduce cancer-related fatigue in cancer survivors.

METHODS: Any person with a diagnosis of cancer, regardless of the stage of treatment, and no contraindication to exercise were eligible to take part in the study. Upon completion of a PAR-Q+ questionnaire and informed consent, participants performed a baseline exercise assessment and pre- intervention qualitative assessment of Fatigue and health related QoL performed via questionnaires. The exercise assessment measured the participants cardiorespiratory fitness, muscular endurance, flexibility, balance, and body composition. A 12-week personalized exercise program was developed for each participant based on their test results and symptoms. Each program contained aerobic exercise, resistance exercise and flexibility exercise that was tailored to the individual. An exercise physiologist/physiotherapist provided step by step guidance and supervised the weekly sessions and delivery of the exercise intervention. Each participant received weekly one to one advice and monitoring throughout the program via email, telephone, and weekly online exercise sessions. The intervention was adapted based on progress made which was assessed every 4 weeks during the program. At the end if 12 weeks, participants too part in a post-intervention exercise assessment and completed the questionnaires again.

RESULTS: 49 participants completed the exercise program including both the pre-intervention and post- intervention exercise assessment. Participants significantly improved their aerobic capacity and muscular endurance and reduced their symptoms of cancer-related fatigue from pre-intervention to post-intervention. A strong positive correlation was discovered between the participants post- intervention muscular endurance test scores and their post-intervention fatigue scores.

CONCLUSION: A personalized exercise program tailored to individuals' capacity and symptoms can significantly improve physical function and reduce the cancer-related fatigue experienced by cancer survivors. Future studies should focus on optimizing the process of assessing and prescribing exercise to cancer survivors to maximize their recovery from cancer and its treatment.

**EFFECTS OF PHYSICAL EXERCISE AND PROBIOTIC SUPPLEMENTATION ON GUT MICROBIOTA IN PEDIATRIC PATIENTS WITH ACUTE LYMPHOBLASTIC LEUKEMIA IN REMISSION**

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INTRODUCTION: Pediatric acute lymphoblastic leukemia (ALL) is the most common childhood cancer, often treated with intensive chemotherapy and antibiotic protocols that disrupt gut microbiota diversity and function. These disruptions can persist for years after treatment, leading to long-term health complications, including reduced microbial diversity, metabolic imbalances, and decreased physical fitness. This study investigated the impact of physical exercise and probiotic supplementation on gut microbiota, physical fitness, and overall health in pediatric patients with ALL in remission.

METHODS: This crossover study included 22 pediatric patients with ALL in remission (3–5 years post-treatment). Thirteen participants began as the experimental group and nine as the control group. The intervention consisted of an 8-week strength training program (3 sessions/week), followed by an 8-week probiotic intervention with daily consumption of Lactobacillus casei CNCMI-1518. Strength and anthropometric measures were assessed alongside gut microbiota analysis using 16S rRNA sequencing.

RESULTS: Logistic regression analysis identified several variables significantly associated with probiotic intervention outcomes, identifying key predictors of gut microbiota improvements. The probiotic intervention increased gut microbiota diversity (Chao1 index, p=0.065) and beneficial taxa, including butyrate producers Blautia caecimuris (p=0.007) and Blautia schinkii (p=0.024), as well as Lacticaseibacillus casei (p=0.011) and Veillonellaceae (p=0.054). Physical exercise showed a modest effect on the shift in gut microbiome and handgrip; however, weight (p=0.008) and BMI percentile (p=0.023) improved.

CONCLUSION: This study demonstrated that probiotic supplementation significantly improved gut microbiota diversity and increased beneficial taxa. Physical exercise moderately influenced gut microbiota composition but significantly improved weight, BMI percentile, and handgrip strength in pediatric ALL patients. These findings suggest that probiotics can effectively restore gut health, while exercise supports anthropometric recovery in this population. This study was supported by the following granting schemes: APVV-22-0047 and VEGA 1/0313/25.

**EFFECTS OF VIRTUALLY SUPERVISED EXERCISE IN PHYSICAL FUNCTION AND STRENGTH IN LATINA AND HISPANIC BREAST CANCER SURVIVORS: PRELIMINARY RESULTS FROM THE ROSA TRIAL**

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INTRODUCTION: Latina and Hispanic breast cancer survivors (LHBCS) experience many treatment-related side effects compared to White counterparts. Previous studies have highlighted a high prevalence of impaired physical function among LHBCS, particularly those with obesity. Regular exercise has been shown to improve muscular strength and physical function in breast cancer survivors. However, most studies have focused on non-Hispanic white women, limiting our understanding of how exercise may benefit LHBCS. Therefore, we designed an exercise intervention that is culturally tailored to the needs of Latina and Hispanic women, aiming to address the unique barriers they face to engage in exercise (NCT04717050). This study aimed to assess the effects of a 16-week virtually supervised aerobic and resistance training intervention on physical function and muscular strength in LHBCS.

METHODS: Sedentary, overweight or obese (BMI>25.0 kg/m2) LHBCS (N=64) were randomized to a combined aerobic and resistance exercise program (ACTIVAS; n=32) or waitlist control (n=32). The ACTIVAS intervention consisted of a thrice-weekly, 16-week home-based virtually supervised aerobic (50-85% VO2peak) and resistance training (60-75% 1-RM) program via Zoom. The waitlist control completed a self-directed home-based stretching program. Physical function was measured at baseline and post-intervention (week 17) using the Sit-to-stand, Margaria stair climb and Timed-up and Go (TUG) tests. Upper and lower body muscular strength were measured by a 10-repetition maximum test using chest press and leg press, respectively. Repeated measures ANCOVA and paired t-tests were conducted.

RESULTS: Participants were 55±10 years old, obese (BMI=30.7±5.6 kg/m2), and 44% had received chemotherapy, radiation and surgery. Physical function data was available for 67% of participants, upper body strength for 69% and lower body strength for 66%. Baseline characteristics were similar between groups. At post-intervention, the ACTIVAS group showed a significant improvement in TUG (mean difference (95% CI): -0.5 s (-1.0, -0.1), p=0.02) compared with waitlist controls (Pgroupxtime=0.01). Upper and lower body muscular strength significantly increased within the ACTIVAS group at post-intervention (Upper: 4.4 kg (1.9, 6.8), p=0.001; Lower: 10.6 kg (0.1, 21.1), p=0.04). No significant within- or between-group changes were found for the Margaria stair climb or Sit-to-stand tests.

CONCLUSION: A virtually supervised exercise intervention improved upper and lower body strength, as well as physical function measured by the TUG among Latina and Hispanic breast cancer survivors. These results support the incorporation of virtually supervised exercise interventions into survivorship care plans for LHBCS, with the potential to improve physical function and strength. Future research is needed to optimize exercise strategies for this vulnerable population.

**IN VIVO MULTI-ORGAN ANALYSIS OF GLUCOSE UPTAKE, BLOOD FLOW AND BLOOD VOLUME OF THE EFFECTS OF PHYSICAL ACTIVITY AND CHEMOTHERAPY IN BREAST CANCER**

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INTRODUCTION: We have previously shown that physical activity (PA) can benefit heart during doxorubicin (DOX) treatment in a breast cancer mouse model (1), but the effects in other tissues remain incompletely characterized.

METHODS: The effects of PA (voluntary wheel-running) and DOX were analyzed with positron emission tomography (PET) imaging with [18F]-FDG, [15O]-H2O and -CO tracers in female FBV/N-mice (n=77) subcutaneously injected with breast cancer cells (I3TC). Glucose uptake (GU), blood flow (BF), blood volume (BV), and blood mean transit time (MTT) were analyzed using PET data from tumor, brain, liver, gastrocnemius muscle, bone marrow, and compact cortical bone. Tumor characteristics such as vasculature and hypoxia were analyzed by using histology. Mice were divided to four tumor-bearing groups: Control, DOX treated and further to PA and no-PA.

RESULTS: DOX significantly decreased BV in the whole tumor (P=0.003), tumor high flow areas (P=0.005), compact bone (P=0.004), bone marrow (P=0.019), brain (P=0.011) and BF in the brain (P=0.01). DOX significantly decreased MTT in bone marrow (P=0.34) and compact bone (P=0.008). GU increased over time in the brain (P=0.001) and liver (P=0.0002). Brain GU also significantly increased by PA when comparing all PA groups to sedentary groups (P=0.037). Analyzes also revealed a significant DOX and PA interaction in the femur GU (P=0.038). No significant effects of time, PA or DOX were found in gastrocnemius muscle GU. DOX significantly decreased tumor maximal GU (P=0.028) and metabolic tumor volume (MTV) (P=0.048), but other factors observed by [18F]-FDG were not affected by DOX. Time reduced glucose uptake when tumor volume was used as a covariate, but PA significantly decreased the GU heterogeneity (P=0.018) when comparing the groups. A significant interaction was also found between PA and time on MTV (P= 0.035), PA depressing over-time the decrease of MTV. PA significantly decreased large vessel (<8µm) density (P=0.013) in the tumor. Significant interaction was found between PA and DOX on α-sma-positive vessel proportion (P=0.016). Post hoc test revealed that PA and DOX alone significantly increased α-sma-positive vessel proportion, but not together. In addition, DOX alone significantly decreased α-sma positive vessel amount (P=0.044). No other differences were found in tumor vasculature or hypoxia. There were no statistical differences in tumor volume between the groups.

CONCLUSION: Particularly drug treatment of breast cancer appears to have many effects on circulatory function and glucose uptake in different tissues, but PA also affects some of these effects.

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## Conventional Print Poster Presentations

### CP-MH06 Cardiovascular Health

**COMPARING SUPERVISED AND HOME-BASED EXERCISE INTERVENTIONS IN PERIPHERAL ARTERY DISEASE: CLOSING THE GAP ON FUNCTIONAL OUTCOMES**

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INTRODUCTION: Supervised exercise therapy (SET) is a first-line recommendation for improving walking performance in people with peripheral artery disease (PAD) and intermittent claudication (IC) [1]. However, low adherence and limited availability [2] often mean that home-based exercise therapy (HBET), usually consisting of basic walking advice, is recommended instead. Whilst SET leads to greater improvements in functional outcomes than HBET [3], recent studies have explored structured HBET interventions that incorporate more prescriptive walking advice and technology such as phone applications or smartwatches to track adherence and progress. In this systematic review and meta-analysis, we provide an update of the literature on the comparative efficacy of SET vs. HBET on maximal and pain-free walking outcomes. Within HBET, we further compare structured programmes to simple walking advice.

METHODS: A systematic literature search was conducted using Embase, Web of Science, and PubMed. Studies were included if they evaluated SET or HBET interventions lasting 12 weeks and reported outcomes related to maximal or pain-free walking distance or time. Structured HBET was defined as a home-based programme that included prescriptive walking advice, with or without additional support such as a fitness tracker or phone application.

RESULTS: A total of 27 studies were included in this review: 20 compared SET to HBET, 5 compared structured to unstructured HBET, and 2 compared all three interventions. 631 participants were included in the SET group and 509 in HBET. To further compare different types of HBET interventions, 197 participants were included in the structured HBET group and 191 participants were in the unstructured group. The mean age of participants was 65.7 years (65.9% men).

Compared with HBET, SET significantly improved maximal walking distance by a mean difference (MD) of 155.9 m [95% CI 110.8–201.0, p<0.001]. Pain-free walking distance increased by an MD of 112.0 m [95% CI 73.9–150.1, p<0.001]. When comparing the two types of HBET, structured HBET led to significantly greater improvements in maximal walking distance (MD: 53.5 m [95% CI 5.8–101.2], p=0.03), but showed no significant difference in pain-free walking distance (p=0.09).

CONCLUSION: Although SET remains the gold standard for improving functional outcomes in patients with PAD and IC, structured HBET programmes incorporating prescriptive walking advice and technology resulted in greater maximal walking improvements than unstructured programmes. These findings highlight structured HBET as a practical alternative to SET and its potential to help close the gap in functional outcomes between the two types of exercise programmes. Future research should prioritise optimising and scaling structured HBET interventions.

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**CARDIOVASCULAR RISK IMPOSED BY POLYCYSTIC OVARY SYNDROME APPEARS TO BE MITIGATED BY HABITUAL EXERCISE TRAINING**

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INTRODUCTION: The prevalence of virtually all cardiovascular diseases are elevated in females with polycystic ovary syndrome (PCOS). While the pathophysiology of cardiovascular diseases in PCOS continue to be elucidated, a number of cardiovascular risk factors have been well-established as being common to PCOS. These include elevated blood pressures (BP), impaired endothelial function, and greater adiposity. Although these cardiovascular risk factors are effectively managed with exercise in other populations, short-term (e.g. 12-16 week) exercise intervention studies show conflicting results in females with PCOS. Thus, we used a cross-sectional approach to examine whether established differences in cardiovascular risk persist between females with and without PCOS (i.e. CTRL) who undertake habitual exercise training, defined as a minimum of 5 hours of structured moderate-vigorous physical activity weekly over the last year.

METHODS: Females with PCOS (n=7) and CTRL (n=7) were matched by age (24 ± 5 vs. 23 ± 6 yrs, respectively) and body mass index ([BMI]; 22.6 ± 2.2 vs. 22.6 ± 2.2 kg/m2, respectively). Blood pressure was assessed via manual sphygomomanometry, endothelial function was quantified as %FMD according to standardized methodology, and body composition was assessed using dual X-ray absorptiometry.

RESULTS: Systolic BP (109 ± 6 vs. 105 ± 4 mmHg, P=0.22), and diastolic BP (69 ± 6 vs. 65 ± 4 mmHg, P=0.26) were not different between PCOS and CTRL. Likewise, %FMD was not different between PCOS and CTRL (7.6 ± 2.5 vs. 8.8 ± 2.2%, P=0.34). Similarly, neither android fat (1.00 ± 0.36 vs. 0.94 ± 0.37 kg, P=0.76), gynoid fat (3.59 ± 0.94 vs. 3.40 ±1.08 kg, P=0.73), android/gynoid ratio (0.28 ± 0.06 vs.0.28 ± 0.07 g, P=0.96), or whole-body fat (29.86 ± 4.02 vs. 27.57 ± 5.29 %, P=0.40) were different between PCOS and CTRL

CONCLUSION: These preliminary findings suggest that habitual physical activity may be effective in mitigating the established negative cardiovascular consequences of PCOS. Future research is warranted in investigating the most effective type and frequency of physical activity in reducing cardiovascular risk amongst females with PCOS.

**THE CHALLENGES OF THE DIAGNOSIS AND MANAGEMENT OF EXERCISE-INDUCED ACUTE KIDNEY INURY: A REVIEW OF THE CURRENT LITERATURE**

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INTRODUCTION: Exercise-induced acute kidney injury (Also known as EIAKI or ALPE) is a significant, yet underrecognised and understudied cause of acute renal failure following exercise. It can be distinguised from rhabdomyolysis by normal or only mildly raised serum creatine kinase levels (CK) and is typically seen in activities that are predominantly anaerobic such as sprinting, weightlifting or military fitness testing and can be career ending. Dialysis is required in up to 20% of those with EIAKI and it is closely linked to renal hypouricaemia which has a reported prevalence between 0.15-1.39% in Asian countries like Japan and South Korea. Therefore an understanding of the pathophysiology, diagnosis, management and prevention of EIAKI is of the utmost importance to clinicans. A review of the literature was done to summarise the current knowlege of this condition.

METHODS: A literature review on Pubmed using the search terms "exercise induced acute kindey inury", "renal hypouricaemia" & "Acute Renal Failure with Severe Loin Pain and Patchy Renal Ischemia after Anaerobic Exercise ". Case reports and reviews detailing the management and prevention of the condition were collected, with the results summarised below.

RESULTS: There were no randomised-controlled trials looking at the management of EIAKI found in the literature. However a case-report described an improvement in renal function in 2 cases after intravenous continuous infusion of 2 µg/kg/min dopamine. Another study reported that EIAKI was prevented in 5 patients with renal hypouricaemia by taking 300mg of allopurinol for 5 days. Management and preventioon strategies in other studies included maintaining adequate hydration, avoiding NSAIDs, having a good baseline fitness and if feasible, avoiding the aggravating exercise.

Most patients had a spontaneous recovery in their renal function after 3 days and 25% of patients had at least one recurrence. There was no data on long-term ability to return to exercise or long-term effects on kidney function.

CONCLUSION: Exercise-induced Acute Kidney Injury (EIAKI) or Acute Renal Failure with Severe Loin Pain and Patchy Renal Ischemia after Anaerobic Exercise (ALPE) is marked by a significant rise in creatinine after intense anaerobic exercise, normal or mildly elevated CK levels and back or loin pain. Diagnosis is supported by a Computed Tomography (CT) scan showing wedged-shaped infarcts on the kidney.

The majority of patients with EIAKI have been found to have hereditary renal hypouricaemia and it is thought to be caused by either renal vasoconstriction due to oxidative stress which uric acid normally inhibits or uric acid nephropathy due to increased excretion by the kidneys. No definitive management strategy exists for EIAKI but dopamine infusion may reverse the vasocontriction caused by anaerobic exercise, and allopurinol as a Xanthine oxidase inhibitor may prevent the formation and excretion of uric acid . Further research is required to better optimise the management of this condition.

**THE EFFECTS OF EXERCISE ON IMMUNE CHECKPOINT INHIBITOR-RELATED CARDIOTOXICITY: IMPACT ON CARDIAC FUNCTION**

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INTRODUCTION: Immune checkpoint inhibitors (ICIs) significantly advance cancer immunotherapy, enhancing antitumor immunity by blocking the PD-1/PD-L1 pathway. However, their most severe immune-related adverse event (irAE) is cardiotoxicity, leading to myocarditis and heart failure due to off-target immune activation. T-cell and macrophage infiltration, oxidative stress, mitochondrial dysfunction, and endothelial impairment contribute to these effects. ICIs disrupt mitochondrial biogenesis and function, reducing ATP production and exacerbating oxidative damage, ultimately impairing cardiovascular function. Exercise exerts well-established cardioprotective effects by promoting mitochondrial biogenesis and reducing oxidative stress, thereby preserving cardiac function. This study investigated whether Exercise mitigates ICI-induced cardiotoxicity, focusing on cardiac structure and function through echocardiographic assessment. The findings highlight Exercise's potential to enhance ICI efficacy while reducing cardiotoxic effects, offering key insights for optimizing cancer immunotherapy while safeguarding cardiovascular health.

METHODS: Male 8-week-old C57BL/6 mice (n=18) were divided into three groups: Control, ICI, and ICI + Exercise. ICI-induced cardiotoxicity was modeled by administering nivolumab (10 mg/kg, i.p.) twice weekly for six weeks. The exercise group performed treadmill running (9 m/min, 5 days/week) for six weeks. Echocardiography was conducted at the study endpoint to assess cardiac function. Data were analyzed using one-way ANOVA with Tukey's post hoc test ($p < 0.05$ considered significant).

RESULTS: Exercise training preserved myocardial function, evidenced by significantly higher fractional shortening and ejection fraction in the exercise group compared to the ICI-treated group ($p < 0.05$, $p < 0.06$). The ICI group exhibited reduced end-diastolic and end-systolic volumes ($p < 0.0001$ vs. Exercise, $p < 0.006$ vs. control), indicating impaired ventricular filling and ejection. Left ventricular diameters in diastole and systole were significantly lower in the ICI group ($p < 0.0003$ vs. Exercise, $p < 0.01$ vs. control), suggesting contraction abnormalities rather than hypertrophy.

CONCLUSION: Exercise effectively mitigates ICI-induced cardiotoxicity by preserving mitochondrial function, reducing oxidative stress, and inhibiting apoptosis. It restores cardiac energy metabolism and enhances myocardial elasticity, ultimately improving heart function. These findings underscore Exercise's therapeutic potential as a complementary intervention in ICI therapy, offering a promising strategy to attenuate immune-related adverse events and optimize clinical outcomes in cancer immunotherapy.

**EFFECTS OF BODY MAINTENANCE DEVICE-INDUCED PASSIVE LIGHT EXERCISE ON ARTERIAL STIFFNESS AND WALL TISSUE ELASTICITY**

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INTRODUCTION: Increased arterial stiffness due to aging and physical inactivity is a risk factor for cardiovascular diseases. Aerobic exercise or stretching is generally known to reduce arterial stiffness; however, in recent years, physical activity has declined due to the development of various technologies. Body maintenance devices can induce passive light exercise, such as stretching and/or massage, but its effects on arterial stiffness and arterial wall tissue elasticity remain unclear. The present study thus aimed to examine the effects of body maintenance device-induced passive light exercise on arterial stiffness and wall tissue elasticity.

METHODS: Fifteen healthy adults (mean age, 21.1 ± 0.4 years) participated in both body maintenance (BM) and control (C) trials in random order on separate days. In the BM trial, participants performed 30 minutes of passive light exercise using body maintenance devices, while in the C trial, they rested in the same body positions as in the BM trial. Arterial stiffness and arterial wall tissue elasticity were measured using the Cardio-Ankle Vascular Index (CAVI) and Shear Wave Elastography (SWE) before (Pre), immediately after (Post), and 30 minutes after (Post 30) each session.

RESULTS: There was no significant difference in heart rate between both trials. Furthermore, no significant changes were observed in resting heart rate, blood pressure, and pulse pressure. CAVI values showed no significant differences between the trials before starting, and no significant changes were found in the C trial. However, in the BM trial, CAVI significantly reduced at Post and returned to baseline at Post 30(BM, Pre: 5.9 ± 0.2; Post: 5.7 ± 0.1; Post 30: 6.0 ± 0.1, Control, Pre: 5.8 ± 0.1; Post: 6.0 ± 0.2; Post 30: 6.0 ± 0.2, both $P < 0.01$). No significant differences were observed in the elastic modulus or shear wave velocity in either condition.

CONCLUSION: Therefore, our findings suggest that body maintenance device-induced passive light exercise reduces arterial stiffness but not arterial wall tissue elasticity. The observed reduction in arterial stiffness seems likely to be functional changes rather than structural changes in the arteries.

**EFFECTS OF DIFFERENT EXERCISE MODES ON CARDIOVASCULAR DISEASE RISK FACTORS IN JAPANESE ADULTS**

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INTRODUCTION: The development and progression of cardiovascular disease (CVD) are the primary causes of overall mortality in the world. It is well known that habitual aerobic exercise is a promising first-line approach for preventing and managing CVD risk factors, such as arterial stiffness and blood pressure (BP) (1). Recent studies have demonstrated the effects of other modes of exercise training, including high-intensity interval training (HIIT) and splint interval training (SIT), on CVD risk factors (2). However, these relative impacts of these modalities on the CVD risk factors remain unclear. This study aimed to elucidate the effects of the different modes on the CVD risk factors in Japanese adults.

METHODS: Fifty-four civil servants working in Japan (40 ± 13 years) were randomly divided into four groups; sedentary control (CON), moderate-intensity continuous exercise training (MICT; for 40 min at 60-70% maximal oxygen uptake [VO2max] intensity), HIIT (8 sets of 2-min 80% VO2max intensity and 3-min 40% VO2max intensity), and SIT (8 sets of 20-s maximal exercise periods with 10-s rests) groups. Participants in the MICT, HIIT and SIT groups performed their respective training 3 days/week for 8-week. As indicators of CVD risks, carotid-femoral pulse wave velocity (cfPWV) and BP were measured before and after each intervention. The differences in the effects of each intervention on CVD risks were compared using one-way ANCOVA, adjusting for sex and age. Statistical significance was defined as $p<0.05$.

RESULTS: No significant differences were found in VO2max, cfPWV, and BP when compared among the four groups at baseline. Percent changes in VO2max before and after the interventions were significantly greater in the MICT and HIIT

groups compared to the CON group (p<0.05). Additionally, percent changes in cfPWV were significantly lesser than that in the CON group (CON: 59 ± 77 cm/sec vs MICT: -57 ± 76 cm/sec, p<0.001, HIIT: -87 ± 76 cm/sec, p<0.001, and SIT: -25 ± 77 cm/sec, p=0.007). Moreover, the reductions in cfPWV in the HIIT group were significantly greater than that in the SIT group. Furthermore, percent changes in systolic BP in the MICT and HIIT groups were significantly lesser than that in the CON group (each p<0.05). However, no significant differences of percent changes in diastolic BP were observed among the four groups.

CONCLUSION: Habitual exercise using different exercise modes, including MICT, HIIT, and SIT, may similarly reduce CVD risk factors in Japanese adults. However, the magnitude of the impact of each exercise mode on specific CVD risk factors may vary.

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**EFFECT OF 12-WEEK ISOMETRIC HANDGRIP TRAINING ON AMBULATORY BLOOD PRESSURE IN HYPERTENSIVE WOMEN: RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Hypertensive woman has shown a higher risk of myocardial infarction, stroke, chronic kidney disease and hypertensive retinopathy than men. Isometric handgrip training (IHT) has shown to reduce blood pressure (BP) in hypertensive adults, although its effects on ambulatory BP is uncertain, especially in women. Therefore, the aim of this study was to evaluate the effects of 12 weeks of IHT on ambulatory BP in hypertensive women.

METHODS: Hypertensive women were randomly assigned to either an isometric handgrip training group or a control group (CG). The IHT group followed a protocol of 4 x 2-minute contractions at 30% of maximal voluntary contraction, with one-minute rest intervals among sets, alternating hands, three times per week for 12 weeks. The control group followed the same protocol as the IHT group and performed the sham training with a stress ball. The ambulatory BP (24-hour, awake and sleep) were measured before and after the intervention period.

RESULTS: A total of 59 hypertensive women were randomized and 40 participants (age: 56.7 ± 11.3 years; 29.8 ± 5.4 kg·m−2) completed the 12-week intervention. IHT significantly reduced 24h systolic BP (IHT: 123 ± 2 vs. 117 ± 2 mmHg; control: 121 ± 3 vs. 124 ± 3 mmHg, p= 0.033) and mean BP (IHT:99 ± 2 vs. 94 ± 1 mmHg; control: 96 ± 2 vs. 99 ± 2 mmHg, p=0.033). IHT decreased awake systolic BP (IHT: 125 ± 1 vs. 118 ± 2 mmHg; control: 122 ± 3 vs. 125 ± 3 mmHg, p=0.029) and awake mean BP (IHT:101 ± 2 vs.95 ± 2 mmHg; control: 97 ± 2 vs. 100 ± 2 mmHg, p=0.035). No significant effects were observed for 24-hour diastolic BP, awake diastolic BP and sleep BP (P > 0.05 for all).

CONCLUSION: Twelve weeks of IHT reduced awake systolic ambulatory BP, leading to a reduction in 24-hour systolic BP in hypertensive women.

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**EFFECTS OF STEP-BOX EXERCISE PROGRAM ON ARTERIAL STIFFNESS AND SYSTEMIC CARDIOMETABOLIC BIOMARKERS IN POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Cardiovascular disease (CVD) is the leading cause of death, and arterial stiffness, a precursor of atherosclerosis, increases in postmenopausal women. With advancing aging, traditional cardiometabolic biomarkers such as lipids and glucose increase, whereas serum adropin, an emerging biomarker which is involved in cardiovascular health and regular physical activity, decreases. Regular physical activity is recommended as a biobehavioral strategy to improve cardiovascular and overall health. Step box exercise, a group aerobic movement with music of different beats, is preferred by postmenopausal women because it combines characteristics of interval training with the fun. To date, it is difficult to discover studies that comprehensively evaluate the effects of step box exercise on arterial stiffness, traditional cardiometabolic markers, and serum adropin levels in postmenopausal women. The purpose of this study was to assess the effect of 12-week of step-box exercise program on arterial stiffness, systemic lipids, glucose and adropin levels in postmenopausal women.

METHODS: Postmenopausal women (n=23) were randomly assigned to step-box exercise group (SBE) or non-training control group (CON). The SBE group performed step-box exercises, 50 minutes a day, 3 days a week for 12 weeks. Arterial stiffness was assessed by aortic pulse wave velocity (PWV) and augmentation index (AIx) using a SphygmoCor Xcel system. For evaluating systemic cardiometabolic biomarkers, serum lipids, glucose, insulin and adropin levels were analyzed before and after the intervention.

RESULTS: After 12 weeks of intervention, AIx significantly decreased in SBE group (38±3 vs. 34±2, p=0.02), while it did not change in CON group (33±3 vs. 32±4, p=0.80). AorPWV did not present any statistically significant changes in both groups. Twelve weeks of step-box exercise program significantly improved serum high-density lipoprotein cholesterol (HDL-c, 43±1 vs. 50±2, $p < 0.01$). There was no significant group by time interaction in serum adropin level between SBE and CON group, but serum adropin level in SBE group was increased by approximately 13% (67±1 vs. 76±5, p=0.055). In the whole group, change in serum adropin level was positively associated with change in HDL-c ($r = 0.46$, $p = 0.04$), and negatively associated with change in insulin level ($r = -0.54$, $p < 0.01$) and calculated homeostasis model assessment of insulin resistance (HOMA-IR, $r = -0.55$, $p < 0.01$). However, change in serum adropin level was not related to change in arterial stiffness measures.

CONCLUSION: Twelve weeks of step-box exercise program reduce AIx, a measure of arterial stiffness, and increase serum HDL-c level in postmenopausal women. Additionally, the increase in serum adropin through step-box exercise program is associated with the increase in serum HDL-c level and the decrease in insulin resistance. Step-box exercise program can be an effective behavioral strategy for reducing cardiovascular and cardiometabolic risk in postmenopausal women.

**ACUTE EFFECTS OF ARM-CRANK EXERCISE ON THE ARM AND LEG VASCULAR FUNCTION OF PERIPHERAL ARTERY DISEASE PATIENTS: A RANDOMIZED CROSSOVER TRIAL**

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INTRODUCTION: Arm-cranking exercise can be an interesting option for peripheral artery disease patients, because it minimizes the claudication symptoms and has shown to increase walking capacity. However, their effect on vascular function is poorly known. Ou aim was to evaluate the acute effects of arm-cranking exercise on arm and leg vascular function in patients with peripheral artery disease and compare these effects to those of walking exercise.

METHODS: This randomized crossover trial employed single-blind data collection and included 17 patients with peripheral artery disease and intermittent claudication (53% male, 66±7 years, 26.7±4.4 kg/m²). Participants completed three experimental conditions—walking, arm-cranking (AC), and control—in a random order. The exercise conditions consisted of 15×2-minute bouts at an intensity corresponding to 4–6 on Borgs scale. Brachial and femoral artery flow-mediated dilation (FMD) were assessed before and after each condition.

RESULTS: No significant baseline differences in vascular variables were observed between sessions ($P>0.05$ for all). There were no significant differences for neither brachial (Control: 4.5 ± 2.8% vs. 3.4 ± 1.9%; Walking: 5.1 ± 3.2% vs. 4.8 ± 3.8% ; AC: 4.4 ± 2.7% vs. 4.0 ± 2.1%; $P = 0.554$) nor femoral artery FMD (Control: 6.6 ± 4.7 vs. 7.0 ± 5.0; Walking: 7.4 ± 4.3 vs. 5.6 ± 4.3; AC: 6.8 ± 4.1 vs. 5.6 ± 4.3 10'; $P = 0.339$).

CONCLUSION: A single session of arm-cranking exercise does not acutely affect arm or leg vascular function, showing a response similar to that of walking exercise. Funding: FAPESP #2023/00630-6; CNPq #308954/2021-1; CAPES#88887.986418/2024-00

**WAIST-TO-HEIGHT RATIO AS A PREDICTOR OF CARDIOVASCULAR AND METABOLIC HEALTH IN CHILDREN**

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INTRODUCTION: Understanding the relationship between central adiposity and health outcomes in children is crucial for early prevention of non-communicable diseases (NCDs). Waist-to-height ratio (WHtR) has emerged as a key anthropometric measure for predicting cardiovascular and metabolic health risks.

METHODS: This study investigates the association between WHtR, blood biomarkers (HbA1c, lipid profiles, ferritin, iron levels), blood pressure (systolic and diastolic), and overall cardiovascular and metabolic health in children aged 6-12 years.

RESULTS: A positive correlation between WHtR and unfavourable lipid profiles, with elevated total cholesterol and non-HDL cholesterol levels, alongside decreased HDL levels in the highest WHtR quartile, was displayed, suggesting increased cardiovascular risk. Similarly, the combination of high erythrocyte, low Reticulocyte Enumeration Assay (REA), high ferritin, and low iron, combined with high CRP, may imply chronic inflammation due to adiposities. Elevated systolic and diastolic blood pressure values further underscore this cohorts cardiovascular risks associated with central adiposity.

CONCLUSION: WHtR's ability to predict these metabolic and cardiovascular risk factors highlights its potential as a simple, non-invasive screening tool in public health settings, particularly in paediatric populations where invasive blood sampling and frequent testing can be ethically and logistically challenging. By using WHtR as a proxy for more invasive tests, health professionals could efficiently identify children at higher risk, enabling timely interventions that could significantly alter their long-term health outcomes.

Conventional Print Poster Presentations

CP-MH08 Exercise during Pregnancy / Obesity

**COMPARISON OF TIME-MATCHED AEROBIC, RESISTANCE OR COMBINED EXERCISE TRAINING IN WOMEN LIVING WITH OBESITY: THE EXOFFIT STUDY**

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INTRODUCTION: Improvements in cardiorespiratory fitness (CRF) have been shown to largely attenuate the negative health risks associated with obesity. To date literature in women with obesity has focused upon the evaluation of aerobic-based exercise interventions. Hence, there is a need to evaluate resistance and combined interventions with this cohort. This study aimed to evaluate feasibility and efficacy of three exercise modalities in women with obesity for improving CRF, strength, body composition and other health outcomes.

METHODS: Sixty-seven women with obesity were randomised to the control (CON) or one of three exercise groups (aerobic [AE], resistance [RE], COM). Exercise groups trained x3 times/week for 12 weeks (up to 150-minutes/week). Feasibility outcomes included adherence, attendance, recruitment and retention rates and adverse events. Secondary outcomes were CRF (predicted VO2 max), body composition (body weight [BW], waist circumference [WC], body fat percentage [%BF], fat mass [FM] and lean mass [LM]) and strength (5RM bench press, leg dynamometry, grip strength) and self-reported measures of physical activity, mood, sleep, pain and quality of life.

RESULTS: Findings support feasibility of all three exercise modalities in terms of adherence, attendance, and retention. Interventions with a resistance component (COM and RE) were associated with the greatest improvements across the broad range of health outcomes measured. Combined was the most promising for body composition outcomes including BMI (Effect size [ES]=0.79, p=0.04), BW (ES=0.75, P=0.05), %BF (ES=0.77, p=0.04), FM (ES=0.83, p=0.03) and WC (ES=0.90, p=0.02), physical activity (i.e. moderate PA [ES=0.69, p=0.07), mood (ES=0.83, p=0.03) and sleep (ES=0.78, p=0.04). Resistance was most promising for CRF (ES=1.47, p=0.002), strength (i.e. bench press [ES=2.88, p=<0.001]) and pain (i.e. pain severity [ES=0.40, p=0.31]).

CONCLUSION: For health outcomes, these results indicate the importance of including a resistance component when prescribing exercise for women with obesity to achieve meaningful improvements.

**USING A CO-PRODUCTION PROCESS TO REFINE AN EXERCISE SPECIALIST LED, MHEALTH FACILITATED, PHYSICAL ACTIVITY INTERVENTION FOR USE IN A PAEDIATRIC COMPLICATIONS FROM EXCESS WEIGHT SERVICE**

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INTRODUCTION: To address the increasing prevalence of complications associated with severe childhood obesity, NHS England has established 21 Complications of Excess Weight (CEW) services. With the aim of improving physical activity (PA) provision within CEW services, our group developed an exercise specialist led, mHealth supported, exercise and PA intervention (MOTIVATE-CEW). A feasibility study to evaluate MOTIVATE-CEWs potential suggested it was well received by families and initial uptake and adherence to PA was good. However, there were concerns over the maintenance of PA. With the aim of improving long term engagement, we followed Medical Research Council (MRC) guidance on intervention development and utilised service users and stakeholder perspectives during a co-production process to refine the MOTIVATE-CEW intervention.

METHODS: The study was conducted within the Alder Hey Children's Hospital (AHCH) CEW service (England) and drew upon a conceptual model of healthcare service co-production to guide intervention development. An intervention co-production group was established, including young people receiving care from the AHCH CEW service, parents or guardians of young people and health care professionals (HCPs) from the multidisciplinary AHCH CEW team. Four workshops were conducted, with the intervention co-production group split to form separate young person and adult workshops. Workshop 1 refined the behaviour change techniques (BCTs) used in the original intervention. Workshop 2 introduced additional BCTs identified in the literature to enhance long-term PA maintenance. Workshop 3 focused on defining core research outcomes and study design. Workshop 4 invited feedback on the revised intervention and study procedures. Multiple qualitative methods documented the intervention development process, capturing audio and visual data. Emerging intervention components were iteratively mapped to a logic model.

RESULTS: Twenty-three stakeholders participated (7 patients, 5 parents/guardians, and 11 HCPs, all from the AHCH CEW service). The co-production process highlighted two key principles that were used to underpin the refined intervention: 1) personalisation is essential since every young person and family is different, and 2) young people value autonomy and flexibility in shaping their exercise and PA plans. Based on stakeholder insights, we developed a refined logic model that guided updates to the intervention's content, resources, and delivery. The revised intervention retained one original element, refined four elements, and introduced five new components.

CONCLUSION: By utilising MRC guidance and integrating stakeholder perspectives with existing research, we have refined MOTIVATE-CEW into a tailored exercise and PA intervention designed to meet the specific needs of the young people and

carers in CEW services. Future research will evaluate the feasibility of the revised intervention before progressing to a full-scale, multi-site RCT.

**BODY FAT DISTRIBUTION AND METABOLIC ADJUSTMENTS SHAPE ENDURANCE PERFORMANCE IN OVERWEIGHT WOMEN**

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INTRODUCTION: Excess adipose tissue influences metabolic efficiency, oxygen use and energy availability and therefore impacts endurance. Surplus fat, often seen as a limitation, may serve as an energy source during low-intensity exercise. In trained overweight individuals, higher fat oxidation delays fatigue by slowing glycogen depletion, depending on mitochondrial function and fatty acid availability. A lower insulin response improves fat mobilization for sustained energy. Despite an increased oxygen demand for basal physiological functions, overweight individuals often have high cardiopulmonary capacity, raising the question of whether these adaptations offer endurance advantages. This study aims to evaluate body composition and metabolic response to endurance performance in metabolically healthy overweight women.

METHODS: Thirty-five metabolically healthy overweight women (BMI 32 kg/m² ± 4.2, age 27-58, mean 41 years) participated in a 12-week exercise program: 3 weekly 50-minute aerobic sessions (60-70% max HR) and 2 weekly bodyweight resistance sessions. Endurance was assessed via a 5-minute cycle ergometer test (60 rpm, 70W), measuring (1) post-exercise heart rate recovery, (2) lactate concentration, and (3) leg muscle endurance (15 reps on an isokinetic dynamometer). Body composition was evaluated using BMI, fat mass (kg, %), excess fat percentage, and visceral fat, measured with body composition analyser. Data analysis included descriptive statistics and Pearson's correlation with SPSS.

RESULTS: BMI reduction (0.8 kg/m² ± 1.8) correlated with baseline BMI ($p < 0.05$), excess fat percentage (15.4% ± 1.6, $p < 0.05$), and visceral fat change (0.1% ± 0.8, $p < 0.05$), indicating greater reductions in BMI with higher initial adiposity. Cardiovascular endurance improvements were linked to lactate reduction (-0.1 ± 1.4) and faster heart rate recovery at 2 and 4 minutes (Pulse2minsafter, 83.3 ± 12.9, $p < 0.05$; Pulse4minsafter, 80.1 ± 10.1, $p < 0.01$). Faster recovery was associated with lower pre-intervention fat percentage (38.2% ± 3.5) and better muscle endurance post-training (61.8% ± 7.2, $p < 0.05$). Muscle endurance improvements were influenced by visceral fat and total fat loss (0.7 kg ± 2.7, $p < 0.01$). Enhanced leg work output was linked to fat loss and lactate clearance ($p < 0.05$), with balanced improvements in both legs ($p < 0.01$).

CONCLUSION: Body composition, rather than BMI alone, is a key factor in endurance improvements in overweight women. Visceral fat reduction most strongly correlated with cardiovascular recovery, lactate clearance, and muscle endurance. These findings suggest fat distribution, rather than total adiposity, drives metabolic and performance benefits. Future research should explore non-visceral fat stores as potential energy reserves and examine individual fat oxidation efficiency.

**EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON SELF-DETERMINED MOTIVATION TOWARD PHYSICAL ACTIVITY IN WOMEN WITH ABDOMINAL OBESITY**

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INTRODUCTION: There has been growing interest in high-intensity interval training (HIIT) as an alternative to moderate-intensity continuous training (MICT) for reducing adiposity and cardiometabolic risk factors in patients with obesity. However, research on the impact of HIIT on self-determined motivation toward physical activity remains limited. The objective of this study was to compare self-determined motivation toward physical activity and cardiometabolic outcomes after 12 weeks of either HIIT or MICT, both matched for energy expenditure, in women with abdominal obesity.

METHODS: Twenty women with abdominal obesity (age range, 28-56 years) were submitted to 12 weeks of intervention and were randomly allocated into 2 groups: MICT (n=10) and HIIT (n=10). The MICT group performed a 38 to 62-minute continuous exercise at 70 % of the maximal heart rate. The HIIT group training performed 3 to 6 sets of 4-minute bouts at a running velocity corresponding to 90 % maximal heart rate, interspersed by a 4-min active recovery period at 50 % maximal heart rate. Self-determined motivation toward physical activity was evaluated with a validated questionnaire at the beginning and after 12 weeks. Adiposity indices, cardiorespiratory fitness (VO2max) and lipoprotein-lipid profile were also measured.

RESULTS: Exercise adherence during the intervention was high, with no significant difference between HIIT and MICT. However, the HIIT group showed a greater increase in self-determined motivation toward physical activity compared to the MICT group (p=0.016). However, no significant improvements in VO2max and lipoprotein-lipid profile were observed in either the MICT or HIIT groups after the 12-week intervention.

CONCLUSION: Although we found the HIIT and MICT had no impact on cardiometabolic health, HIIT was associated with greater improvements in self-determined motivation toward physical activity. In this context, HIIT may be linked to better long-term adherence to exercise. This research further highlights the need for strategies aimed at helping women enhance their autonomous motivation toward physical activity.

**IMPACT OF SPONTANEOUS PHYSICAL ACTIVITY ON GUT-ADIPOSE TISSUE CROSSTALK IN AN OBESE MOUSE MODEL.**

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INTRODUCTION: High-fat diet-induced obesity promotes intestinal inflammation, disrupts gut microbiota composition and compromises intestinal barrier function. Regular physical activity (PA) reduces adipose tissue accumulation, modulates gut microbiota (GM) composition and enhances metabolic health. This study aimed to examine the effects of spontaneous PA on gut-adipose tissue crosstalk in a mouse model of obesity and to identify specific bacterial strains as potential therapeutic targets.

METHODS: Forty-eight male C57BL/6 mice were initially fed either a control diet (CTRL, n=24) or a high-fat diet (HFD, n=24) for 12 weeks. Each group was then subdivided into two subgroups for an additional 12 weeks: sedentary (CTRL-SED, n=12; HFD-SED, n=12) or spontaneous PA (CTRL-PA, n=12; HFD-PA, n=12). Mice in the PA groups had access to a running wheel in their cage, whereas those in the SED groups had a locked wheel. Body weight and energy intake were monitored weekly and body composition was assessed at week 23 using EchoMRI. Blood, epididymal (EAT) and mesenteric adipose tissues (MAT) were collected at week 24. Fecal samples were collected at weeks 0, 12, and 23 to analyze GM composition by 16S rRNA gene sequencing. Short-chain fatty acid (SCFA) levels were analyzed on fecal samples collected at W23. Total running distance was recorded between weeks 12 and 24.

RESULTS: Preliminary results showed that 24 weeks of diet significantly impacted body composition, leading to increased body weight, fat mass (FM), EAT and MAT in HFD groups ($p<0.001$). However, 12 weeks of PA mitigated FM accumulation and MAT expansion in HFD mice (PA effect $p< 0.02$). At W23, fecal SCFA analysis revealed a significant increase in butyric, valeric, and acetic acids in the HFD-SED group compared to CTRL-SED ($p<0.01$), while these concentrations were lower in HFD-PA compared to HFD-SED ($p<0.01$). Regarding gut microbiota composition, the relative abundance of Bacteroidales increased between W12 and W23 in PA groups ($p<0.001$). Additionally, Bacteroidales abundance at W23 was negatively correlated with FM (g), suggesting that lower FM was associated with a higher presence of Bacteroidales. A negative correlation was also found between FM and changes in alpha-diversity from W12 to W23 ($r = -0.52$ ; $p< 0.001$).

CONCLUSION: These preliminary findings suggest that PA can modulate gut microbiota composition, particularly by modulating Bacteroidales, an order within the phylum Bacteroidota that is typically reduced in individuals with obesity. Further analyses on tissue inflammation and intestinal permeability will provide additional insights to better elucidate these interactions.

**EFFECT OF POSTPARTUM ENDURANCE EXERCISE TRAINING ON CARDIOMETABOLIC HEALTH AMONG BREASTFEEDING PEOPLE WITH OVERWEIGHT/OBESITY: PRELIMINARY DATA FROM A RANDOMISED CONTROLLED TRIAL.**

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INTRODUCTION: Overweight/obesity during pregnancy is not only associated with adverse pregnancy outcomes, but also with postpartum weight retention which increases the risk of obesity-related complications later in life. Females have lower cardiorespiratory fitness one year postpartum, compared to their age-matched counterparts without a live birth. Since obesity and low cardiorespiratory fitness are major risk factors for chronic diseases, the postpartum period is a golden window' to modulate the future risk of adverse health outcomes. In the MILKSHAKE trial (1), we aim determine the effect of endurance training on breastmilk composition. Here, we report preliminary findings on maternal cardiometabolic health. We aimed to determine the effect of an 8-week exercise intervention that included high-intensity interval training (HIIT) on cardiometabolic outcomes among breastfeeding people.

METHODS: Exclusively breastfeeding people who were 6 weeks postpartum and had a pre-pregnancy body mass index of ≥ 25 kg/m^2 and/or postpartum ≥ 28 kg/m^2, were randomised (1:1) to an intervention group or a control group. The intervention group completed an 8-week supervised endurance exercise programme including moderate-intensity continuous training and HIIT, with 2-4 weekly sessions. We measured peak oxygen uptake (VO2peak) using direct expired gas analysis, body composition (estimated with bioimpedance), waist circumference, blood pressure, resting heart rate, and circulating markers of cardiometabolic health (lipids, fasted glucose, glycated haemoglobin). The between-group differences were determined using a linear mixed model.

RESULTS: We have thus far included 57 participants (intervention 28, control 29). Participants in the exercise group increased their relative VO2peak from 30.8 (standard deviation [SD] 7.1) at baseline to 35.2 (SD 5.2) after 8 weeks, with an estimated between-group difference of 3.0 mL/kg/min (95% confidence interval [CI] 0.8 to 5.1, p = .007). In the exercise group, resting heart rate decreased by 4.9 beats/min (95% CI 1.1 to 9.0, p = .012), total cholesterol by 0.4 mmol/L (95% CI 0.1 to 0.7, p = .004), and low-density lipoprotein by 0.4 mmol/L (95% CI 0.1 to 0.7, p = .005) compared with the control group. There were no between-group differences in body composition measures, blood pressure, triglycerides, high-density lipoprotein, fasted glucose, or glycated haemoglobin.

CONCLUSION: Supervised endurance training improved VO2peak, resting heart rate, total cholesterol, and low-density lipoprotein in breastfeeding people with overweight/obesity, but had no statistically significant effect on body composition, blood pressure, or the measured circulating markers of cardiometabolic health.

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**WOMEN AFTER GIVING BIRTH: TYPE OF DELIVERY AND PHYSICAL ACTIVITY-RELATED HEALTH COMPETENCE POSTPARTUM**

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INTRODUCTION: Due to the health-promoting effects of physical activity, postpartum women are recommended to complete a weekly minimum of physical activity. However, only a small proportion of women achieve the level recommended by the WHO [1]. Postnatal phenomena such as physical limitations, fatigue, or depressive moods are discussed as significant barriers [2]. The aim of the present study was to investigate postpartum physical activity-related health competence (PAHCO) by 1) analysing corresponding differences between women after normal birth and women after caesarean section and 2) examining the role of time after birth for PAHCO.

METHODS: N=150 complete data sets were generated via an online survey (n=85 women giving birth normally, n=65 women after caesarean section). The assessment included socio-demographic data, specific questions about the birth (type, time), and the 42-item PAHCO questionnaire with its three subcompetence areas (movement competence, control competence, self-regulation competence) [3]. We calculated analyses of covariance (ANCOVA) to detect differences in PAHCO between postpartum groups.

RESULTS: Our study showed that women undergoing caesarean section rate significantly lower levels of PAHCO than women following normal birth. Significant differences were found in all three subcompetence areas ($F \geq 8.79$, $p \leq .004$, $\eta 2 \geq .058$). The greatest differences emerged in the cognitive and affective attitude components as part of self-regulation competence. The circumstance of a previous birth experience had no influence on PAHCO. However, the length of time since giving birth was significantly associated with the ability to master strength and endurance demands and the cognitive attitudes towards physical activity, favouring women who had given birth >12 months ago.

CONCLUSION: The results suggest that women who have had a caesarean section obviously have less competence in (a) ensuring the regularity of movement (self-regulation competence), (b) orienting activities towards health (control competence) and (c) performing at a high motor and fitness level than women with a normal birth. This indicates that aftercare and postnatal care services as well as advice on physical activity should be more specifically tailored to the needs of postpartum women by considering time since birth and how the child was born.

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**PHYSICAL ACTIVITY DURING PREGNANCY AND POSTPARTUM: PATTERNS, PERCEPTIONS, AND BARRIERS FROM A SOUTH AFRICAN PERSPECTIVE**

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INTRODUCTION: The health benefits of regular levels of physical activity (PA) are well reported. In the last decade, the evidence for exercise during pregnancy and postpartum increased exponentially. In low-middle-income countries, as South Africa, where the burden of communicable and non-communicable diseases is increasing, more than 60 % of women at childbearing age are overweight and 35% obese (1). Mother and child mortality statistics and teenage pregnancies, therefore, overshadow the PA and exercise during pregnancy and postpartum agenda within the South African context. Hence, we aim to present evidence on physical activity patterns during pregnancy in South African women, and the perceptions and barriers to participating in regular physical activity.

METHODS: A systematic review of the literature was performed according to the PRISMA Guidelines. PubMed, PsycINFO, SPORTdiscus, SabiNet, and Medline were searched until January 2025. Studies included the search terms; pregnancy, postpartum, physical activity levels, exercise, perceptions, barriers and beliefs. Twenty-two articles were identified and abstracts and titles screened, data extracted and synthesised.

RESULTS: The relevant literature revealed that there is a scarcity of peer reviewed research on physical activity and exercise during pregnancy and postpartum for South Africa. The few studies identified, reported that the WHO guidelines for physical activity during pregnancy are not reached. PA levels decrease even more postpartum than during pregnancy. Women also tend to retain about 5 kg of body mass at three months postpartum. The systematic review targeting barriers and perceptions of PA during pregnancy and postpartum found that information related to exercise was mostly obtained from local media outlets. The available data indicate that cultural believes contribute to the perceptions about engaging with PA during pregnancy and postpartum. Barriers for participation in PA are mostly related to socioeconomic challenges, family responsibilities and lack of knowledge (2).

CONCLUSION: There is a scarcity of literature related to physical activity patters of South African women. Understanding the perception about exercise and the barriers to increasing physical activity will assist in the co-creation of intervention programs that may lead to sustainable physical activity and exercise interventions during pregnancy for improved health outcomes. Exercise interventions may be a cost-effective alternative strategy to prevent pre-eclampsia and gestational diabetes in the region.

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**BARRIERS AND FACILITATORS TO PRENATAL PHYSICAL ACTIVITY: A CULTURAL PERSPECTIVE FROM CHINA AND POLAND**

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INTRODUCTION: Prenatal physical activity (PA) supports maternal and fetal health, reducing risks of gestational diabetes, hypertension, and excessive weight gain [1]. Despite these benefits, cultural norms and societal attitudes significantly impact the adoption of PA during pregnancy. This study examines barriers and facilitators of prenatal PA in China and Poland from a cross-cultural perspective.

METHODS: A cross-cultural, mixed-methods study was conducted with 400 pregnant women (200 each from China and Poland). Quantitative data were collected using the Pregnancy Physical Activity Questionnaire (PPAQ) to assess PA levels (MET-min/week), awareness of prenatal exercise guidelines, and perceived barriers and facilitators. Semi-structured interviews explored cultural beliefs and practices regarding prenatal PA. Quantitative analyses, including ANOVA and logistic regression, compared PA levels and identified predictors, while qualitative data were thematically analyzed to uncover cultural patterns.

RESULTS: Chinese participants reported significantly lower PA levels (mean: 482 ± 217 MET-min/week) compared to Polish participants (mean: 1089 ± 300 MET-min/week; $p < 0.01$). In China, key barriers included traditional beliefs prioritizing rest during pregnancy (70%), fear of harming the fetus (57%), and limited guideline awareness (54%). In Poland, barriers were less pronounced, with time constraints (33%) and insufficient access to facilities (23%) being most cited.

Facilitators differed: in China, healthcare provider encouragement (41%) and family support (29%) were prominent, whereas in Poland, social exercise groups (58%) and tailored programs (49%) were key motivators. Urban participants in both countries exhibited greater PA levels and awareness of guidelines compared to rural participants ($p < 0.01$). Logistic regression analysis identified guideline awareness and positive attitudes as significant predictors of PA levels (China: $\beta = 0.54$, $p < 0.01$; Poland: $\beta = 0.67$, $p < 0.01$). Qualitative analysis revealed cultural themes, such as a strong belief in "energy conservation" during pregnancy in China and a focus on active lifestyles within urban Polish contexts.

CONCLUSION: Cultural norms and beliefs play a pivotal role in shaping prenatal PA behaviors. Chinese pregnant women encounter more significant cultural and informational barriers, while their Polish counterparts primarily face structural and logistical challenges. Raising awareness about prenatal exercise guidelines and addressing cultural misconceptions are essential steps in promoting PA in both regions. Culturally tailored interventions may prioritize dispelling traditional beliefs in China and improving access to prenatal exercise programs in rural Poland.

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## Conventional Print Poster Presentations

### CP-SH05 Physical Activity Promotion I

**THE KEY NEEDS OF CARDIAC PATIENTS TO STAY PHYSICALLY ACTIVE AFTER AMBULATORY REHABILITATION: A QUALITATIVE ANALYSIS**

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INTRODUCTION: Cardiovascular disease is the leading cause of mortality worldwide, representing a major global health burden. Physical inactivity increases cardiovascular risk, while regular physical activity supports health maintenance. In cardiac patients, the transition from structured rehabilitation to daily life is key for sustainable secondary prevention. Understanding patients exercise needs provides insights into experiences, barriers, and motivation, enabling tailored interventions that enhance adherence, safety, and well-being, while considering medical, psychological, and social factors. We conducted qualitative interviews with cardiac patients, therapists, and physicians to explore strategies for long-term physical activity support.

METHODS: We employed a qualitative research design with 11 semi-structured individual interviews with cardiac patients (55% female, aged 30-80 y) with coronary heart disease. They participated or had participated in ambulatory cardiac rehabilitation at our university hospital and were part of a secondary prevention program. Participants spoke and understood German at an adequate level. Additionally, we conducted a focus group interview with 5 rehabilitation center employees (therapists and physicians, 20% female). Thematic reflexive analysis was used to evaluate data.

RESULTS: In the individual interviews, four main categories emerged: attitude to sport, needs, barriers and motivation. All participants mentioned particularly motivation in the context of sports and physical activity. Intrinsic and extrinsic factors played an almost equal role in patient motivation, accounting for 49% and 51% of responses, respectively. Key intrinsic motivators were goal achievement (33%), body awareness/well-being (22%), challenge/enjoyment of movement (22%), and health awareness (20%). Extrinsically, patients were influenced by their social environment (55%), available programs (21%), and experiencing nature (16%). Psychological pressure from illness (7%) played a minor role. Professionals in the focus group identified barriers such as lack of social support, physical limitations, psychological issues, and daily life constraints. Additionally, inadequate education about the disease and the benefits of physical activity were frequently noted.

CONCLUSION: This qualitative study highlights motivation as a crucial factor in exercise behavior among cardiac rehabilitation patients. Both intrinsic and extrinsic motivation influence adherence, but sustaining lifestyle changes requires strengthening intrinsic motivation. Key factors potentially include social support, health awareness, daily life coordination, and diverse program offerings. Future research should further examine individual motivation, patient-professional relationships, family dynamics, and age-related differences. Qualitative studies and intervention trials should develop tailored exercise programs to enhance adherence and promote long-term health.

**THE IMPACT OF DIFFERENT TYPES OF SCREEN TIME SEDENTARY BEHAVIOR ON DEPRESSION SYMPTOMS IN CHILDREN AND ADOLESCENTS**

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Objective: Previous studies have suggested that screen time sedentary behavior may contribute to depression in children and adolescents. However, the differential effects of various types of screen time on depression symptoms in this population remain unclear. This study aims to clarify the impact of different types of screen time sedentary behavior on depression symptoms in children and adolescents through a nationwide cross-sectional survey conducted over two years.

Methods: Based on the China Family Panel Studies, a total of 6,052 children and adolescents aged 10-18 were surveyed in 2020 and 2022. Depression symptoms were assessed using the Centre for Epidemiologic Studies Depression (CES-D) scale. Participants were surveyed on their frequency of screen time for activities such as online gaming, online shopping,

online learning, online socializing, and online entertainment. Three generalized linear regression models were used: Model 1 examined the effect of different types of screen time on depression symptoms; Model 2 controlled for gender, age, urban-rural type, and education level; and Model 3 further controlled for physical activity frequency and sleep duration.

Results: The results of Model 1 indicated that compared to children and adolescents who did not engage in online shopping, those who did were 24% more likely to experience depression (Odds Ratio [OR] = 1.24, 95% CI: 1.03-1.45). Similarly, those who engaged in online entertainment were 27% more likely to experience depression compared to non-users (OR = 1.27, 95% CI: 1.03-1.52), with daily users having a 44% higher probability of depression (OR = 1.44, 95% CI: 1.17-1.70). After controlling for gender, age, urban-rural type, and education level, the effect of online shopping on depression probability became non-significant, but the effect of online entertainment remained. Additionally, compared to adolescents who never used online socializing, those who did had a 31% lower probability of depression (OR = -0.31, 95% CI: -0.59 to -0.03). After further controlling for physical activity and sleep, the effects of online shopping, online socializing, and online entertainment on depression were no longer significant.

Conclusion: Among different types of screen time sedentary behaviors, online shopping and online entertainment are risk factors for depression symptoms in children and adolescents, while online socializing serves as a protective factor. Future policies should address the differential impacts of screen time behaviors on the mental health of children and adolescents and develop targeted interventions.

**IMPROVING SPORT OPPORTUNITIES, PARTICIPATION, AND EXPERIENCES FOR CHILDREN IN OUT-OF-HOME CARE**

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Background: Participation in sport offers significant physical, psychological, and social benefits. However, children in out-of-home care face complex barriers that limit their involvement, resulting in lower participation rates compared to their peers in other household arrangements. We aimed to identify carers' recommendations for improving sport participation and experiences for children in care.

Methods: A total of 42 foster and kinship carers in Western Australia participated in the study. Data were collected through online surveys and interviews using a sequential explanatory mixed-methods approach, integrating both quantitative and qualitative analyses.

Results: Three key recommendations—along with corresponding implementation strategies—were identified for policymakers, researchers, peak sporting bodies, and sporting organisations: (1) embedding inclusive practices within existing

sport programs; (2) developing education and training for sport program providers; and (3) enhancing support for carers to facilitate children's sport participation.

Conclusions: This study provides actionable guidance for increasing sport participation among children in care, helping to maximise their opportunities for physical, psychological, and social development.

**A THREE-ARM RANDOMIZED CONTROLLED TRIAL COMPARING LIFESTYLE INTERVENTIONS WITH DIFFERENT INTENSITY ON AVERAGE DAILY STEPS AMONG PRE-DIABETIC ARAB ADULTS LIVING IN EAST JERUSALEM**

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Background:

Individuals with prediabetes face a higher risk of developing Type 2 Diabetes Mellitus, but targeted interventions that incorporate physical activity (PA) can help prevent progression [1]. However, no prior PA intervention studies have been conducted among prediabetic Israeli Arab adults residing in East Jerusalem. This study aimed to compare the effects of lifestyle interventions with varying intensities on daily steps and self-reported PA habits. We hypothesized that higher-intensity interventions would lead to greater increases in PA.

METHODS: A three-arm parallel randomized controlled trial (RCT). Adult participants were recruited through primary care settings and randomly assigned (1:1:1) into low (arm A)-, moderate (B)-, and high-intensity (C) PA intervention groups. Arm A received an activity tracker and general PA recommendations. Arm B also received a personalized PA prescription. Arm C additionally received a motivational interview and a Mediterranean diet consultation. Baseline data were collected one week post-recruitment, with follow-up after ~7 months (SD=3.1) due to COVID-19 delays. Primary outcome was the change in daily steps, assessed via activity trackers. Secondary outcomes included self-reported PA. ANOVA and post-hoc pair-wise comparisons evaluated pre- and post-intervention changes, while multiple regression controlled for baseline steps and sex. Sensitivity analyses combined arms B and C to assess trends.

RESULTS: A total of 175 participants [mean (SD) age 55.0 (7.5) years, mean BMI 32.4 (6.0) kg/m2, 32.6% male] were randomized. Baseline daily steps averaged 6,391.4 (SD 3,268.1). At follow-up, n=130 completed assessments (A=45, B=41, C=48). No significant differences were observed across groups. Post-hoc analyses revealed significant step increases in arm C vs. arm A (p=0.04) and in arms B and C combined vs. arm A (p=0.02). Regression analysis showed an inverse association between baseline steps and step change (p=0.015). Arm C participants had a significantly higher step increase (+1,294.4 steps; p=0.016), while arm B and sex had no significant effects. Self-reported PA habits increased slightly but results were not statistically significant.

Conclusions:

In this three-arm RCT assessing PA interventions in the prediabetic Arab population of East Jerusalem, high-intensity PA interventions significantly improved PA levels, even during COVID-19 lockdowns, while moderate-intensity interventions showed no significant effect. PA interventions could be integrated into primary care to enhance cost-effective diabetes prevention strategies.

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## Conventional Print Poster Presentations

### CP-PN01 Muscle Metabolism

**THE OCCURRENCE OF REDS INDICATORS WAS NOT ASSOCIATED WITH PERCEIVED SLEEP QUALITY BUT WAS LINKED TO AN INCREASED USE OF SLEEP MEDICATION**

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INTRODUCTION: Sleep disturbances are a potential negative consequence of problematic low energy availability [1]. For instance, four weeks of energy restriction impacted the sleep patterns of non-athletes [2]. Additionally, athletes reported, via interviews, that their subjective perception was that weight reduction negatively affected their sleep [3]. The aim of this study was to investigate the association of perceived sleep and primary indicators of Relative Energy Deficiency in Sport (REDs).

METHODS: National and international level female athletes (n=128; 23.3±4.8 years) representing various sports participated in the study during their preparatory season. Athletes' sleep quality was assessed by the Pittsburgh Sleep Quality Index (PSQI). Seven components of sleep (quality, latency, duration, efficiency, disturbance, sleep medication use, and daytime dysfunction) were calculated from the PSQI. REDs indicators included primary and secondary amenorrhea assessed via

LEAF-Q (low energy availability in females questionnaire), low serum free triiodothyronine concentration, history of bone stress injury, low bone mineral density (Z-score <-1) at the lumbar spine analysed by Dual-energy X-ray absorptiometry, and an elevated score for the EDE-Qs (eating disorder examination questionnaire short). Participants were divided into groups based on the use of hormonal contraception: naturally menstruating (NM, n=80) and hormonal contraceptive users (HC, n=48), and further based on the primary indicators of REDs: no-risk (0 indicator), risk (1 or more indicators). The differences in PSQI points between groups were analysed with Mann-Whitney U Test and the differences of prevalence with Chi-Square Tests (SPSS 28.0.0).

RESULTS: REDs indicators were observed in 50% of NM and 54% of HC, while poor sleep (5 or more points in PSQI) was observed in 45% of NM and 40% of HC. There were no differences between no-risk and risk groups in total PSQI score or the PSQI components (NM: p=0.104-0.897; HC: p=0.367-0.791), but medication use was higher in NM-risk (p=0.023). Medication use was more prevalent in NM-risk (23%) than in NM no-risk (5%; p=0.026). Additionally, there was a trend for higher medication use (p=0.073) and prevalence of medication use (p=0.081; 21% vs. 4%) in HC-risk compared to HC-no-risk.

CONCLUSION: The primary indicators of REDs were not linked to perceived sleep quality. However, female athletes with more indicators of REDs were more likely to use sleep medication. The relationship between energy availability and sleep should be further explored.

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**IMPACT OF 14 DAYS OF BED REST WITH OR WITHOUT EXERCISE ON CALF MUSCLE AND FAT VOLUMES, AND FIBER TYPE COMPOSITION**

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INTRODUCTION: Bed rest is a common occurrence in clinical settings, including hospitals and extended care facilities. The resulting inactivity leads to muscle mass loss, reduced strength, and diminished functional capacity, which can increase mortality risk, particularly in older adults. Muscle loss in this population is strongly linked to a higher risk of falls. While physical activity is known to mitigate age-related declines in muscle mass and function in older adults, its effectiveness in counteracting the detrimental effects of bed rest on skeletal muscle mass and fiber composition in older adults remains unclear. This study examined the effects of 14 days of six-degree head-down tilt bed rest (HDBR) on muscle volume, as measured by MRI, and muscle fiber composition, assessed through biopsy samples in older adults. Additionally, it evaluated whether an in-bed exercise countermeasure could mitigate the detrimental impact of bed rest on muscle mass.

METHODS: Twenty-two participants (aged 55–65 years) were randomized into two groups for a two-week HDBR: a control group (♂: 6, ♀: 5) and an exercise group (♂: 5, ♀: 6). The exercise group performed one hour of combined resistance and aerobic exercise daily while remaining in bed. Needle muscle biopsies from the vastus lateralis and calf muscle and fat volumes by MRI were conducted prior to, and after HDBR.

RESULTS: At baseline, no significant differences were observed between groups. Following 14 days of bed rest, both groups experienced a reduction in total calf muscle volume (control: 28.4 ± 2.0 $cm^3$ to 25.1 ± 2.0 $cm^3$; exercise: 29.3 ± 2.2 $cm^3$ to 26.7 ± 2.2 $cm^3$). However, a significant group effect was observed in calf fat volumes, with a decrease only in the exercise group (18.1 ± 2.0 $cm^3$ to 16.9 ± 1.9 $cm^3$, p = 0.001), while no significant change was observed in the control group (16.2 ± 1.8 $cm^3$ to 16.4 ± 1.7 $cm^3$). Our preliminary findings suggest that neither bed rest alone nor bed rest with exercise significantly alters muscle fiber composition.

CONCLUSION: HDBR resulted in a significant reduction in calf muscle volume in both the control and exercise groups, highlighting the rapid muscle loss associated with inactivity in older adults. However, a reduction in calf fat volume was observed only in the exercise group, suggesting potential metabolic benefits of in-bed exercise during prolonged inactivity. Further analysis will offer deeper insights into muscle fiber changes following HDBR.

**LOCAL COOLING OF SKELETAL MUSCLE BEFORE ACUTE EXERCISE AND ENDURANCE TRAINING HAS A SYNERGISTIC EFFECT ON MITOCHONDRIAL ADAPTATIONS IN MICE**

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INTRODUCTION: Cooling interventions after exercise have been used to enhance skeletal muscle mitochondrial adaptations to endurance exercise (1). Recently, we found that intermittent cooling of skeletal muscle for 1 hour modulates intramyocyte [hydrogen peroxide], which plays an important role in intramuscular signaling. This cooling pattern increases gene expression of Nrf2, a transcription factor that responds to altered [hydrogen peroxide]. Increased Nrf2 expression prior to endurance exercise enhances exercise-induced mitochondrial adaptations (2). Therefore, this investigation was

designed to test the hypothesis that local cooling of skeletal muscle prior to running exercise would enhance mitochondrial adaptations in mouse skeletal muscles.

METHODS: Acute experiment: Male C57Bl/6J mice (9 and 10 weeks old) were divided into sedentary (n=7) and exercise (n=7) groups. Both groups were subjected to cooling stimulation (muscle temperature: 35~13~35°C x 6 sets, total 60 min) on the left leg. The sub-groups were Room temperature + sedentary (RT + Sed), ICE + sedentary (ICE + Sed), Room temperature + exercise (RT + Ex), and ICE + exercise (ICE + Ex). The exercise group performed a 60-minute treadmill running (15 m/min, slope 10 degree incline) immediately after the temperature intervention whereas Sed animals rested. Three hours after the the exercise or rest, tibialis anterior (TA) muscles of all groups were excised, and mRNA levels of PGC1α, Ucp3, and pdk4 were measured. Training experiment: In 14 mice, the same cooling and exercise protocol as in the acute model was performed 4 times / week for 4 weeks, and 24 hours after the last training bout, TA and EDL muscles were harvested. Mitochondrial enzyme activity, mitochondrial and antioxidant-related proteins were measured. Statistical analyses using a paired two-way ANOVA, and multiple comparison tests were performed for interaction effects. A statistical level of $p<0.05$ was accepted.

RESULTS: Acute Responses: ICE + Ex showed significantly higher levels of PGC1α mRNA than RT + Ex (+14%, $p=0.012$). Ucp3 and Pdk4 increased with exercise ($p<0.001$), but decreased with cooling stimulation ($p<0.05$). Training Responses: CS activity increased additively (+18%) with the combination of training and cooling as did β-HAD activity compared with training alone (+24%, $p=0.017$). There were no differences in the levels of mitochondrial-related proteins OXPHOS, PGC1α, or antioxidant enzymes Sod1,2 among groups.

CONCLUSION: Local cooling stimulation of skeletal muscle prior to acute running exercise promoted an increase in PGC1α mRNA levels. Running training under pre-cooling conditions increased the activity of the mitochondrial enzymes CS and β-HAD compared to training under normal conditions. This study demonstrates that pre-conditioning with local cooling has a synergistic effect on the mitochondrial adaptations induced by running exercise.

**DESMINOPATHY-ASSOCIATED TLR4 DYSREGULATION AND MITOCHONDRIAL ALTERATIONS: POTENTIAL EFFECTS OF UROLITHIN A IN A TRANSLATIONAL MODEL**

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INTRODUCTION: Desminopathy is a human myopathy characterized by the progressive loss of muscle fiber organization, leading to a reduction in muscle size, mobility, and strength. In desminopathy, inflammation disrupts muscle homeostasis and repair, contributing to progressive muscle deterioration. TLR4 signaling plays a critical role in mediating inflammatory responses and can induce structural changes in mitochondria. Mitochondrial dynamics and structure are closely associated with mitochondrial health and are involved in mitophagy. Mitochondrial morphology has also been implicated in desminopathy progression. Urolithin A, a recently identified natural compound, has been shown to induce mitophagy and potentially enhance mitochondrial homeostasis. Based on this rationale, our objectives were 1) To analyze TLR4 signaling in peripheral blood mononuclear cells (PBMCs) from desminopathy patients; 2) To determine the role of Urolithin A in TLR4 signaling and its effect on mitochondrial morphology in LPS-induced myotubes.

METHODS: 1) Five desminopathy patients and five healthy controls were included. Blood samples were collected to isolate PBMCs and assess health parameters. TLR4 signaling and mitochondrial dynamic proteins were analyzed by Western blot, while mitochondrial morphology was evaluated using transmission electron microscopy; 2) On day 6 of differentiation, C2C12 myotubes were stimulated with LPS (1 ng/ml) for three hours and/or Urolithin A (50 µM) for 24 hours. Protein levels associated with TLR4 signaling and mitochondrial dynamics were determined by Western blot, and mitochondrial morphology was assessed using electron microscopy.

RESULTS: 1) Desminopathy patients exhibited higher CK-MB levels compared to controls. Additionally, proteins related to inflammatory signaling, such as JNK were elevated in desminopathy patients. Consistently, IκBα and TLR4 protein levels were lower in desminopathy patients compared to controls; 2) Urolithin A reduced LPS-induced inflammatory signaling by downregulating TAK1, JNK, and ERK proteins. Moreover, LPS stimulation increased p-DRP1 levels, whereas Urolithin A treatment restored this protein to control levels. Furthermore, LPS reduced mitochondrial perimeter, while Urolithin A maintained a perimeter similar to that of control cells.

CONCLUSION: Desminopathy patients exhibited higher levels of proteins associated with TLR4 signaling, in parallel with increased markers of skeletal muscle damage. These findings suggest that Urolithin A effectively mitigates LPS-induced inflammation by modulating the TLR4 signaling pathway and mitochondrial dynamics. Thus, Urolithin A may represent a promising therapeutic agent for conditions associated with mitochondrial dysfunction and inflammation, highlighting its potential role in promoting skeletal muscle health.

**HAMSTRINGS MUSCLE DAMAGE INDUCED BY FOOTBALL (SOCCER) TRAINING METHODS: CASE-SERIES**

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INTRODUCTION: Hamstring muscles play a key role in force production during sprinting biomechanics [1], and during shank deceleration before ground contact [2], so they are particularly susceptible to muscle strains in high-speed movements. Furthermore, the number of hamstring strain injuries has increased twofold over the last 20 years, due to highly

congested schedules [3]. Accordingly, several training methods have been implemented to reduce injury risk. Therefore, the purpose of the research was to compare the extent and time course of hamstrings muscle damage caused by repeated sprint training and inertial-based resistance training in comparison to a real football (soccer) match.

METHODS: Regional first-division football male players [n = 4, age = 23.0 ± 0.8 years, mass = 72.6 ± 5.7 Kg, height = 174.3 ± 4.2 cm, BMI = 24.0 ± 2.8 (mean ± SD)] participated in three common exercise exposures: (i) FM: a 90-minute football match; (ii) RST: a repeated sprints training (10-repeated 40-meter sprints, rest: 3'); and (iii) FRBD: a Flywheel Russian belt Deadlift training session (5 sets x 10 repetitions, rest: 3'). The extent of muscle damage was measured using the peak torque and perceived soreness in the hamstrings, through the 90°hip:20°knee test, together with serum biomarkers of structural damage (creatine kinase [CK], sarcomeric mitochondrial CK [sMtCK]), oxidative stress (malondialdehyde [MDA]) and irisin, both at baseline and at +24, +48- and +72-hours post-exercise. Two-way repeated measures ANOVA [time (pre, 24h, 48h, 72h) x exercise (RST, FM, FRBD) was conducted to identify the effect of time on neuromuscular and biochemical markers. Associations between variables were analyzed using Spearman's Rho correlation coefficient. The level of significance was set at $p < 0.05$.

RESULTS: All three exposures caused significant decreases in hamstrings peak torque [$F(3,27) = 9.923$, $p < 0.001$] and increases in perceived soreness [$F(3,24) = 6.768$, $p = 0.002$], CK [$F(3,27) = 10.632$, $p = 0.006$], sMtCK [$F(3,27) = 24.728$, $p < 0.001$], MDA [$F(3,27) = 7.283$, $p < 0.001$] and Irisin [$F(3,27) = 8.682$, $p < 0.001$] during the post-exercise recovery period. No significant differences were found between exercise exposures, nor correlations between neuromuscular and biochemical markers of muscle damage.

CONCLUSION: Both RST and FRBD training sessions produce a magnitude and time course of hamstrings muscle damage comparable to that of a real football match. Practitioners are required to consider appropriate recovery periods after sprint-based or inertial-based resistance training sessions during a competitive week.

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**THE EFFECT OF DL-HOMOCYSTEINE ON ENERGY METABOLISM IN C2C12 MUSCLE CELLS VIA INHIBITION OF KYNURENINE AMINOTRANSFERASE**

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INTRODUCTION: In large-scale skeletal muscle metabolome analysis, kynurenine is increased in the skeletal muscles of the elderly, while its downstream metabolites, kynurenic acid (KYNA) and NAD+, are increased in active adult skeletal muscles (1). This suggests that the kynurenine pathway plays an important role in skeletal muscle energy metabolism. Kynurenine aminotransferase (KATs), the principal enzyme in this pathway, catalyzes the conversion of kynurenine to kynurenic acid.Recent studies have demonstrated that exercise increases the expression of KATs genes in mouse skeletal muscle and affects fatigue resistance and energy metabolism. However, the effect of KATs on the cell proliferation potential and energy metabolism of muscle cells themselves remains to be elucidated. The present study was thus designed to elucidate the impact of DL-Homocysteine, a KATs inhibitor, on the cell proliferation potential and energy metabolism of muscle cells.

METHODS: In this study, we utilized C2C12 myoblasts to assess the dynamics of cell proliferation and ATP synthesis during the proliferation phase, as well as the energy metabolism shift during the differentiation phase. These evaluations were conducted under varying concentrations of DL-homocysteine (10 μM, 100 μM, 200 μM). The energy metabolism shift was determined by quantifying the inhibition of ATP synthesis derived from oxidative phosphorylation by oligomycin and the amount of lactic acid produced.

RESULTS: The groups administered 100 μM and 200 μM of the inhibitor exhibited a marked decrease in cell proliferation rate and total protein content compared to the control group. Conversely, the inhibitor significantly augmented the amount of ATP synthesis.On day 5 of differentiation, the groups administered the inhibitor demonstrated a substantial increase in ATP synthesis compared to the control group. In terms of changes in energy metabolism on day 5 of differentiation, the treatment group exhibited a significant increase in lactate production compared to the control group. Furthermore, in the treatment group, the rate of glycolysis was significantly higher than the rate of oxidative phosphorylation, indicating a shift towards glycolysis in energy metabolism.

CONCLUSION: In humans, KYNA has been demonstrated to be associated with the oxidative capacity of skeletal muscle.1) In this study, it was proposed that the inhibition of KATs from day 0 of myocyte differentiation increased the amount of ATP produced via glycolysis on day 5. This is attributable to the involvement of the kynurenine pathway in mitochondrial oxidative phosphorylation, and it is conceivable that the inhibition of this pathway may have activated the glycolytic pathway as a compensatory measure. These results underscore the necessity for further investigation into the mitochondrial function and oxidative capacity of muscle cells. Future research is anticipated to elucidate the underlying mechanisms through which KATs regulate these processes.

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**TOPICAL APPLICATION OF CANNABIDIOL FOR MUSCLE RECOVERY : A RANDOMIZED, DOUBLE-BLINDED PILOT STUDY ON RECOVERY OF MUSCLE FUNCTION AFTER EXERCISE-INDUCED MUSCLE DAMAGE**

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INTRODUCTION: The purpose of this pilot study was to investigate the effects of Cannabidiol (CBD) gel compared to a placebo gel on muscle damage and recovery of muscle function over four days following a strenuous exercise. CBD has gained attention for its potential anti-inflammatory and analgesic properties, making it a possible aid for muscle recovery after exercise-induced muscle damage (EIMD).

METHODS: Fifteen physically active students (age: 21.4 ± 2.1 years; mass: 78.0 ± 9.5 kg; height: 181.7 ± 5.0 cm) participated in the study. Participants performed 10 sets of 10 drop jumps from a 0.6m box, with 2 minutes of rest between sets, to induce muscle damage. In a randomized crossover design, 2 grams of either CBD gel or a placebo gel were applied to the quadriceps and hamstrings immediately after exercise and over the next 72 hours. Muscle function recovery was assessed by measuring maximal isometric and isokinetic concentric peak torque of the knee extensor, plasma myoglobin concentration, and Delayed Onset Muscle Soreness (DOMS) (via visual analog scale) at baseline, immediately post-exercise, and at 24h, 48h, and 72h intervals.

RESULTS: ANOVA revealed a significant interaction between time and condition for isometric torque ($p<0.02$). In the CBD condition, maximal isometric peak torque was restored within 24 hours, compared to 72 hours in the placebo condition ($p<0.05$ for both). No significant differences were observed between the CBD and placebo conditions for plasma myoglobin concentrations or Delayed Onset Muscle Soreness scores.

CONCLUSION: The topical application of CBD gel may accelerate the recovery of muscle strength following strenuous exercise, as evidenced by faster restoration of isometric peak torque compared to placebo. However, CBD had no significant effect on plasma markers of muscle damage or subjective soreness. These findings suggest that CBD could be a useful tool for improving muscle strength recovery, although further research is needed to fully understand its mechanisms and broader impact.

**DO AGE OR SEX MEDIATE THE EFFECTS OF IMMOBILIZATION-INDUCED DECLINES IN MUSCLE VOLUME AND NEUROMUSCULAR FUNCTION? A LITERATURE REVIEW AND FUTURE PERSPECTIVES**

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INTRODUCTION: The effects of unloading on the neuromuscular system have been studied for both the upper and lower limbs. A systematic review showed that muscle strength and muscle size decline following immobilization, with strength decreasing more than size (Campbell et al. 2019). The data reveal immobilization-induced declines of 0.3-0.7% per day for muscle mass and 0.3-2.0% per day for muscle function. While these data summarize the actual knowledge in the field, it remains unknown whether age or sex mediate the declines. Therefore, we reviewed studies investigating the effects of age or sex on immobilization-induced neuromuscular declines.

METHODS: We conducted a literature review to identify studies examining age- or sex-specific effects following an immobilization period. Search strings were used to identify studies that compared immobilization-induced declines in different sexes or age-groups.

RESULTS: The majority of immobilization studies included mainly healthy young men. Only three studies compared immobilization effects between young men vs. women. In these studies, muscle strength was reduced by 3 to 16% in men and 17 to 28% in women. Two of the three studies also investigated possible sex-specific effects on immobilization-induced atrophy, reporting comparable muscle losses at the myofiber (1 study) and whole muscle level (2 studies). One study reported larger reductions in electromyographic activity after disuse in women (-32%) than men (-2%). Comparisons between young and old men showed inconsistent results in terms of atrophy, with three studies reporting pronounced losses in young (3 studies) and other studies reporting more pronounced effects in old (3 studies) participants. It is noteworthy that the effects of immobilization in older women were not compared with any other cohort in any study.

CONCLUSION: The available literature indicates that immobilization-induced effects on strength are more pronounced in young women than young men. While atrophy is identical between sexes, neuromuscular activation is likely more impaired after immobilization in women. The effects of age on immobilized-declines are less consistent with respect to muscle mass and possible mechanisms for age-specific differences on muscle strength remain poorly understood. To address this gap, we will conduct a parallel-group intervention study involving four groups (two sexes: male/female; two age groups: 18–35 and 65+ years) undergoing ten days of lower limb cast immobilization followed by three weeks of retraining. The dominant limb will be immobilized while the non-dominant limb serves as control. Neuromuscular function (strength, power, gait) and underlying mechanisms (high-density EMG, interpolated-twitch technique, dynamic ultrasound for muscle contractility and tendon stiffness, dynamic MRI) will be assessed.

Literature

Campbell, M. et al. (Sports Med) 2019

**ASSESSMENT OF MUSCLE FUNCTION AND STRETCH-SHORTENING CYCLE PERFORMANCE IN OLDER ADULTS: A FOUNDATION FOR ECCENTRIC OVERLOAD RESISTANCE TRAINING - A PILOT STUDY**

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INTRODUCTION: Age-related decline is not uniform in measures of neuromuscular function. There is a relative maintenance in maximal voluntary eccentric vs. concentric and isometric force (MVC). It is unclear how age effects measures that are even more closely related to daily function such as stretch-shortening cycle (SSC) efficiency tested during dynamometry and vertical jumps. Identifying age-differences in neuromuscular outcomes could inform prescription of resistance training especially with an eccentric overload to target age-typical deficiencies at the start of a resistance training program.

METHODS: We compared healthy, active young adults (32.4 ± 5.59 years, n=4) and older adults (73.75 ± 2.75 years, n=4) in selected neuromuscular outcomes of the knee extensor muscles. Participants performed MVC knee extension and SSC contractions on a dynamometer and peak strength, the rate of torque development and mechanical efficiency was calculated. In addition, squat and counter-movement jumps were also performed where jump height and related parameters calculated. All measurements were conducted twice to establish test-retest reliability.

RESULTS: Mechanical efficiency and SSC effect during SSC contractions were similar between Young (Y: 45.09 ± 2.06%) vs. Old (O: 44.92 ± 1.13%) and (Y: 1.10 ± 0.10 vs. O: 1.08 ± 0.17) respectively. However, younger adults demonstrated knee extensor higher torque and rate of torque development during the isometric contractions (Y:0.78 ± 0.24 vs. O: 0.25 ± 0.17 Nm/ms, $p = 0.01$, $d = 2.50$). There also were no age-differences in MVC (Y: 130.45 ± 15.91 vs. O: 122.87 ± 23.26 Nm, $p = 0.60$, $d = 0.39$). Squat jump height (Y: 0.27 ± 0.05 vs. O: 0.13 ± 0.02 m, $p < 0.01$, $d = 3.17$), and countermovement jump height (Y: 0.34 ± 0.06 vs. O: 0.15 ± 0.03 m, $p < 0.01$, $d = 3.87$). All measurements demonstrated excellent test-retest reliability (ICC > 0.85).

CONCLUSION: While mechanical efficiency and SSC effect remain preserved with aging, explosive strength and jump performance show significant age-related declines. The lack of significant difference in MVC despite age differences suggests it may not be a sensitive indicator of age-related muscle function changes. Such data inform our subsequent eccentric overload training intervention to improve older adults' neuromuscular function especially affected by aging.

**TENSIOMYOGRAPHY AS A MUSCLE QUALITY ASSESSMENT METHOD FOR SARCOPENIA IN SLOVENIAN OLDER ADULTS**

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INTRODUCTION: Despite the significant health burden of sarcopenia, a consensus on classification is still lacking. Global prevalence estimates vary widely, ranging 10 to 27%, depending on classifications. Recent research suggests that muscle quality - defined as micro- and macroscopic aspects of muscle architecture and composition - could play a key role in sarcopenia classification. Thus, non-invasive tensiomyography (TMG) has emerged as a promising tool, with previous studies demonstrating its ability to detect muscle fibre composition and early atrophic changes before could be detected with muscle imaging techniques. However, its sensitivity to detect differences in the sarcopenic muscle remains unknown. This study aimed to validate TMG as a sarcopenic muscle quality assessment method.

METHODS: We investigated prevalence of sarcopenia in a random sample of Slovenian older adults (n=681, aged 73±9, 68.4% female) according to revised European Working group on Sarcopenia in Older People (EWGSOP2) and Sarcopenia definition and outcome consortium (SDOC) classifications with recently adopted cut-off points. Vastus lateralis (VL) contractile parameters were assessed by TMG (delay and contraction time, contractile velocity and radial displacement) and compared between sarcopenic and non-sarcopenic. Further, on a subsample of 51 participants (aged 82±8; 53% females) we assessed VL muscle architecture by ultrasound (thickness, pennation angle, fascicle length), volume and fat fraction (MFF) by continuous thigh Dixon sequence magnetic resonance imaging.

RESULTS: Sarcopenia prevalence was 10.9% (EWGSOP2) and 22.5% (SDOC). In general, sarcopenic had longer delay and contraction times, lower radial amplitude (higher stiffness) and lower contraction velocity than non-sarcopenic which was confirmed by moderate Pearson correlation of those parameters with performance in sarcopenia classification tests (sit-to-stand test, timed up-and-go test, handgrip strength and gait speed) with r-values ranging between -.382 and .362. Furthermore, on a subsample we found that radial displacement positively correlated with muscle thickness ($r=.408$, $p<.004$), fascicle length ($r=.460$, $p=.001$), and negatively with MFF ($r=-.506$; $p<.001$). Similarly, contraction velocity positively correlated with muscle thickness ($r=.433$; $p=.002$), fascicle length ($r=.460$; $p=.001$) and negatively with MFF ($r=-.533$; $p<.001$). Contraction time showed positive correlation with MFF ($r=.330$; $p=.027$).

CONCLUSION: We provided the prevalence of sarcopenia among Slovenian older adults, revealing considerable discrepancies between the two classification systems. Our findings support the potential of TMG as a viable method for muscle quality assessment. Given TMG is non-invasive and sensitive to changes in sarcopenia muscle alternations, TMG could contribute to improving sarcopenia classification and detection.

Conventional Print Poster Presentations

CP-PN02 Sex Differences and the Female Athlete

**SEX DIFFERENCES IN MUSCLE MORPHOLOGY AND GENE EXPRESSION ACROSS THE HUMAN LIFESPAN**

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INTRODUCTION: Sex differences in skeletal muscle morphology and function start in utero and evolve throughout life due to interactions between genetic, hormonal, and environmental factors. However, the molecular mechanisms driving these differences across the lifespan remain unclear. This study investigates how muscle structure and gene expression change with age in males and females, aiming to identify factors contributing to sex-specific muscle aging and function.

METHODS: A total of 96 biological males and 96 biological females aged 18–80 years and stratified by decade participated in this study. Body composition was assessed using dual-energy X-ray absorptiometry (DXA) and peripheral quantitative CT (pQCT) scans. Muscle strength was evaluated through a leg press 5-repetition maximum (RM) test. Muscle biopsies collected from the vastus lateralis were analysed using RNA sequencing (RNA-seq) and immunohistochemical (IHC) staining, with all statistical analyses conducted in RStudio (version 4.3.1).

RESULTS: Preliminary transcriptomic analysis revealed distinct sex- and age-associated patterns in gene expression. Pathways related to energy metabolism and cellular respiration exhibited notable differences between sexes, while age-related variations in the male cohort were particularly evident in pathways linked to immune function and protein degradation.

CONCLUSION: Ongoing analyses will integrate the muscle transcriptome with sex hormones, body composition, muscle morphology, and function to provide a comprehensive understanding of how sex differences in muscle present across the lifespan. By identifying the molecular and structural factors that contribute to sex-specific muscle aging, this study will enhance our understanding of muscle health, disease susceptibility, and performance across different life stages.

**NOCTURNAL CHANGE IN BODY TEMPERATURE, AND SLEEP QUALITY IN MENOPAUSAL WOMEN**

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INTRODUCTION: Middle-aged women often experience menopause which drastically changes physiological function called as "menopausal symptoms (e.g., vasomotor symptoms, sleep disorders and mood depression)" (Nelson, 2008, Guidozzi, 2013). Sleep disorder is known to be a major menopausal symptom, resulting in sustained fatigue and impaired quality of life. During sleep, core body temperature gradually reduced, and elevated core body temperature during sleep disrupts sleep quality (Flecher et al., 1999). Although dysfunction of body temperature during sleep (i.e., lack of lowering body temperature) may be associated with decreased sleep quality in menopausal women, change in body temperature during sleep has not been sufficiently reported in menopausal women. Therefore, the present study aimed to compare body temperature fluctuations and sleep status between menopausal women and young women.

METHODS: 19 menopausal women (MW; 49.1±2.7 years old) and 14 young women (YW; 20.3± 0.8 years old) were recruited. Skin temperature (Tsk) at proximal site was measured continuously over 7 days. Subjective sleep parameters were evaluated using Pittsburgh Sleep Quality Index (PSQI), and objective sleep parameters were evaluated using actigraphy.

RESULTS: Tsk during sleep was significantly higher in MW (35.0±0.4℃) than YW (34.6±0.5℃, $p < 0.05$). In YW, Tsk was elevated immediately after falling asleep and then gradually decreased, whereas in MW, no decrease in TSK was found ($p < 0.05$). Also, TSK remained significantly higher in MW compared to YW during 20-80% phase for whole night ($p < 0.05$). In subjective sleep parameters evaluated by PSQI, sleep quality was significantly impaired in MW compared to YW ($p < 0.05$). However, objective sleep parameters evaluated by actigraphy did not differ significantly between groups ($p > 0.05$).

CONCLUSION: Menopausal women presented specific change in nocturnal body temperature compared with young women. The lack of decrease in body temperature during sleep may be associated with impaired subjective sleep quality.

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**DOES THE MENSTRUAL CYCLE INFLUENCE OBJECTIVE ATHLETIC PERFORMANCE? A SYSTEMATIC REVIEW OF STUDIES FOLLOWING THE GOLD STANDARD METHODOLOGY**

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INTRODUCTION: Whether the menstrual cycle (MC) influences athletic performance in eumenorrheic females is subject of ongoing scientific investigation with controversial results. Current methodological recommendations emphasize the importance of accurate MC phase determination and classification, to reduce the risk of hidden effects due to inadequate methodology. This review therefore focuses exclusively on studies that combine serum analysis of 17ß-estradiol and progesterone with luteinizing hormone (LH) surge detection to determine the MC phases.

METHODS: The databases Medline, PubMed, Scopus and SPORTDiscus were searched for studies that investigated objective athletic performance in at least two different MC phases in eumenorrheic females.

RESULTS: The search yielded 1024 results, of which 98 % were excluded, primarily due to inadequate cycle phase determination. 19 studies with a total of n = 279 subjects (25.6 ± 3.6 years) were included. The populations investigated ranged from sedentary, to moderately active to athletic, with a mean sample size of n = 13.9 ± 7. On average, three MC phases were compared (range two – six), with the early follicular (EF) phase being most frequently analyzed in 18 studies. The risk of bias in most studies was rated as medium to high, especially in domains as the randomization process and the selection of reported outcomes. 58 % of the studies reported that at least one objective performance parameter differed between the MC phases. However, the direction and extent of the effects are variable in some cases. One study found maximal aerobic capacity to be impaired during the EF phase. Also, ventilation during submaximal running and cycling was reported to be reduced during the EF phase. In two studies, peak sprinting power was impaired in the late luteal and EF phase, when estradiol and progesterone concentrations are low. Seven out of eight studies on maximum voluntary contraction found no effect of the MC phase on performance. Only one reported enhanced strength during the late follicular compared to the mid luteal phase. All of the three studies investigating coordinative skills and agility reported improved performance during the ovulatory phase.

CONCLUSION: Despite the restriction to studies with high methodological standards, it remains difficult to compare the results. This is mainly due to the heterogeneity of the MC phases and populations studied, and the risk of bias. However, contrary to the current state of scientific knowledge, various athletic performance parameters appeared to be influenced by the MC phase in more than half of the studies examined. Our results suggest impaired peak sprinting power during the low hormone phases and increased coordination and agility during ovulation. Maximum strength, jump height and aerobic endurance were largely unaffected by the MC phase.

**MENSTRUAL CYCLE-RELATED VARIATION IN SPRINT PERFORMANCE IN FEMALE TRACK AND FIELD ATHLETES: A PILOT STUDY**

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INTRODUCTION: Numerous studies involving female participants categorize the menstrual cycle into two to four phases for performance assessments. However, this segmentation often fails to account for short-term variations in results. Given that many sports require repetitive or endurance activities, linear sprinting stands out due to its high intensity, brief duration, and precision. Minor differences in performance outcomes can be critical, particularly when athletes operate near their peak capacity. This study aimed to investigate two-day fluctuations in sprint capacity throughout the menstrual cycle and to identify specific days when performance dips or enhancements occur among female track and field athletes.

METHODS: Three healthy professional and semi-professional female track and field athletes (age: 24.0 ± 2.8 years; height: 169.3 ± 2.5 cm; weight during FP: 64.5 ± 4.8 kg; O: 64.5 ± 5.0; LP: 64.4 ± 4.7) participated in this study. Each had a regular 28-day menstrual cycle. The athletes underwent testing every second day throughout their menstrual cycle, performing a 30-second all-out sprint on a non-motorized treadmill. Measurements included distance, maximum velocity, capillary blood, and RPE on each test day.

RESULTS: Analysis of the 30-second all-out sprint performances throughout the menstrual cycle showed slight fluctuations in the distance covered, with no distinct trends across the menstruation (122.04 ± 2.77), follicular phase (122.98 ± 2.84), ovulatory phase (125.03 ± 2.15), and luteal phase (125.52 ± 4.27). Notably, all three athletes recorded their shortest distances during menstruation and exhibited improvements on the day of the estrogen surge before ovulation.

CONCLUSION: Sprint performance exhibited minor fluctuations throughout the menstrual cycle. However, to derive more definitive conclusions and to determine if consistent patterns of performance changes exist across athletes, further testing with a larger sample size is planned.

**PHYSIOLOGY SEX-RELATED DIFFERENCES IN TRAINED RUNNERS AFTER 20 WEEKS TRAINING PROGRAM**

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INTRODUCTION: Previous research has suggested that different training strategies may influence the running economy (RE) and performance (1). However, few studies have analyzed the changes in RE following a combined strength and endurance training program. Rodriguez-Barbero et al (2) showed an improvement of around 5% in RE in recreational and well-trained runners after 8 weeks of a regular endurance training program without changes in spatiotemporal parameters. However, the sex-related differences are not well known. Therefore, this study aimed to analyze the effect of a 20-week training program on the physiology of male and female athletes of similar performance levels.

METHODS: The study included ten trained runners (five males and five females with 764.2 ± 25.7 and 746.0 ± 82.2 World Athletics points, respectively). A pre-test-post-test design assessed the effects of a 20-week endurance and strength training program. First, all participants completed the RE test, consisting of 2x5-min running at 11 km·h-1 for females and 13 km·h-1 for males, separated by two minutes of passive recovery. Then, all participants completed a grade exercise test. The test started at 10 km·h-1 for 5 min, and the speed increased by 1 km·h-1 every minute until volitional exhaustion. During the test, respiratory variables were measured using a gas analyzer (MedGraphics, St. Paul, MN, USA). The first (VT1) and second (VT2) ventilatory thresholds and the maximal aerobic speed (MAS) were assessed. A repeated measures ANOVA was used to analyze the pre-post differences produced in the physiological variables between both sexes.

RESULTS: There were no significant differences in the interaction time (pre and post) × sex (male vs. female) in all physiological variables. However, there were significant differences in the time (pre vs post) factor. Thus, RE worsened significantly ($p<0.05$) after the training program. Oxygen cost at VT1, VT2, and the VO2max were significantly higher ($p<0.05$) after the 20 weeks. Finally, the speed at VT1, VT2, and MAS significantly increased ($p<0.05$) after the training program.

CONCLUSION: The effects of 20 weeks of regular endurance and strength training produced a 3.4% deterioration in the RE at submaximal speed. Conversely, we found an improvement of 5.2% and 3.1% in VO2max and MAS. The speed and the oxygen cost associated with the VT1 and VT2 increased with the training program. This suggests that a long endurance training program could improve performance and physiological factors, but sex does not influence these changes in a similar performance level sample.

**COMPARING HEART RATE VARIABILITY BETWEEN NATURAL MENSTRUAL AND ORAL CONTRACEPTIVE CYCLES IN TWO FEMALE ATHLETES: A CASE STUDY**

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INTRODUCTION: Heart rate variability (HRV) is widely used to monitor athletes' training status [1]. Previous studies have shown that the menstrual cycle (MC) and hormonal contraceptive (HC) use influence HRV in physically active females [2-3]. However, given the impact of training load (TL) on HRV, research specifically focusing on female athletes should be investigated. Recently, (2021) Elliott-Sale et al. proposed MC methodological guidelines to study female athletes however the feasibility of these guidelines in the daily training environment (DTE) is understudied in the Canadian sport context. Therefore, the study objectives were to report on the feasibility of these guidelines in DTE and to describe the effects of a natural MC and HC on HRV in Canadian female athletes.

METHODS: Two female athletes (Tier 3 classification) in this case study agreed to participate and provided data across two cycles (C1 and C2). Athlete one (28-year-old runner) used a combined oral hormonal monophasic pill (OHC) and athlete two (21-year-old kayaker) reported they had a natural (eumenorrheic) MC. HRV was measured nightly using a biosensor ring (Oura) [4] and TL (sRPE) was reported daily. MC length was self-reported (journal counting), and estradiol and progesterone saliva samples were collected (OHC: 1/weekly; MC: 3X/weekly). Ovulation was determined by a dipstick (urinary). Adherence rates were reported for feasibility (% of available HRV, journal, and salivary data), and RMSSD (avg±SD) were reported for the HRV analysis.

RESULTS: Adherence rate was 99.5% for OCP and 100% for MC. For OHC, the average RMSSD value tended to decrease for the first (70.0 ms2±8.4) to the second (61.4 ms2±7.6) week of active pill and increase from the third (67.1 ms2±9.0) week to the placebo week (72.4±14.9). MC displayed higher average RMSSD values at ovulation (66.8 ms2±7.1) compared to the luteal phase (58.2 ms2±9.1). For the follicular phase, no consistent trend was observed across either cycles. In C1, the average RMSSD value was lower (64.3 $ms^2$±10.1) compared to ovulation, whereas in C2, the opposite was observed, with a higher RMSSD value (72.8 $ms^2$±9.6) during the follicular phase. The average variation in the mean RMSSD between phases was greater for OHC (20.6%) than for MC (9.1%). Total TL for both cycles was higher for MC (24020.4 AU) than for OHC (12401.2 AU).

CONCLUSION: Based on the high adherence rates it is feasible in this context to implement ovarian hormone measures within DTE. HRV was observed to have greater variation with OHC when compared to a natural MC, contrary to previous findings in active females [2-3]. It is possible that the TL, which is higher for an athlete compared to an active female, could partly explain these results.

[1] Bucheit (2014); [2] Ahokas et al., (2022); [3] Sims et al., (2021); [4] Cao et al., (2022)

**HORMONAL CONTRACEPTIVE USE, MENSTRUAL DISTURBANCES AND SELF-PERCEIVED PERFORMANCE IN DANISH ELITE FEMALE SOCCER PLAYERS**

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INTRODUCTION: Despite growing evidence indicating physiological effects of the menstrual cycle and hormonal contraceptive use, reports from athletes suggest that athletes experience self-perceived effects of their menstrual cycle on performance. The perceived effects have been related to the physical symptoms experienced as a result of their cycle, which has been supported by findings from our lab, indicating greater correlations between psychological well-being and performance than hormonal fluctuations (1).

Despite soccers global popularity, research on female players, especially concerning hormonal contraceptive use and menstrual dysfunction, is limited. Low energy availability—a risk factor for menstrual dysfunction and reduced performance—is commonly reported among female athletes, though data on Danish players are lacking.

The primary aim of this study is to assess the prevalence of hormonal contraceptive use, menstrual dysfunction, and self-perceived performance in relation to the menstrual cycle in Danish elite female soccer players.

METHODS: Using a descriptive, cross-sectional study design, an online questionnaire was sent to 571 female soccer players from different soccer leagues. The questionnaire included questions on the player's use of hormonal contraception, the menstrual cycle and irregularities of the menstrual cycle. Responders of the questionnaire received a follow-up questionnaire including questions on the players' self-perceived experience of the menstrual cycle.

RESULTS: In total 342 female soccer players from four different soccer leagues answered the questionnaire. Of the 342 players, 181 players (53%) were users of hormonal contraception. Among the hormonal contraception users, 86% used a combined, oral contraceptive and 14% used a progestin-only formulation. Among the non-hormonal contraceptive users (47%), 63% reported having a regular menstrual cycle while 37% reported irregular menstrual cycles. Of the players reporting irregular menstrual cycles, one player reported primary amenorrhea whereas 13% reported secondary amenorrhea.

The follow-up questionnaire was answered by 138 players with 60% being hormonal contraceptive users and 40% being non-users. Amongst the hormonal contraceptive users, 23% reported that they felt their pill cycle impacted their performance. Amongst the non-users of hormonal contraceptives, 47% reported that they felt their menstrual cycle impacted their performance.

CONCLUSION: This study highlights a significant self-perceived impact of the menstrual cycle and hormonal contraceptive use on athletic performance among Danish elite soccer players. Additionally, menstrual irregularities, including amenorrhea, were reported. This study underscores the need for further research on the menstrual cycle's impact on female athletes to better support their health and performance optimization.

References:

1. Dam et al, Med Sci Sports Exerc 2022.

**FETAL RESPONSES TO EXERCISE IN TWIN PREGNANCY**

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INTRODUCTION: It is well established that moderate-to-vigorous intensity physical activity (MVPA) during pregnancy is associated with extensive health benefits for both mother and fetus. However, there are certain medical conditions (contraindications) where engaging in MVPA is not advised due to the potential for adverse health outcomes. Twin pregnancy is listed as a contraindication in many global guidelines based on expert opinion rather than empirical evidence. Therefore the aim of this study was to evaluate the maternal/fetal responses to an acute bout of aerobic exercise in twin pregnancies.

METHODS: Twenty-four participants with a singleton (n = 12, 26 ± 5 weeks of gestation, 33 ± 3 years of age) or twin (n = 12, 26 ± 5 weeks of gestation, 33 ± 2 years of age; 11 dichorionic/diamniotic and 1 monochorionic/diamniotic) pregnancies were recruited. Participants underwent a graded exercise test on the cycle ergometer. Maternal cardiac function (heart rate [HR], cardiac output [CO], stroke volume [SV], ejection fraction [EF]; echocardiography), mean arterial pressure (MAP; photoplethysmography) were measured before and immediately following incremental cycling exercise. Fetal HR (ultrasound) was measured pre- and post-exercise. The change (Δ) from rest to maximal effort was compared between groups (T-tests; $\alpha$=0.05 was deemed significant). All data are expressed as mean ± standard deviation.

RESULTS: As expected, women pregnant with twins had higher resting HR (S: 83±6 vs. T: 95±12 bpm, respectively; P<0.01) and CO (S: 4.3±0.4 vs. T: 4.9±1.4 L.min-1, respectively; P=0.02) but similar SV (S: 55±9 vs. T; 55±12 mL, respectively; P=0.27), EF (S: 68±7 vs. T: 66±9%, respectively; P=0.07) and MAP (S: 82±9 vs. T: 91±8 mmHg, respectively; P<0.01) compared to singleton pregnancies. At maximal effort, maternal heart rate (S: 148±12 vs. T: 155±9 p=0.22) and percent maximal heart rate (S: 79±7 vs. T: 83±5) were not different between groups. Fetal HR was unchanged in response to exercise

at 70% HR reserve in both groups (singleton: change 0±4 vs. twin: change 0±4, P=0.53) with no incidences of fetal bradycardia or tachycardia.

CONCLUSION: While resting cardiovascular metrics were elevated in twin compared to singleton pregnancy, an acute bout of vigorous intensity physical activity was well tolerated by mother and fetus in both groups.

**BASELINE ANDROGEN STATUS PREDICTS FREE ANDROGEN INDEX (FAI) RESPONSE TO A 12-MONTH NUTRITIONAL INTERVENTION IN EXERCISING WOMEN WITH MENSTRUAL DISTURBANCES**

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INTRODUCTION: Functional hypothalamic oligo/amenorrhea (FHOA) has been attributed to chronic energy deficiency and is characterized by suppressed serum triiodothyronine, insulin, leptin, and lower resting metabolic rates. However, some cases of exercise-associated oligomenorrhea do not align with FHOA metabolic profiles. Some oligomenorrheic women may present with elevated androgens (hyperandrogenemia), exhibiting higher body mass index, percent body fat, insulin, and leptin levels, as well as a higher Free Androgen Index (FAI), and luteinizing hormone/follicle-stimulating hormone (LH/FSH) ratios. These endocrine differences suggest heterogeneity in the etiology of menstrual disturbances among exercising women which may impact treatment strategies. Specifically, if the etiology of oligomenorrhea involves hyperandrogenemia, a nutritional intervention leading to weight gain may exacerbate ovarian dysfunction. This study investigated if initial indications of hyperandrogenemia, i.e., high baseline FAI, predicted changes in FAI in response to a 12-month nutritional intervention in exercising women with oligo/amenorrhea.

METHODS: This secondary analysis of the REFUEL RCT included 23 exercising women with oligo/amenorrhea who were randomized to increase their caloric intake for 12 months in the study. Control participants who were randomized to maintain their current diet are excluded. Daily urinary estrone-1-glucuronide (E1G), pregnanediol glucuronide (PdG), and mid-cycle LH were assayed to determine menstrual status. Serum total testosterone (T) and sex hormone-binding globulin (SHBG) were repeatedly measured to calculate FAI ([T/SHBG]*100) as a measure of androgen exposure. Data were analyzed at baseline (BL) and intervention weeks 21, 33, and Post-intervention. Generalized linear mixed models (GLMMs) with fixed effects of time and BL FAI as a covariate were used to predict changes in FAI across the study.

RESULTS: Mean values for time points are as follows: BL FAI (4.98±0.6), Week 21 (5.37±0.54), Week 33(6.16±0.82), and Post (4.8±0.56). GLMMs revealed significant main effects for baseline FAI ($F[1,25]=55.36$, $p<.001$) and time ($F[2,23]=4.22$, $p=0.028$), with significant BL_FAIxtime interaction ($F[2,23] =5.22$, $p=0.014$). Higher BL_FAI was associated with sustained high FAI across all time points ($\beta=0.67$, $p<0.001$), but this relationship varied based on time point, with stronger effects on Week 21 and Week 49 FAI and weaker effects at Week 33 FAI ($\beta=-0.30$, $p=.065$).

CONCLUSION: Baseline FAI significantly predicted changes in FAI throughout the 12-month nutritional intervention. Higher BL FAI was associated with higher FAI across all time points, suggesting that women with higher FAI may require closer nutritional monitoring to ensure effective treatment of their menstrual dysfunction. The time-dependent fluctuations in FAI indicate that androgen exposure during refeeding may vary depending on BL FAI, thus warranting further research to optimize intervention strategies for this population.

## Conventional Print Poster Presentations

### CP-PN03 Physiology and Nutrition - Mixed

**BASELINE STRENGTH AND ACTIVITY ARE ASSOCIATED WITH IMPROVED RECOVERY KINETICS FOLLOWING ECCENTRIC EXERCISE IN OLDER ADULTS**

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INTRODUCTION: Muscle function recovery following exercise-induced damage (EIMD) is thought to be influenced by individual strength, mobility and activity level. However, evidence in older adults remains limited. This study investigated whether baseline muscle function, mobility, and habitual physical activity predict recovery following an unaccustomed eccentric exercise bout in healthy older adults.

METHODS: Thirty older adults (70.9 ± 4.0 years, 11 males, 19 females) completed a single bout of eccentric exercise (10 sets of 10 repetitions; 1 s concentric, 1 s hold, 3 s eccentric). Muscle soreness (DOMS), countermovement jump (CMJ), and maximal voluntary contraction (MVC) were assessed pre- and post-exercise (24, 48, and 72 h). Baseline measures included handgrip strength, a 4-meter walk test, a chair rise test, one-repetition maximum (1RM), and Skeletal Muscle Mass Index (SMI). Physical activity was categorized using the International Physical Activity Questionnaire (IPAQ). Recovery was quantified as the area under the curve (AUC) of the percent loss from baseline using the trapezoidal method. Spearman correlations and Kruskal-Wallis tests assessed associations between AUC values, baseline measures, and IPAQ activity levels.

RESULTS: Following exercise, MVC loss was 12.05% at 24 h and recovered by 48 h. CMJ force loss peaked at 48 hours, while CMJ height, power, and velocity continued to decline through 72 hours. DOMS peaked at 24 hours across all conditions (standing, sitting down, and standing up). No significant differences were observed between men and women in

any recovery metric. Spearman's correlations revealed that AUC-MVC was negatively associated with 1RM (ρ = -0.45, p = 0.015) and handgrip strength (ρ = -0.39, p = 0.036). CMJ Velocity (ρ = 0.39, p = 0.039) and Power (ρ = 0.38, p = 0.042) losses were positively correlated with age. Additionally, individuals classified as moderately active according to the IPAQ showed significantly better CMJ power recovery than those with low activity levels (p = 0.031).

CONCLUSION: Older individuals with higher baseline strength and moderate physical activity may be more resistant to functional impairments following EIMD, with baseline functionality potentially predicting recovery kinetics. Greater strength in active individuals could also support better recovery. Given the ongoing study and sample size limitations, these findings should be interpreted with caution.

**EFFECTS OF ISOMETRIC HANDGRIP EXERCISE ON EXECUTIVE FUNCTION IN YOUNG AND OLDER ADULTS: A FNIRS STUDY.**

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INTRODUCTION: Evidence suggesting that acute exercise enhances executive functions predominantly arises from studies focused on aerobic exercise. It remains unclear whether strength physical exercises, such as intermittent isometric handgrip exercises, affect executive functions in young and older adults. We examined the dose-effect response of several physical loads and their potential effect on perceptual cortex hemodynamics effects.

METHODS: Using a crossover design, 46 participants completed intermittent isometric handgrip exercise using three modalities concerning repetition or duration 1): 4 repetitions of 2 min of 30% of maximal voluntary contraction (MVC) with 3 min of recovery 2) with 1 minute of recovery and 3) 8 repetitions of 2 min of 30% of MVC with 3 min of recovery and 4) a control condition in a randomized order. Before and after each condition, they performed a Stroop task assessing inhibition and flexibility processes. Perceptual, cognitive difficulty and prefrontal cortex oxygenation were measured during both tasks.

RESULTS: For the Stroop task, we found a greater good response only for the condition 4 repetitions with 3 minutes of recovery of flexibility task. We found no effect of exercise on inhibition task. This was accompanied by a lower perceived difficulty of the task and lower physical perceived physical effort only on this condition. Although hemodynamic changes have been observed, they do not seem to explain the cognitive changes.

CONCLUSION: Acute isometric handgrip exercise with adequate load improves flexibility, but the inhibition remains unaffected. This effect of the load is accompanied by an improved perceived difficulty of physical and cognitive effort.

**BASALINE VAGAL ACTIVITY AND FAT OXIDATION RELATIONSHIPS IN ACTIVE POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Metabolic flexibility (MF), the ability to adapt and adjust substrate oxidation relative to substrate availability, has been recently linked to the autonomic function in postmenopausal women (2), likely due to the vagus nerve activity at the hepatic level (1). Autonomic function at rest, assessed through Heart Rate Variability (HRV), showed to be associated with MF indicators such as maximal fat oxidation MFO or the final lactate in a FATmax test (RER=1.07) (2). However, the relationship between the cardiovascular variables fat oxidation and HRV at rest are not well known and the current study will study this.

METHODS: Forty-five menopausal active women (67.9±5.3 years; 65.8±11.5 kg; 40.3±4.2 kg muscle mass) performed a resting metabolic rate test in supine position. Basal metabolic rate (BMR) and MFO were assessed by indirect calorimetry using a K5 metabolic cart (Cosmed, Rome, Italy) for 30 minutes. HRV was simultaneously registered by means of a H10-polar band and the Sensor Polar Logger App. The first 5 were discarded. Participants arrived at the same time (8:30 a.m. & 10:00 a.m.), after 12h overnight fasting, preceded by a standardised dinner (50% carbohydrate content) the previous day. Prior to recording, they remained in a supine position for a period of 15 minutes, relaxed and with eyes closed. After normality test, Spearman and Pearson correlations were applied.

RESULTS: BMR was low (990±270 kcal/day), despite a larger RER (0.79±0.05) and fat contributed the total energy expenditure (69.9±15.7% fat; 0.072±0.031 g/min; 1.69 mg/min/kgFFM) compared with similar sample (3). HRV revealed a basal autonomic steady state both in linear-indexes root mean square of successive differences between beats (RMSSD, 25.8±18.2 ms), as in non-linear indicators SD1 (18.3±12.9 ms), sample entropy (SampEn, 1.73±0.20) or detrended fluctuation analysis α1 (DFAα1, 0.95±0.21). An association between FATox (both in absolute and relative units) with the main autonomic variables: parasympathetic (PNS) index (r=0.56; 0.58), low frequency power (r=0.37; 0.36), RMSSD (r=0.31; 0.32) and SD1 (r=0.31; 0.32) was confirmed by the significant, positive and moderate correlation. BMR was also significantly, positively and moderately associated with PNS index (r=0.51), pnn50 (r=0.32), RMSSD (r=0.31) and SD1 (r=0.31), instead of LF which was not associated with BMR. DFAα1 and SampEn did not show any significant associations.

CONCLUSION: Vagal activity assessed through HRV confirms to be associated with basal metabolic rates and Fatox rates at rest i.e. metabolic flexibility. Our data support the hypothesis linking fat oxidation and vagal activity, thus underlining the importance of HRV in the assessment of cardiovascular (both, metabolic and autonomic) health.

References:

1. Matsubara et al. Neuropharmacology; (2022)

2. Monferrer-Marín et al. European Journal of Applied Physiology; (2024)

3. Maghbooli, Z., et al. BMC womens health; (2022)

**THE RELATIONSHIP BETWEEN BLOOD GLUCOSE, INSULIN, AND LEPTIN AND MOTIVATION FOR PHYSICAL ACTIVITY AND EXERCISE**

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INTRODUCTION: Numerous studies have demonstrated that physical activity and exercise are beneficial to human health. However, many individuals do not meet the recommended levels of physical activity. While animal studies have suggested that leptin and insulin are involved in behavioral control, evidence in humans remains limited (Hennige et al., 2009; Choi et al., 2007). Glucose, insulin, and leptin interact with each other (Sartorius et al., 2012). However, most studies have not explored this interaction comprehensively. Therefore, this study aims to investigate whether blood glucose, insulin, and leptin levels are associated with motivation for physical activity and exercise.

METHODS: The participants were 12 healthy adults (7 men and 5 women, age: 23.1 ±3.5 years, BMI: 22.4±1.5 kg/m²). Each participant completed two conditions randomly with at least a five-day washout period; 1) high-frequency food intake (10 times/6 h 40 min) and 2) low-frequency food intake (twice/6 h 40 min), to induce changes in blood glucose, insulin, and leptin levels. Blood samples were collected at nine time points (every 40 min from the first to the ninth time point). Physical activity and exercise motivation and sleepiness were assessed using a visual analog scale. Pearson's correlation coefficient was used to test the correlation between blood parameters and motivation at baseline. Two-way ANOVA was used to test the interaction effect of time and condition. A linear mixed model was used to test the association between the blood parameters and motivation at each time point.

RESULTS: Glucose, insulin, and leptin levels and motivation at baseline had no significant associations. Significant interactions between time points and conditions were observed for blood insulin levels and sleepiness ($p < 0.05$). In the analysis of the association between blood parameters and motivation using a mixed linear model across all time points, significant associations were found between glucose and exercise motivation ($\beta = -0.126$, $p < 0.05$), insulin and physical activity motivation ($\beta = -0.143$, $p < 0.05$), exercise motivation ($\beta = -0.185$, $p < 0.05$), and sleepiness ($\beta = -0.161$, $p < 0.05$).

CONCLUSION: Glucose and insulin levels were significantly associated with motivation for physical activity and exercise. When blood glucose and insulin levels are high, individuals tend to feel less motivated to engage in physical activity. It is suggested that factors involved in feeding regulation may also influence motivation for physical activity and exercise through behavioral control, thereby affecting energy expenditure. These findings enhance our understanding of the mechanisms underlying motivation for physical activity and exercise and may inform strategies to increase engagement.

Sartorius et al., Cell Physiol Biochem. 2012;30(1):238-46. Choi et al., Behav Brain Res. 2008;188(1):100-8. Hennige et al., Diabetologia. 2009;52(11):2416-2424.

**INFLUENCE OF BODY COMPOSITION ON RELATIVE RESTING METABOLIC RATE IN RECREATIONAL WOMEN ATHLETES**

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INTRODUCTION: Total daily energy expenditure is highly dependent upon resting metabolic rate (RMR) as it makes up approximately 50% of energy utilized. Altered RMR may have implications on body composition, such as losses or gains in fat mass and fat free mass (FFM). Since RMR has shown to be strongly correlated with body mass, absolute RMR alone may not provide sufficient context when assessing body composition. Instead, evaluating RMR relative to body composition, specifically FFM, may offer more meaningful insights. Thus, the purpose of this study is to examine the influence of body composition on relative RMR in recreational women athletes.

METHODS: 28 recreational female athletes (age=22.0±3.8 years; height=165.3±8.3; body mass=67.0±14.7; RMR=1525.6±237.2; BF%=27.4±7.6; FFM=47.8±3.7; FFMI= 17.4±1.8; relative RMR= 23.3±3.7) participated in this study. Body composition was evaluated using bioelectrical impedance analysis (BIA), and the following metrics were recorded: body mass, body fat percent (BF%) and FFM. FFMI was calculated (FFM (kg) / height (m2)). RMR was measured using indirect calorimetry following an overnight fast (≥8 hours) and at least 12 hours without vigorous exercise. Participants rested in a seated position for 25 minutes prior to laying supine for a 30 minute collection period. The first 10 minutes served as a familiarization period, while the last 20 were used to assess RMR. Relative RMR was expressed as kcal/kg body mass/day. Hierarchical linear regression was used to evaluate the influence BF%, FFM, and FFMI, respectively, on relative RMR ($p<0.05$).

RESULTS: Model 1 was significant ($\beta=29.330$; $R2=0.204$; SEE=3.373; $p=0.016$) and identified BF% as a significant predictor of relative RMR ($\beta=-0.220$; $p=0.016$). Model 2 remained significant ($\beta=40.026$; $R2=0.474$; SEE=2.794; $p=0.001$), with both BF% ($\beta=-0.159$; $p=0.038$) and FFM ($\beta=-0.258$; $p=0.001$) being significant predictors. Model 3 included BF%, FFM, and FFMI ($\beta=38.114$; $R2=0.478$; SEE=2.843; $p=0.001$), but only FFM ($\beta=-0.229$; $p=0.030$) was a significant predictor of relative RMR. Model 2 was determined to be the best-fitting model due to its lower standard error and significance of both predictors.

CONCLUSION: Data from the present study suggest relative RMR is negatively influenced by both BF% and FFM, with each 1 unit increase in BF% and FFM associated with a decrease of 0.159 kcal/kg and 0.258 kcal/kg, respectively. While the negative association between BF% and relative RMR is supported by previous studies, the inverse relationship between FFM and relative RMR is unexpected. It is possible this relationship may be influenced by total body mass, warranting

further investigation. Results may differ in males and in elite or professional athletes, as these populations typically exhibit lower body fat percentages and different body composition characteristics than the present cohort.

**CIRCULATING MUSCLE-SPECIFIC MIRNA EVALUATION AFTER FIVE WEEKS OF STRENGTH TRAINING AND HYPER-CALORIC KETOGENIC DIET**

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INTRODUCTION: The evaluation of the effectiveness of training programs and associated diets is a crucial point that concerns sports sciences; it is mainly concerned with elite sports, but amateur athletes are also increasingly attentive to these issues. In this sense, miRNAs, non-coding nucleotide sequences, and epigenetic regulators of protein synthesis; a specific class is characteristic of skeletal muscle and is called myomir; this study aims to evaluate the variation of a pool of miRNAs in response to training and dietary patterns, specifically hyper-caloric ketogenic

METHODS: Thirty subjects aged between 18 and 50 years (same women and men) with at least 2 years of experience in strength training without any apparent pathologies, without injuries in the last 6 months, underwent physical and strength assessments (bioimpedance, stratigraphy, 1RM squat, benchpress and deadlift, Counter movement jump) and reported a food diary for 7 days; they operated for 5 weeks a training based on cluster sets, to improve strength and hypertrophy; combined with a ketogenic nutritional program (less than 50 g of carbohydrates per day, ketonemia monitored with blood sampling) hypercaloric (an excess of calories of 20-25% compared to the estimate of caloric consumption); at the beginning and end of the study, blood samples were taken in the morning on an empty stomach with at least 3 days of rest from training. The expression levels of myo-miRNAs were determined using the TaqMan™ probes—advanced miRNA Assay RT-PCR and applying the 2^(-DDCt) method.

RESULTS: Subjects reported, on average, a 2.3% weight decrease (most likely due to glycogen and associated water depletion), a 5% increase in phase angle, and 3.6% in LMI (bioelectric parameters positively correlated with fitness and muscle mass); a 7.7% decrease in fat percentage; an increase in the 1RM of squat, deadlift, and bench press, respectively of 8.7%, 29.7%, and 11.1%, while the CMJ is practically unchanged; GH shows an increase of 16,2%, IGF1 increases of 10%, myostatin decreases of 22,5% finally the reticulocyte shows an increase of 14%; miRNAs reported in logarithmic scale have reported percentage variations in terms of fold or change equal to: miR-1-3p -80%, miR-21-5p -65%, miR-133a-3p -98%, miR-206 -20%, miR-208b-5p -60%, miR-222-3p -20%, miR-378

CONCLUSION: The program produced improvements in terms of strength and body composition, showing how the hypercaloric ketogenic diet is compatible with strength training; the critical novelty is the strong regulation of myomir: miR-1, 206, and 208 related to IGF1 that increased, and miR-133 22 and 378 related to myostatin that decreased; this confirms the epigenetic action of physical exercise that could be monitored through circulating miRNAs; the rest of the influenced miRs concern protein synthesis and the regulation of the inflammatory state, two other basic parameters for a positive response to physical exercise. No significant sex-related differences were noted.

## Conventional Print Poster Presentations

### CP-PN11 Hypoxia, Physiology and High Altitude

**COMPLEX NETWORKS APPLIED TO THE NORMOBARIC "LIVING HIGH – TRAINING LOW" MODEL IN EXPERIMENTAL MICE**

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INTRODUCTION: Living in a hypoxic environment combined with physical training in a normoxic condition (living high-training low, LH-TL) is widely studied in exercise physiology, with emphasis on its metabolic adaptations [1]. With growing interest in the topic, advanced analytical approaches that transcend conventional statistics are needed [2]. This study aimed to analyze the effects of 6-week LH-TL on muscles and tissues in C57BL/6J mice, using the complex network model.

METHODS: Forty animals were grouped according environmental condition (normoxia-Nx or hypoxia-Hx) and training (non-N or trained-T) totaling 4 groups (Nx-N, Nx-T, Hx-N and Hx-T). Hx mice were exposed to 14.5% inspired oxygen (~3,000m) for 18h/day. T mice underwent 6-week treadmill running (80% of the critical velocity, 40min/day, 5 days/week) in normoxia. Euthanasia occurred 48h after the last training session. Data corresponding to the mass of muscles, liver, heart, kidney, brain and adipose tissues, and the stores of glycogen in muscles, liver and heart tissues, as well as body composition measurements, were analyzed by the Scheirer-Ray-Hare test, with Dunns post hoc. Undirected weighted graphs (G=V,E,w) of the complex network were constructed from the 4 scenarios (groups) to analyze the degree (number of connections) and eigenvector (prestige of the node related to the prestige of its neighbors) centrality metrics. The graphs were composed of 27 vertices (V, nodes) and the edges (E) denoted interactions based on Spearmans correlation coefficients ($r \geq 0.5$) to construct the weight function (w) [3].

RESULTS: The density of the graphs for the 4 scenarios studied were 0.27, 0.18, 0.16, and 0.25, respectively. For degree, the complex network highlighted muscle glycogen nodes among all parameters. In Nx-N and Hx-T scenarios, there was high

centrality for white gastrocnemius glycogen. Furthermore, aerobic training promoted highlights for oxidative parameters, such vastus lateralis mass, gluteus glycogen, and, especially in the Hx-T group, soleus glycogen (11 connections). Hypoxia increased the centrality of carcass mass, an effect enhanced by training. Only in Hx-T was the hypothalamus mass highlighted (10 connections). Interestingly, eigenvector centrality reinforced the degree findings. Nonparametric statistics showed differences in some parameters, especially for brown adipose tissue and femur masses, and liver glycogen, but these do not seem to be, at least in our conditions, integrated with the other parameters studied, since they did not reveal prominent complex networks centralities. However, gastrocnemius and triceps glycogen stores were highlighted in both analyses.

CONCLUSION: The complex network model was sensitive to the isolated and combined effects of physical training and hypoxia, which were not fully represented by conventional statistics. This approach may refine data interpretation in investigations involving LH-TL.

1.Girard et al.,2023, 2.Beck et al.,2024, 3.Brandes,2001

Support: FAPESP, CNPq, CAPES, FAEPEX

**DOES BACKPACK LOAD CARRIAGE WEIGHT AFFECT SUSCEPTIBILITY TO ACUTE MOUNTAIN SICKNESS DURING INTERMITTENT WALKING IN HYPOXIA?**

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INTRODUCTION: The growth of global adventure tourism has led to millions of travellers visiting areas of high-altitude for recreational trekking, charity fundraising challenges and/or cultural immersion over several days to weeks annually. These activities necessitate carrying backpacks that contain hiking provisions of additional weight without understanding how increased load carriage may affect physiological responses at altitude, nor whether they may increase the risk of experiencing symptoms of acute mountain sickness (AMS) - a common altitude illness typically observed above 2500m. There is limited understanding whether existing backpack load recommendations used at sea-level (maximum load equating to 1/3 of body weight) apply at altitude, or whether increasing loads exacerbate symptoms of AMS. The purpose of the study was to therefore assess backpack weight of 10%, 20% and 30% of body weight on physiological and perceptual strain and symptoms of AMS, during a simulated hillwalking test in hypoxia.

METHODS: Thirteen physically active males and females (23±1 years) completed three intermittent walking tests (including: 35-mins rest, 60-min walk [3x20-min intervals with 5-min rest] at 4km.hr-1 at 10% gradient, followed by 15-mins recovery) within normobaric hypoxia (FIO2: 0.13). These were conducted within a randomised order whilst carrying a backpack loaded with additional weight that was either 10%, 20% or 30% relative to the participants' body mass. Physiological, perceptual and Lake Louise Questionnaire (LLQ) scores were assessed throughout.

RESULTS: Heart rate and ventilation were higher (both $p<0.05$) during the 30% backpack test compared to 10% (+13±11 b.min-1 and +9.4±7.6 L.min-1), but no differences were found between 10% and 20%. LLQ scores were higher ($p<0.05$) during the 30% backpack test compared to the 10% (+2±1 A.U.) and 20% (+1±1 A.U.), but no differences ($p>0.05$) were found between 10% and 20%. Rating of perceived exertion (RPE: 6-20 Borg [1982]) were higher (all $p<0.05$) during the 20% and 30% trials compared to 10% (+2±2 and +4±2 A.U.), and also during the 30% compared to 20% trial (+2±2 A.U.). No differences in pulse oxygen (O2) saturation, nor volume of O2 uptake (all $p>0.05$) were found between tests.

CONCLUSION: Carrying additional backpack weight increases markers of physiological and perceptual strain and may augment AMS symptoms. Altitude travellers without prior experience of hiking and who are carrying a backpack for an extended period of time should understand these responses and potential risks to health, as well as educate themselves on safe altitude knowledge/travel and contributing risk factors.

**THE EFFECT OF BREAKFAST OMISSION ON EXECUTIVE FUNCTION BETWEEN NORMOXIC AND HYPOXIC EXERCISE IN HEALTHY YOUNG ADULTS**

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INTRODUCTION: Executive function has been shown to be improved after acute light exercise, and limited research suggests these beneficial effects remain even after breakfast omission (1). In contrast, executive function is impaired in hypoxia at rest, during and after exercise (2,3). This study aimed to determine the interactive effects of exercise, and breakfast consumption on executive function after light exercise. We hypothesized executive function would be improved after light exercise in normoxia, but reduced after exercise in hypoxia, with or without breakfast.

METHODS: Twelve healthy young adults (10 men and 2 women with a mean age of 21 years) participated in this study. All participants completed four morning experimental conditions in a random order; i) breakfast omission (overnight fasting) in normoxia (20.9% O2), ii) having breakfast in normoxia (20.9% O2), iii) breakfast omission in hypoxia (13% O2), and iv) having breakfast in hypoxia (13% O2). In each condition, participants arrived after an overnight fast and had or did not have a standard breakfast, and then rested for 60 min, which was followed by 20 minutes of light-intensity leg cycling exercise (80 watts for men and 60 watts for women). Cerebral oxygenation (COX) was assessed by near-infrared spectroscopy pre-, during exercise, and post-exercise. Blood glucose, blood lactate, and executive function such as Digit span task (DST) and Hopkins verbal learning test (HVLT) were assessed pre-and post-exercise, respectively.

RESULTS: At rest, blood glucose was lower after breakfast omission regardless of normoxia or hypoxia (delta -20% and P<0.001). After exercise, blood lactate in hypoxia was significantly higher than in normoxia (delta 2 mmol/L in normoxia vs. 4 mmol/L in hypoxia, P<0.001). A significant interaction (oxygen×time, P<0.001) in COX was found, where regardless of breakfast, COX was unchanged in normoxia (1.8% increase during exercise compared to pre-exercise) but decreased by 3.8% in hypoxia. In normoxia and hypoxia, the DST backward score was improved post-exercise compared to pre-exercise (P=0.02) but was impaired by breakfast omission (P=0.03). In contrast, the DST forward score, and HVLT were unaffected by exercise, oxygen level, or breakfast (all P>0.05).

CONCLUSION: Acute moderate exercise improved backward scores of DST, but not forward scores and HVLT irrespective of oxygen levels or breakfast. Breakfast omission impaired only backward scores of DST. Hypoxia did not influence both DTS and HVLT. These results suggest that exercise improved short-term and working memory, but, breakfast omission impaired working memory. Moreover, hypoxic-induced reductions in cerebral oxygen hemodynamics did not affect executive function.

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**EEFECTS OF 4-WEEKS OF HIIT IN NORMOBARIC HYPOXIA ON SLEEP AND CARDIAC AUTONOMIC ACTIVITY**

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INTRODUCTION: The implementation of high-intensity interval training (HIIT) within altitude/hypoxic training environments has recently emerged as a novel tool to boost both individual and team sports performance (1, 2). Such training method can be physically challenging, imposing a greater stress on athletes. Thus, ensuring optimal recovery during these intense training periods is essential, with sleep playing a vital role despite being relatively underexplored. This study examined the effects of 4-weeks of HIIT and repeated sprint training (RST) in a simulated hypoxia setting on sleep and nocturnal heart rate variability (NHRV).

METHODS: Eight well-trained subjects (mean ± SD age: 38.8 ± 4.6 yrs) were either assigned to the normoxia (CON: n=4) or hypoxia (HYP: n=4) condition after having their sleep monitored for 2 weeks (baseline). Then, for 4 weeks, participants performed 3 training sessions (HIIT=2, RST=1) each week in either a normoxia or simulated hypoxia setting (intervention). Sleep was objectively monitored through wrist-worn actigraphy devices, and NHRV was monitored through heart rate (HR) monitors. Comparison between groups, study phase (baseline and intervention) and the type of day (baseline, exercise, and rest) were examined.

RESULTS: Overall, sleep duration was 452.5 (95% CI 440.0; 464.9) minutes and sleep efficiency 90.5 (89.8; 91.2) %. Resting HR was 50.3 (49.3; 51.3) bpm and NHRV 4.3 (4.2; 4.4) ms. There were similar results (p>0.05) in sleep and NHRV between baseline and intervention period in any group, besides wake-up time, which was earlier during the intervention for the CON group (p = 0.008, d = 0.47).

CONCLUSION: Although subjects' average sleep duration throughout the duration of the study was within current recommendations for healthy adults (7 or more hours per night on a regular basis), large heterogeneity in sleep variables and schedules was observed. Moreover, and compared with the baseline period, sleep and NHRV was not impacted to a larger extent when 4-weeks of HIIT and RST were held in simulated hypoxia conditions, when compared with the condition where the training design was held in normoxia.

Acknowledgements

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**ACTIVE HEAT ACCLIMATION IN WOMEN: CROSS-ADAPTION POTENTIAL FOR EXERCISE PERFORMANCE IN HYPOXIA**

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INTRODUCTION: Heat acclimation can mitigate heat-related decrements in maximal oxygen uptake and maximal aerobic power (MAP), enhancing exercise capacity in hot and thermoneutral environments [1]. The cross-adaptation hypothesis posits that adaptation to one stressor (e.g., heat) also augments tolerance to another (e.g., hypoxia) [2]. While evidence supporting this hypothesis exists, it remains unclear whether such cross-adaption occurs in women, as most relevant research has exclusively tested male participants [3]. Thus, the aim of this study was to assess whether a 10-day active heat acclimation intervention improves peak oxygen uptake and MAP under simulated altitude conditions in healthy women.

METHODS: Twenty-eight healthy women were randomly assigned to a hot (HA; n=15; T: 35°C, Relative Humidity: 50%) or a thermoneutral (CON; n=13; T: 20°C, RH: 50%) group, and underwent a 10-day intervention. All participants cycled for 1 h per day at 40% thermoneutral MAP. Pre- and post-intervention, peak oxygen uptake and MAP were assessed under three conditions: neutral (NEU; T: 20°C, RH: 50%), hypoxia (HYP; T: 20°C, RH: 50%, FIO2: 13%), and heat (HEAT; T: 35°C, RH: 50%) using incremental exercise tests to exhaustion on separate days, interspersed by a rest day. Pulmonary ventilation, pulse oxygenation, and heart rate were measured throughout all exercise tests. Subjective thermal comfort was also assessed. Data were analysed using 2x2 mixed-effects ANOVA (group [HA,CON] * time [pre,post]), with statistical significance accepted when $p<.05$.

RESULTS: No significant interaction effects were observed. Neither intervention altered peak oxygen uptake under any condition (HA vs. CON; NEU: 0.2±7.3% vs. -0.1±7.5%; HYP: -0.9±3.5% vs. 1.3±9.8%; HEAT: 0.6±6.0% vs. 0.0±9.4%; all time $p\geq.803$), whereas MAP was significantly increased under all conditions, similarly in both groups (HA vs. CON; NEU: 1.5±4.6% vs. 5.1±4.9%; HYP: 1.7±5.8% vs. 4.3±6.2%; HEAT: 3.4±4.1% vs. 3.6±4.9%; all time $p\leq.012$). In hypoxia, no significant pre-post changes were observed in peak ventilation ($p=.666$), peripheral oxygenation ($p=.188$), or heart rate ($p=.485$). Additionally, no changes in thermal comfort were noted in either the hot ($p=.315$) or the hypoxic ($p=.270$) condition.

CONCLUSION: Heat exposure during 10 moderate-intensity cycling sessions did not provoke any performance or cardiorespiratory benefits in hot or hypoxic conditions, when compared to the same training conducted in thermoneutral conditions. The present data, therefore, do not support the potential for "heat-to-hypoxia" cross-adaptation in healthy young women, at least with the small "thermal dose" and training impulse employed in this study. Further work should explore protocols with higher heat and exercise doses, which may yield more beneficial effects in this regard.

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**PREDICTIVE VALIDITY OF A HYPOXIC SENSITIVITY TEST FOR ASSESSING RESPONSES TO ALTITUDE TRAINING**

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INTRODUCTION: Altitude training has gained popularity among endurance athletes, promoting performance-enhancing physiological adaptations. However, individual variability in responses makes the traditional one-size-fits-all approaches to altitude training problematic. Understanding and predicting individual sensitivity to altitude remains a complex challenge due to the multifactorial nature of altitude adaptation. This study explored the complex relationship between key physiological markers during sea-level exercise performance and individual sensitivity to hypoxia, and the efficacy of hypoxic sensitivity to predict adaptation to altitude.

METHODS: Twenty-five athletes (18 males, 7 females) from the University of Birmingham's Athletics and Cross-Country Club who attended a 3.5-week altitude camp (at ~1800 m) were recruited. Athletes performed a hypoxic sensitivity test (HST) in a normobaric hypoxic chamber beforehand. The protocol included rest and exercise under normoxic and hypoxic conditions (4000 m). Heart rate (HR), oxygen saturation (SpO2), and ventilation were measured to assess hypoxic sensitivity and predict the adaptive response to the altitude camp. Submaximal and maximal treadmill testing was conducted both pre- and post-camp. HR, SpO2, lactate, VO2 max and fuel utilisation were assessed via continuous measurements.

RESULTS: Post-altitude training, athletes showed significant improvements ($P < 0.05$) in velocity at maximal oxygen consumption (vVO2 max) (2.5%), speed at LT2 (2.2%) and a slight but non-significant improvement in LT1 speed (1.2%). Beneficial shifts in economy (kcal/kg/km), higher exercising SpO2 (%), and lower HR (bpm) were observed pre-post camp during submaximal exercise testing stages ($P < 0.05$). However, pre-camp hypoxic sensitivity testing did not predict the change in any of these performance outcomes (LT1: $r = -0.359$, $P = 0.131$; LT2: $r = -0.304$, $P = 0.205$; and vVO2 max: $r = -0.200$, $P = 0.442$).

CONCLUSION: The study sought to establish if a hypoxic sensitivity test (HST) could predict an individual's adaptive response to altitude training. However, no predictive relationship was observed, although beneficial changes in performance metrics support the physiological advantages of altitude training. Further work in this area is needed to ensure athletes can optimise training and performance outcomes from altitude training, while mitigating the risk of altitude sickness, overtraining or deconditioning, and help inform acclimatisation strategies in moderate and high-altitude, as well as clinical settings.

**ASSESSING THE SUITABILITY OF MUSCLE OXYGEN SATURATION SLOPE ZERO AS A MEASURE OF MAXIMAL METABOLIC STEADY STATE**

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INTRODUCTION: Near-infrared spectroscopy (NIRS) is a tool for non-invasive evaluation of muscle oxygenation status. Recent data (1) indicated that a zero slope value in the tissue saturation index (%TSI) during a constant-load exercise can be used as a proxy to estimate the exercise intensity associated with the maximal metabolic steady state (MMSS), which demarcates the boundary between the heavy and severe exercise intensity domains. However, to date, no study has characterized the suitability of this approach during a constant-load bout of exercise at the actual MMSS intensity. Further,

there is no information whether this approach would be consistent across different muscles. Thus, this study assessed the suitability of the %TSI slope zero approach to characterize the MMSS physiological responses from the vastus lateralis (VL) and the rectus femoris (RF) muscles.

METHODS: Eighteen participants (8 females) completed four laboratory visits over three weeks. The first visit consisted of a ramp incremental cycling test to task failure. The remaining visits were utilized to determine the MMSS through the evaluation of the maximal lactate steady-state (MLSS) in the presence of a stable oxygen uptake. After excluding the initial phase (i.e., first 2 min of exercise), the %TSI slope in the VL and RF was calculated from minute 2 to 5. The suitability of %TSI zero-slope approach at MMSS was analyzed by calculating the average, standard deviation (SD), variance, confidence intervals (95%CI), and range of the slope. Statistical significance was evaluated by comparing the individual slopes to zero by a one-sample t-test. Data were analysed using the SAS statistical package (SAS Institute Inc., USA). Statistical significance was accepted at $P \leq 0.05$.

RESULTS: Overall, for the VL muscle, the average slope was 0.22 %/min, with SD of 0.91, variance of 0.83, 95% CI between -0.25 and 0.68 %/min, range between -1.43 and 2.44 %/min. For RF muscle, the average slope value was -0.51 %/min, with SD of 1.00, variance of 1.02, 95%CI between -1.03 and 0.00 %/min, range between -2.24 and 1.04 %/min. The %TSI slopes was not statistically different from zero for VL ($p=0.22$) and RF ($p=0.07$) muscles.

CONCLUSION: Based on the current results, despite the %TSI slopes for the VL and RF muscles not being different from zero, the analysis showed considerable variability. This is a relevant finding since the exercise bout was performed at a verified MMSS intensity, which should have resulted in %TSI zero slope with minimum variability if this outcome is to be assumed as a suitable approach to identify the heavy-severe intensity boundary.

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**EFFECTS OF BREATH-HOLDING WARM-UP ON PERFORMANCE AND PHYSIOLOGICAL RESPONSES DURING HIGH-INTENSITY EXERCISE SIMULATING A 200 M SWIM**

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INTRODUCTION: Warm-up, a preliminary exercise performed before the main activity, has been shown to enhance performance by increasing muscle temperature and blood flow to active muscles. Recent studies suggest that incorporating hypoxic inhalation into warm-up routines can further improve performance in a 100m swim compared to conventional warm-up methods (1); however, the underlying mechanisms remain unclear. Moreover, due to equipment limitations, implementing hypoxic inhalation in actual competition settings is challenging. As a potential alternative, voluntary breath-holding may offer similar benefits, but its effectiveness requires direct investigation. Therefore, the purpose of this study was to investigate the effect of breath-holding warm-up on performance and physiological responses during high-intensity exercise simulating a 200 m swimming.

METHODS: Eleven healthy adults (2 females) participated in this study. Participants performed a 5-minute warm-up at 70% of their maximum oxygen uptake (VO2max) under two conditions: 1) without breath-holding (Control) and 2) with intermittent breath-holding (20 s of spontaneous breathing followed by 10 s of breath-holding, repeated for 10 sets; Apnea). Performance was assessed through a constant-load exercise at 110% of VO2max for 90 seconds, followed by a 30-second maximal pedaling test. Measurements included maximal and mean power output, cardiorespiratory parameters (e.g., oxygen uptake, heart rate), oxygen saturation (SpO2), and perceived exertion (RPE). Additionally, near-infrared spectroscopy (NIRS) was used to assess tissue oxygenation saturation (StO2) in the vastus lateralis.

RESULTS: The average $VO_2$ and SpO2 during the warm-up period were lower under the apnea than the control trials ($P < 0.05$) while no difference was observed in StO2 of the vastus lateralis between conditions ($P > 0.05$). These results suggest that the intermittent breath-holding protocol used in this study (10 seconds out of every 30 seconds) was insufficient to induce muscle hypoxia. Furthermore, no significant differences were observed in maximum and average power output, $StO_2$, or RPE between conditions during the performance test ($P > 0.05$). The lack of improvement in exercise performance may be attributed to the warm-up failing to induce hypoxia in the active muscles or to the hypoxic duration being shorter than in previous studies where exercise performance improved following hypoxic inhalation with warm-up.

CONCLUSION: The results of this study suggest that a warm-up involving intermittent breath-holding (10 seconds out of every 30 seconds) does not enhance performance in a 2-min all-out cycling exercise simulating a 200 m swimming, compared to a warm-up with normal breathing.

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**MUSCLE OXYGEN SATURATION REMAINS STABLE DURING SUBMAXIMAL EXERCISE ACROSS DIFFERENT HYPOXIC CONDITIONS IN WELL-TRAINED ENDURANCE ATHLETES**

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INTRODUCTION: Near-infrared spectroscopy (NIRS) is a valuable tool, enabling the non-invasive assessment of muscle oxygen saturation (SmO2) and hemodynamics. It was recently applied to determine exercise intensity thresholds and optimize training prescription [1]. However, up-to-date investigations focus on the measurements performed at the same altitude, whereas the transferability of NIRS-obtained variables between different hypoxic conditions remains understudied. The concepts of "critical oxygenation" (COx), and critical power (CP) were investigated in athletes performing high-intensity exercise in normoxia and hypoxia [2]. COx was hypothesized to be a robust marker of exercise intensity, remaining stable in normoxic and simulated altitude conditions with simultaneous changes in CP and heart rate (HR).

METHODS: 29 healthy and highly-trained endurance athletes (age 22.4±6.8 years, 9 females) completed the study. Across 3 days, they underwent two 3-minute CP cycling tests in a randomized order in normoxia (87m ASL, FiO2=20.8%) and normobaric hypoxia (3200m ASL, FiO2=14.2%). SmO2 (Moxy Monitor at the vastus lateralis, Moxy Monitors, USA), HR (Polar H10 chest strap, Polar Electro Oy, Finland), and external power (Wahoo KICKR trainer, Wahoo Fitness, Atlanta, GA) were continuously measured throughout the tests. COx and CP were established as the average from the last 30 seconds during both tests [3]. Repeated measures ANOVA with partial eta squared (ηp2) effect size allowed to compare COx, HR, and CP between normoxia and hypoxia with sex as an independent variable.

RESULTS: CP was significantly higher in normoxia than in hypoxia (299.7±56.5 vs 254.9±47.7 W in females, 447.0±74.8 vs 357.3±60.7 W in males; $p<0.001$ and ηp2=0.115 for environment, p=0.004 and ηp2=0.014 for environment*sex). Average HR during the last 30 seconds of both tests was significantly higher in normoxia than hypoxia (189.4±7.7 vs 185.1±7.2 bpm in females, 183.5±7.5 vs 180.3±8.1 bpm in males, $p<0.001$ and ηp2=0.047), but not for environment*sex interaction (p=0.424). There were no differences in COx between normoxia and hypoxia (22.4±7.2 vs 21.4±5.3 %SmO2 in females, 11.3±6.5 vs 10.5±9.7 %SmO2 in males; p=0.610 for environment, p=0.946 for environment*sex).

CONCLUSION: This study suggests that COx might be relatively stable across different ambient oxygen concentrations, whereas CP and HR exhibit significant differences between normoxia and hypoxia. Accordingly, NIRS-obtained variables may be useful in optimizing performance and training under different hypoxic conditions. The practical significance of our observations depends on the required accuracy of the exercise intensity determination. Further research seems warranted for validation of the COx concept using established protocols designed for CP and comparing COx values from single- and multiple-effort tests.

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**EFFECT OF HYPOXIA ON MUSCLE ACTIVATION DURING INCREMENTAL EXERCISE NORMALIZED TO RESPIRATORY COMPENSATION POINT**

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INTRODUCTION: A previous study reported an effect of reduced FiO2 on muscle activation during incremental exercise (Torres-Peralta et al., 2014), however only short step duration were used and therefore, a true metabolic steady state may not have been present at all workloads. The objective of this study was to examine the impact of hypoxia on muscle activation during both ramp and steady state incremental cycling normalized for relative intensity to the respiratory compensation point (RCP).

METHODS: Fifteen recreationally active adults (10 M, 5 F) made four lab visits, to complete ramp and step incremental exercise testing in normoxia (NORM; FiO2≈21%) and normobaric hypoxia (HYPO; FiO2≈13.5%). The step test consisted of 6 stages where the 6th workload was equivalent to 80% of the RCP determined from ramp testing. This was immediately followed by a final time to exhaustion (TTe) stage at the midpoint between RCP and peak power output (PPO). Electromyography (EMG) was used to assess muscle activation at each submaximal intensity and task failure, expressed as percent of baseline dynamic maximal effort. 2-way ANOVA, paired t-tests, and effect sizes were used to examine differences between conditions (NORM vs HYPO).

RESULTS: There was a significant condition by intensity interaction effect on muscle activation for rmsRF% ($p < 0.001$; ηp2 = 0.80), and rmsVM% ($p < 0.001$; ηp2 = 0.66) during ramp testing where post-hoc analysis revealed a decrease in rmsRF% (p = 0.049; d = 0.61) and rmsVM% (p = 0.01; d = 0.84) at PPO in HYPO. For the step test, there was a main effect of condition for rmsVM% (p = 0.001; ηp2 = 0.57) and rmsVL% (p = 0.04; ηp2 = 0.32), but not rmsRF% (p = 0.74; ηp2 = 0.009). There was also a significant reduction in rmsVM% (p = 0.01; d = 0.76) and rmsVL% (p = 0.03; d = 0.69) in HYPO compared to NORM at task failure in the step test TTe stage. There was a strong relationship between muscle activation and power output (PO) at task failure across both when combining data from both ramp and step tests.

CONCLUSION: During ramp incremental exercise at workrates below RCP, there was little difference in muscle activation between NORM and HYPO, however during steady-state exercise, rmsEMG activity was lower in HYPO. At task failure, there was a positive association between absolute PO and muscle activation irrespective of condition or test protocol.

These results suggest that relative intensity and metabolic stress likely only play a minor role in muscle activation, whereas the force required to produce a given mechanical workload is the dominant factor. However, this might be modulated by steady-state versus non-steady-state metabolism.

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## Conventional Print Poster Presentations

### CP-PN12 Molecular Signaling

**IMPACT OF LOCAL AND SYSTEMIC OXYGENATION, RONS, AND METABOLITE ACCUMULATION ON THE RENIN-ANGIOTENSIN SYSTEM AND TMPRSS2 IN RESPONSE TO INTENSE EXERCISE**

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INTRODUCTION: The renin-angiotensin system (RAS) regulates cardiovascular function and oxidative stress, with ACE1/AT1R promoting vasoconstriction and ACE2/AT2R inducing vasodilation. ACE2 mediates SARS-CoV-2 entry, aided by TMPRSS2. Both are implicated in post-viral muscle fatigue, as their dysregulation after COVID-19 is linked to inflammation, oxidative stress, and metabolic dysfunction in human skeletal muscle (hSM). Exercise may restore RAS balance and protect against SM wasting. This study examined RAS signalling and TMPRSS2 changes in hSM following incremental exercise to exhaustion (IE) and post-exercise ischaemia, exploring the role of RONS, metabolite accumulation, and oxygenation. We hypothesise that RAS signalling and TMPRSS2 will be upregulated by intense exercise, with greater activation during ischaemic recovery and hypoxia conditions amplifying RONS production.

METHODS: Eleven physically active men completed an IE under normoxic (Nx) and hypoxic (Hyp, PiO2: 73 mmHg) conditions. Immediately following exhaustion, one lower extremity was swiftly occluded at 300 mmHg. V. lateralis biopsies were obtained: baseline (PRE), immediately post-exercise from the occluded extremity (POST), and after 60s from both the occluded (OC1M) and non-occluded (nOC1M). Blood samples were taken from the femoral vein. Protein expression was analysed by WB. Stats: ANOVA, t-test and Pearson's correlation.

RESULTS: At POST, muscle lactate +25% only in OC1M ($P<.05$) while PCr -94 and -48% in OC1M and nOC1M, respectively ($P<.005$) regardless of PiO2. PO2 in the femoral vein was 21.1±2.0 and 10.6±2.8 mmHg at Wmax, in Nx and Hyp, respectively ($P<.001$). TMPRSS2 was upregulated at POST (57%), and OC1M (204%), regardless of FiO2. At nOC1M, TMPRSS2 was reduced to PRE levels ($p>.05$). AT2R expression was reduced at POST (20%, $p<.05$), maintained after 1 min of recovery, regardless of occlusion and FiO2. ACE1 and AT1R remained unchanged ($p>.05$). TMPRSS2 and ACE2 were correlated across conditions ($r=0.48$, $p<.001$) and with Nrf2/Keap1 ratio ($r=0.83/r=0.54$; both $p<.001$), catalase ($r=0.80/r=0.48$; both $p<.001$), pSer359 p47phox NOX2 ($r=0.28$, $p=.01/r=0.65$, $p<.001$, respectively).

CONCLUSION: Our findings show that intense exercise and ischaemic recovery selectively modulate RAS-related protein expression in hSM. The robust upregulation of TMPRSS2 post-exercise, further enhanced by ischaemia, correlating with ACE2 and Nrf2/Keap1 ratio, suggests a link with oxidative stress and RAS adaptation. The reduction in AT2R post-exercise, independent of FiO2 and occlusion, could have reduced AT2R-mediated vasodilatory signalling. The stability of ACE1 and AT1R suggests a selective response to metabolic stress rather than a global RAS activation. These findings support the role of RONS in exercise-induced RAS remodelling, with implications for SM function, COVID-19 viral susceptibility and post-viral fatigue.

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**EFFECTS OF HABITUAL AEROBIC EXERCISE ON MRNA EXPRESSION OF BATOKINES IN BROWN ADIPOSE TISSUE OF OBESE MICE**

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INTRODUCTION: Brown adipose tissue (BAT) promotes energy expenditure and browning of white adipose tissue [1]. BAT has an endocrine system and secreted "batokines" play a crucial role in regulating metabolism and identified ependymin-related protein 1 (EPDR1), C-X-C motif chemokine ligand 14 (CXCL14), fibroblast growth factor-21 (FGF-21), bone morphogenetic protein 8B (BMP8B), etc. [2]. However, the effects of habitual aerobic exercise on changes in mRNA expression of batokines in BAT remain unclear. Therefore, this study investigated whether the habitual aerobic exercise alters the mRNA expression of batokines in interscapular BAT of obese mice.

METHODS: Eight-week-old apolipoprotein E (apoE) knockout (ApoE-/-) mice were used as an obese model and were randomly divided into the following two groups: sedentary control (ApoE-/- SED, n=6) group and 16-wk voluntary wheel running aerobic exercise (ApoE-/- AT, n=6) group. ApoE-/- mice of two groups were fed a high-fat diet during the experimental period. Age-matched C57BL/6J wild-type mice were fed a normal chow and were used as a healthy sedentary control group (WT-SED, n=6). Expression of EPDR1 mRNA, CXCL14 mRNA, FGF-21 mRNA, and BMP8B mRNA in the interscapular BAT (iBAT) were analyzed by using real-time RT-PCR with TaqMan probe. Protein expression levels of PGC1-α, as a marker for promoting the thermogenic function of BAT, in iBAT were analyzed by Western blotting. The effects of exercise training on mRNA expression of batokines were compared using one-way ANOVA. Statistical significance was defined as $p<0.05$.

RESULTS: Epididymal fat mass of the ApoE-/- SED group was significantly higher compared with WT-SED group ($p<0.05$), and that of ApoE-/- AT group was significantly lower compared with ApoE-/- SED group ($p<0.05$). Protein expression levels of PGC1-α in the iBAT were significantly higher in the ApoE-/- AT group as compared with ApoE-/- SED group ($p<0.05$). EPDR1 mRNA levels in the iBAT were higher in the ApoE-/- AT group as compared with ApoE-/- SED group (ApoE-/-SED: 1.1 ± 0.1 vs ApoE-/- AT: 2.5 ± 0.8 arbitrary unit, $p=0.047$). Additionally, BMP8B mRNA levels in the iBAT were lower in the ApoE-/- AT group as compared with ApoE-/-SED group (ApoE-/- SED: 2.8 ± 0.6 vs ApoE-/- AT: 1.2 ± 0.3 arbitrary unit, $p=0.011$). However, no significant differences of mRNA expression levels of CXCL14 and FGF-21 in the iBAT were observed among the three groups.

CONCLUSION: Habitual aerobic exercise may alter the mRNA expression levels of several batokines, including EPDR1 and BMP8B, in iBAT of obese mice.

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**A VALINE INTERMEDIATE 3-HYDROXYISOBUTYRIC ACID DERIVED FROM THE SKELETAL MUSCLES ACTIVATES GLUCONEOGENESIS THROUGH THE LIGAND ACTIVITY OF GPR41**

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INTRODUCTION: Branched-chain amino acids (BCAAs); valine, leucine, and isoleucine, are catabolized as energy substrates in the skeletal muscles in order to meet high energy demands, replacing the reduced supply of glucose, during endurance exercise. A small molecule 3-hydroxyisobutyric acid (3HIB) is an intermediate of valine in the mitochondrial pathway of muscular BCAA catabolism, and a portion of 3HIB is released into the blood circulation in response to the amount of endurance exercises in humans and animals. We have presented at the last ECSS meeting that the administration of 3HIB rapidly and significantly increased blood glucose concentration in rats. Therefore, we hypothesized that 3HIB may play a physiological role in the regulation of blood glucose concentration. Present study evaluated the regulation of blood glucose level by 3HIB and its mechanism.

METHODS: Male Wister rats (8 weeks of age) were intraperitoneally administered a 3HIB solution (60 mg/kg BW) and/or alpha-blocker prazosin (5 mg/kg BW), and glucose and its regulating hormone levels in serum and energy metabolites and mRNA expression in the liver were evaluated after 0, 15, and 60 min (N=7/groups). In addition, the ligand effect of 3HIB on G protein-coupled receptor 41 (GPR41), which is abundantly expressed in sympathetic ganglia, was evaluated by a GPCR ligand-binding assay.

RESULTS: In rats, serum glucose and noradrenaline levels were significantly increased after 15 min of the 3HIB injection, but were returned to baseline levels after 60 min. Blood glucose level after 15 min of 3HIB was unchanged with the addition of prazosin. In the liver, malate concentration and glucose 6-phosphatase mRNA expression, which are a metabolite of 3HIB and a rate-limiting enzyme in the gluconeogenesis pathway, respectively, were significantly increased in the liver after 15 min of 3HIB injection. The GPCR ligand-binding assay confirmed that 3HIB has agonist activity for GPR41 at similar level as serum concentrations after the intraperitoneal administration of 3HIB or the endurance exercises.

CONCLUSION: The effect of 3HIB excreted from the skeletal muscles to elevate blood glucose concentration is thought to be due to the gluconeogenesis in the liver using 3HIB itself as a substrate. In the activation of this hepatic gluconeogenesis, 3HIB may play a role in promoting the release of noradrenaline from the sympathetic nervous system through its agonist activity of GPR41. So, under condition of the severe energy expenditure, 3HIB, which is an intermediate catabolic metabolite of BCAA, a major amino acid in the structural proteins of skeletal muscle, may act as a metabolic signal from skeletal muscle to stimulate glucose supply from the liver.

**INTERMITTENT POST-SPRINT ISCHEMIA POTENTIATES STAT3/IL-6 SIGNALLING IN HUMAN SKELETAL MUSCLE DURING SPRINT INTERVAL TRAINING.**

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INTRODUCTION: High-intensity exercise stimulates RONS production, essential for activating signalling pathways that drive muscle adaptation. IL-6/STAT3 signalling plays a key role in metabolic regulation and antioxidant defence, yet its response to exercise-induced oxidative stress remains incompletely understood. Although IL-6 mediates redox adaptations, the interplay among RONS, STAT3/NFκB activation, and IL-6 expression in skeletal muscle remains unclear. Post-exercise ischaemia prolongs local oxidative and metabolic stress, providing a model to assess RONS-mediated signalling adaptations. This study investigated whether sprint interval training (SIT) with post-sprint ischaemia modulates RONS-sensitive pathways in skeletal muscle. We hypothesised that this intervention enhances STAT3/NFκB activation and IL-6 expression, reflecting a RONS-adaptive modulation of myokine response.

METHODS: Ten active participants (3W/7M) completed six SIT sessions over two weeks (4–6 × 30-s all-out sprints with 4-min recovery). Using a randomised within-leg design, one leg underwent 30–50 sec of ischaemia at 300 mmHg immediately after each sprint (IS-leg), while the contralateral leg acted as an internal control (FC-leg). Muscle biopsies from the vastus lateralis were collected at rest pre-training (from a single leg) and post-training (bilaterally) to analyse protein expression levels of pSTAT3, total STAT3, IL-6, NFκB p65, and IκBα by Western blot.

RESULTS: After training, the IS-leg increased markedly in the NFκB p65/IκBα ratio (+2.0-fold, $p<0.01$), an effect not observed in the FC-leg. After SIT, total STAT3 levels increased significantly in both legs (+1.4-fold, $p<0.03$). Similarly, post-training elevations were noted in both IL-6 and NFκB p65 protein levels, with markedly greater increases in the IS-leg compared to the FC-leg (IL-6: IS-leg +1.5-fold vs. FC-leg +1.1-fold; NFκB p65: IS-leg +4.2-fold vs. FC-leg +2.0-fold, $p<0.05$).

CONCLUSION: These findings reveal that application of post-sprint ischaemia during SIT amplifies basal STAT3/IL-6 and NFκB signalling through extended exposure to RONS and metabolites. This within-subject design effectively isolates the specific effects of ischaemia, highlighting its potential to boost adaptations to oxidative stress. Enhanced IL-6 signalling may regulate inflammatory processes and bolster antioxidant defences, underscoring its dual role in managing exercise-induced oxidative stress. The observed signalling adaptations support the use of post-exercise ischaemia to modulate oxidative stress responses, with implications for muscle recovery and performance. Further studies will determine whether these molecular changes translate into functional improvements in endurance performance.

GRANTS:

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**THE METABOLISM REGULATED BY EXERCISE-INDUCED PPARB IS RELATED TO MUSCLE PROTEIN QUALITY CONTROL**

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INTRODUCTION: Mitochondria dysfunction is a major factor contributing to the development of sarcopenia. Resistance exercise is the most effective intervention to enhance mitochondria function and diminish muscle loss. Resistance exercise increases PPARβ expression, a key regulator of mitochondrial function and protein homeostasis. This study aims to investigate whether PPARβ alleviates aging-induced muscle loss and the underling mechanisms.

METHODS: Human skeletal muscle samples were used to determine whether aging affects PPARβ expression. To further investigate PPARβ function, protein expression and proteomics analysis of tibialis anterior (TA) muscles were performed using LC-MS in 10-week-old wild-type (WT), PPARβ transgenic (mTG), PPARβ knockout (mKO) mice. Differentially expressed proteins were identified and subjected to pathway enrichment analysis to elucidate associated metabolic pathways and functional groups. Ultrastructural changes in the mKO model were examined using electron microscopy. Additionally, to assess the effect of increased PPARβ expression in aging, a PPARβ agonist was administered to 24-month-old mice for 2 months, followed by protein expression analysis.

RESULTS: PPARβ expression was reduced in aged human skeletal muscle. In the mTG model, PPARβ expression was increased, associated with improved muscle mass and endurance exercise capacity, whereas the mKO model exhibited decreased PPARβ expression and impaired endurance exercise capacity. In particular, mKO mice showed sarcomere disorganization, glycogen accumulation, mitophagy impairment, and mitochondrial hypertrophy. Proteomic analysis revealed that PPARβ-induced metabolic changes is related to muscle protein quality control. Moreover, treatment with a PPARβ agonist for 2 months in 24-month-old mice restored PPARβ expression and improved endurance exercise capacity. Further studies are necessary to determine whether exercise-induced PPARβ can regulate muscle protein quality control in aged mice.

CONCLUSION: Our findings suggest that PPARβ serves as a central regulator linking mitochondrial metabolism to muscle protein quality control. However, further studies are necessary to determine whether exercise-induced PPARβ can regulate muscle protein quality control in aged mice and to explore the underlying mechanisms.

**CHRONIC CHANGES IN ESTROGEN RECEPTORS ARE NOT ASSOCIATED WITH MUSCLE HYPERTROPHY IN WOMEN AND MEN**

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INTRODUCTION: The muscle hypertrophy induced by resistance training (RT) has been demonstrated to be similar between women and men (Roberts et al., 2020) However, it has been suggested that the underlying mechanisms driving these adaptations may differ by sex (Roberts et al., 2023). Among these, similarly to the association between androgen receptors and hypertrophy in men, the estrogen receptors (ER) have emerged as a potential hypertrophic mechanism in women. The purpose of this study was to investigate the chronic effects of RT on different fractions of ER in women and men. Additionally, we investigated whether these chronic changes in the ER fractions are associated with hypertrophy of type I and II fibers in women and men.

METHODS: Thirty-eight young women (n = 19) and men (n = 19) underwent 10 weeks of RT. Muscle biopsies were performed at baseline and 96-120 h after the last session (chronic effect). ER, cER, and nER were analyzed using Western blotting, and ER-DNA was assayed through ELISA. Muscle fiber cross-sectional area (fCSA) were analyzed through immunohistochemistry.

RESULTS: Unpaired t tests showed significant baseline differences in ER, where men demonstrated greater baseline contents of total ER compared to women (P = 0.0182). No other significant baseline between-sex differences were observed for cER (P = 0.6081), nER (P = 0.9827) or ER-DNA (P = 0.1857). Chronically, there was a main effect of time only for cER (P = 0.0162), in which decreases were observed in women and men. Additionally, no significant effects were observed for ER, nER and ER-DNA (P > 0.05). Finally, correlation analyses showed only a significant negative weak correlation between baseline ER-DNA and fCSA I (r = -0.247; P = 0.038) for women.

CONCLUSION: A link between ER content and muscle mass has been suggested. However, the effects of resistance training on ER content and its association with hypertrophy have been poorly explored. Our findings contribute to this topic by revealing that chronic changes in ER content are not associated with hypertrophy of type I and II fibers in women and men.

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**ACUTE EFFECTS OF DIFFERENT EXERCISE PATTERNS ON SALIVARY IGA AND LACTOFERRIN SECRETIONS**

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INTRODUCTION: Our recent studies have demonstrated that acute continuous aerobic exercise leads to lower secretion levels of immunoglobulin A (IgA) and higher levels of lactoferrin, an antimicrobial peptide, in saliva [1,2]. However, the acute secretory responses of salivary IgA and lactoferrin to different exercise patterns remain unclear. This study aimed to clarify the acute effects of different exercise patterns with the same total exercise volume and duration on salivary IgA and lactoferrin secretion.

METHODS: In a randomized crossover trial, 12 healthy young untrained men (mean age: 22.2 ± 1.1 years; height: 172.9 ± 6.8 cm; body weight: 65.9 ± 4.1 kg; body fat: 15.9 ± 4.9 %; VO2max: 43.4 ± 6.0 mL/kg/min) performed two exercise patterns with the same total exercise volume: moderate-intensity continuous exercise (MICE) for 20 min cycling exercise load equivalent to 70% maximal oxygen uptake (VO2max), and high-intensity interval exercise (HIIE) for 20 min cycling exercise, with 5 sets of 2-min at 50% VO2max and 2-min at 90% VO2max. Saliva samples were collected at baseline, post-0 min, and post-30 min. The salivary IgA and lactoferrin concentrations were measured by an enzyme-linked immunoassay. The effects of different exercise patterns were analyzed using two-way repeated-measures ANOVA with two trials (MICE and HIIE) × three time points (baseline, post-0 min, and post-30 min). Statistical significance was set at $p < 0.05$.

RESULTS: In the HIIE, the percentage change in salivary IgA secretion rate did not decrease from baseline to after exercise. In contrast, in the MICE, the percentage change in salivary IgA secretion rate was lower immediately after exercise (p = 0.0002). In addition, the percentage change in salivary IgA secretion rate immediately after exercise decreased in the MICE as compared to the HIIE (MICE: -37.6 ± 19.7 % vs HIIE: 3.6 ± 33.6 %, p = 0.0014). However, the percentage change in salivary lactoferrin secretion rate did not change from baseline to immediately after exercise in the MICE and the HIIE. Moreover, the salivary flow rate from baseline to after exercise did not change due to differences in exercise patterns.

CONCLUSION: These results suggest that salivary IgA secretory response may differ between acute MICE and HIIE with the same total exercise volume and duration, whereas secretory responses to salivary lactoferrin may not differ.

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**EXERCISE INTENSITIES DIFFERENTIALLY MODIFIES FEEDING BEHAVIOR AND HYPOTHALAMIC NEURON ACTIVITY**

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INTRODUCTION: While hypothalamic neurons role in regulating energy homeostasis is well established, how forced energy expenditure, such as exercise, modulates these neurons and if these neurons are involved in post-exercise feeding behaviors remains unclear. Despite emerging evidence identifying aerobic exercises potent role in modulating the activity of neurons in regulating appetite, these studies produce conflicting results. These discrepancies may be, in part, due to methodological differences, including differences in exercise intensity.

METHODS: We utilized mature, untrained mouse model to investigate the effects of acute sedentary, low- (10 m/min), moderate- (14 m/min), and high (18 m/min)-intensity treadmill exercise in a randomized crossover on food intake and neuronal activity in the hypothalamus. 12-hour-fasted mice were used, and food intake was monitored for 48 hours post-exercise. Immunohistochemical detection of cFOS was performed 1-hour post-exercise to determine changes in hypothalamic NPY/AgRP, POMC, tyrosine hydroxylase (TH), and SIM1-expressing neuron activity concurrent with changes in food intake. Patch-clamp electrophysiology experiments were used to confirm neuronal activation after exercise.

RESULTS: Our results reveal that acute moderate-intensity exercise significantly increased food intake, AgRP/NPY neuron activation, and PVN Sim1 neuron activation while not affecting ARC POMC neurons. Strikingly, this exercise-induced feeding was completely abolished when ARC AgRP/NPY neuron activity was inhibited, while inhibition of ARC AgRP/NPY neurons did not affect PVN Sim1 neuronal activation. Conversely, high-intensity exercise suppressed food intake, which was concurrent with increased anorexigenic POMC neuron activity. Furthermore, tyrosine hydroxylase (TH) and SIM1 neuron activity in the paraventricular nucleus was elevated.

CONCLUSION: Our results demonstrate that moderate-intensity exercise induces ARC AgRP/NPY activation is critical in promoting food intake post-exercise, thus providing insight into the crucial role of ARC AgRP/NPY neurons in maintaining energy homeostasis in cases of exercise-mediated energy deficit. In contrast, high-intensity exercise may be beneficial for suppressing food intake, possibly due to hypothalamic POMC neuron activation and projections to tyrosine hydroxylase (TH) and SIM1 neurons in the paraventricular nucleus.

Overall, our study identifies a novel role of exercise intensity in differentially modifying post-exercise feeding behavior and hypothalamic neuron activity.

## Conventional Print Poster Presentations

### CP-SH01 Social Sciences - Mixed

**HEAR THE BENEFITS: TIME SPENT IN MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY PREDICTS HEARING SENSITIVITY AND SPEECH IN NOISE COMPREHENSION**

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Introduction: It is well-established that adult aging generally brings declines in hearing ability. Although age-related decreases in sensitivity are common, older adults often report difficulty following conversations in noisy environments. Despite decades of interest in understanding why some listeners struggle to understand speech in noise more than others, answers remain elusive. Prior work suggests that communicating in noisy environments requires the upregulation of executive functions. Given the rich literature supporting the benefits of physical activity for executive functions, we hypothesized that spending time in moderate-to-vigorous physical activity (MVPA) would be beneficial for hearing health.

Method: Participants (N=95,259; 55.9% female) in the UK Biobank dataset wore an accelerometer for 7 days and completed questionnaires. Derived accelerometer data came from a machine-learning model classifying movement behaviors as time spent in sleep, sedentary behavior, light physical activity, and MVPA. Participants also answered two questions about their hearing status: "Do you have any difficulty with your hearing?" and "Do you find it difficult to follow a conversation if there is background noise (such as TV, radio, children playing)?" We grouped participants into whether they spent at least 150 minutes (>1.49% of their week) in MVPA or not (i.e., < 1.49% of their week) and transformed their answers into binary variables by only taking participants who responded "yes" or "no". We then ran logistic regressions to determine if spending at least 150 minutes in MVPA decreases the likelihood of reporting a hearing problem or a problem with speech in noise.

Results: Spending at least 150 minutes in MVPA was a significant predictor of hearing outcomes for both questions. Meeting this criterion was associated with a 7.6% reduction in the odds of reporting a hearing problem and a 5.3% reduction in the odds of reporting difficulty with speech in noise.

Discussion: These findings show that meeting the World Health Organization's recommended physical activity guidelines for adults (at least 150 minutes of MVPA per week) is associated with a significantly reduced likelihood of reporting a hearing or speech in noise problem. These findings suggest that physical activity may be a protective factor in age-related hearing loss and speech in noise comprehension decline. The answer to improving adversity with degraded speech may not lie in another product or advancement in technology but rather in the simplicity of a lifestyle change. Targeting physical activity as a non-invasive and low-cost intervention may make the common issue of hearing loss that comes with age less imminent.

**DOES THE IMPACT OF THE PREDICTION ERROR OF RATINGS OF PERCEIVED EXERTION ON RUNNING PLEASURE EVOLVE AS FAMILIARITY WITH THE EXERCISE ROUTE INCREASES?**

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The rise of affectivism led the exercise psychology field to a new era where the experience of pleasure gained more importance in explaining the underlying mechanisms for physical exercise appraisal and adherence. Recent findings showed that the retrospective pleasure of an exercise session is modulated by the mismatch between the ratings of anticipated and experienced levels of perceived exertion, defined as the prediction error of ratings of perceived exertion (RPE). This new marker is based not only on the retrospective ratings of RPE but also on a novel aspect, prospective thinking, that is humans ability to imagine in a future scenario. Two measurement points of RPE assess the prediction error of RPE as the prospective RPE ("What intensity of exertion do you expect to feel during this session?") and the retrospective RPE ( "What intensity of exertion did you feel during this session?"). A positive prediction error of RPE (lower score of retrospective RPE than prospective RPE) is associated with higher pleasure. In contrast, a negative prediction error of RPE (higher score of retrospective RPE than prospective RPE) is linked with lower pleasure ("What intensity of pleasure did you feel during this session?"). Hence, the hedonic value of a physical exercise session can be explained by a better-than-expected experience. To understand the conditions impacting this new marker, therefore, the pleasure in physical exercise, the current research aimed to better characterize the dynamic of the prediction error of RPE as the familiarity with the exercise trail increases. The research question was whether the impact of the prediction error of RPE on pleasure is modulated by the degree of familiarity with a running route. As individuals run on the same trail for 4 times, they might get familiar with the trail across time (run 1,2,3,4), and they are expected to become more accurate in their anticipation of the level of physical exertion. Thus, as familiarity increases across runs, the impact of the prediction error of RPE on running pleasure will decrease. It was hypothesized that (i) the mismatch between prospective and retrospective RPE (i.e., prediction error of RPE) will decrease across the running sessions, and thereby (ii) the impact of the prediction error of RPE on running pleasure will decrease across the repetition of the running sessions. Participants (N = 50) ran four times on the same running trail in a forest near the university campus in Belgium. For the preliminary analyses, a linear mixed model was run. Initial results with the not-yet-complete sample showed a significant difference in the prediction error between run 1 and run 2, and run 1 and run 3. Pleasure did not significantly change across runs. The influence of covariates and how prediction error of RPE affects pleasure and its potential to enhance adherence to physical exercise is discussed in detail.

For all the details, see preregistration (https://osf.io/x5qj).

**EFFECTS OF A CREATIVE DANCE PROGRAM ON CREATIVITY AND WELL-BEING IN ADULTS: A MIXED-METHODS APPROACH**

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INTRODUCTION: Creativity enhances cognitive flexibility, problem-solving, and emotional resilience, while fostering self-expression and reducing stress. However, fitness programs often overlooked the development of motor creativity and expressive practices. This study aimed to evaluate the impact of an 18-week structured Creative Dance program on the well-being and creativity of adults, comparing it to the effects of a music-based fitness program.

METHODS: A longitudinal mixed-methods experimental design was employed. 71 adults (age: 51.5±5.6) were assigned to three groups: (A) Creative Dance, (B) Music-based fitness program, and (C) a Control group with no intervention. The study collected quantitative data using standardized creativity questionnaires: Emotional Creativity Scale (CES) [1], Movement Creative Self-Efficacy Scale (CAS) [2], and Runco Ideation Behavior Scale (RIBS) [3]; a specific motor test of creativity in dance; and qualitative data provided by semi-structured interviews, which were thematically analyzed using NVivo Software.

RESULTS: A linear mixed-effects model was estimated to examine the effects of group (A, B and C) and time (pre-post and retention, assessed three months after the intervention). Significant Group×Time interactions were observed for CES ($F(4,148)=3.78$, $p=.006$), RIBS total ($F(4,136) = 3.78$,$p=.006$), RIBS - Factor 1 ($F(4,136)=3.63$, $p=.008$), and all the components of the specific creativity dance test ($p<.001$). Subsequent post hoc analysis showed a significant increase of Group A in Creative emotional expression in the posttest ($M=146.44$, 24.83 to 268.04, $p<.05$) and a further increase in retention ($M=164.26$, 95%CI = 42.66 to 285.87, $p<.01$); in ideation and idea generation in retention ($M=4.74$, 95%CI = 0.93 to 8.55, $p<.05$); and in all the components of creativity of the specific test ($p<.001$). Group B and Group C showed no significant changes in the posttest or retention, except for a significant decline in RIBS in group C in the retention test ($M=-5.32$, 95%CI = -9.49 to -1.15, $p< .05$), and a slight decrease in variety of movements during retention ($M=-0.48$, 95%CI = -0.88 to -0.08, $p<.05$) and aesthetic interest ($M = -0.64$, 95%CI = -1.05 to -0.23, $p < .01$) in the specific test.

Considering the qualitative analysis, participants highlighted motivation and adherence, emphasizing group cohesion and the facilitator's role. Group A reported improved coordination, fluency, and self-expression, while Group B noted gains in strength, endurance, and routine adherence.

CONCLUSION: The Creative Dance Program significantly improved creative self-efficacy, ideation, dance creativity, and overall well-being, surpassing the benefits of traditional exercise. These findings underscore the importance of integrating creativity into physical activity to support psychological and motor development in middle-aged adults.

[1] Soroa et al., Creat Res J, 2015

[2] Elisondo, J Creat Behav, 2021

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**QUANTIFYING DECISION MAKING BIAS OF MAJOR LEAGUE BASEBALL HOME PLATE UMPIRE USING A PSYCHOPHYSICAL MATHEMATICAL MODEL.**

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INTRODUCTION:

Home plate umpires strike and ball calls significantly influence baseball game outcomes. Prior research has demonstrated biases in Major League Baseball (MLB) umpires' decision-making (1). Quantifying these biases provides strategic advantages for teams and players. For instance, if strike zone width varies by umpire, understanding these tendencies allows for tactical adjustments. Similarly, if umpire decisions are influenced by catchers, it may reflect framing techniques. This study quantified MLB umpire biases in relation to individual umpires and catchers using a psychophysical mathematical model.

METHODS:

This study analyzed 7,008,208 pitches recorded by MLB Statcast from official games played between 2015 and 2024. From this dataset, we extracted 115,673 fastballs thrown by right-handed pitchers to right-handed batters, where the pitch height was clearly within the strike zone (1 ft < plate_z < 2 ft), the horizontal position at the front of home plate (plate_x) was on the outer edge (plate_x > 0 ft), and the batter did not swing. We applied probit regression with a binary dependent variable (1 for a called ball, 0 for a called strike) and plate_x as the independent variable to estimate a psychophysical sigmoid function. The plate_x position at which the probability of a ball or strike call was 0.5, termed the strike zone boundary, served as an indicator of umpire bias. We calculated strike zone boundaries separately for umpires and catchers with a minimum sample size of 200 calls per individual.

RESULTS:

On average, the estimated strike zone boundary was 3.38 cm outside the home plate, deviating from the official strike zone definition. The strike zone boundary varied by umpire by up to 3.51 cm and by catcher by up to 4.39 cm.

CONCLUSION:

Probit regression analysis quantified biases in MLB home plate umpires' decision-making, revealing significant variations across umpires and catchers. By identifying umpire-specific strike zone boundaries, pitchers can refine their pitch distribution strategies, and batters can adjust their approach at the plate. Similarly, catcher-specific strike zone boundaries may inform managerial assessments of framing skills. These findings offer valuable insights for making better catcher selection and refining pitcher and batter strategies.

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**THE ASSOCIATION BETWEEN EARLY MOTOR DEVELOPMENTAL MILESTONE ATTAINMENT AND CONFLICT MONITORING IN PREADOLESCENT CHILDREN.**

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Early motor developmental milestone (MDM) attainment provides key insights into neurodevelopment, offering potential markers for identifying children at-risk for developmental delays and related disorders. Understanding how MDMs shape developmental trajectories across domains can inform predictive models, early interventions, and preventative strategies. While prior research links earlier MDM attainment to improved physical and mental health 7 to 10 years later, its association with neurocognitive function remains unexplored. Extending this framework, we examined whether early MDM timing predicts brain function during preadolescence. Guardians of 97 children (ages 9–11 years, 49.5% female) retrospectively reported the age (months) at which their child attained five MDMs: (1) holding the head unsupported, (2) rolling over, (3) sitting unsupported, (4) standing, and (5) walking independently. Children completed a modified flanker task while event-related potentials (ERPs) and task performance were recorded. Error-related negativity (ERN; 0-150ms post-error at FCz) and post-error positivity (Pe; 200-600ms post-error at CPz) were measured from commission error trials. Data were analyzed using multiple stepwise linear regressions, adjusting for demographic factors in Step 1, and included each MDM in separate models as independent variables in Step 2. Our findings indicate earlier MDM attainment predicts neuroelectric markers of conflict monitoring during preadolescence. Specifically, for the ERN, earlier attainment of holding the head up

(ΔR2 = .05, F(2, 94) = 4.65, p = .012) and walking independently (ΔR2 = .04, F(2, 94) = 4.4, p = .015) predicted larger ERN amplitude (i.e., more negative), a neural signal indicating the evaluation of conflict engendered by erroneous behavior (head up; pr = -.23, t(94) = -2.24, p = .028, ß = -.22; walking: pr = -.21, t(94) = -2.13, p = .036, ß = -.21). Additionally, earlier attainment of sitting unsupported predicted larger Pe amplitude (i.e., more positive), associated with conscious error detection (ΔR2 = .04, F(1, 95) = 4.65, p = .038, pr = -.21, t(95) = -2.1, p = .038, ß = -.21). MDMs reflect the integration of multiple physiological systems, with postural control (e.g., head up, sitting) and locomotion (e.g., walking) requiring sensorimotor coordination, balance, and engagement of neural structures involved in both motor and cognitive control, such as the anterior cingulate cortex. This study builds on prior research by demonstrating that the timing of MDM attainment is associated with neural markers of conflict monitoring in preadolescence. These findings suggest that earlier MDM attainment may reflect more efficient neural pathways for integrating sensory feedback, motor control, and error monitoring. As such, early MDMs may serve as indicators of future conflict monitoring abilities, offering a potential avenue for early identification of children at risk for cognitive or self-regulation difficulties.

**THE EFFECT OF EXERCISE INTENSITY AND DURATION ON CHANGES IN AFFECTIVE VALENCE DURING EXERCISE**

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INTRODUCTION: Affective responses during exercise have been proposed to influence physical activity adherence. While many studies have demonstrated that exercise intensity impacts the change in affective valence during exercise, the role of exercise duration is unclear. Thus, the present study aimed to examine whether exercise duration influences the change in affective valence during exercise.

METHODS: Twenty-six inactive adults (12 men, 14 women; 29±9 y; 23.71±4.1 kg/m²;32 ± 7.36 ml/min/kg) completed VO2max and ventilatory threshold (VT) tests before three experimental cycling sessions: (1) 10 min at 110% VT, (2) 10 min at 80% VT, and (3) 30 min at 80% VT. Affective valence (Feeling Scale), felt arousal (Felt Arousal Scale; FAS), and rate of perceived exertion (RPE) were recorded at baseline, at the end of the warm-up (5min at 80%VT1), and every 2.5 min during exercise.

RESULTS: Mean affective valence increased during the warm-up for each condition, but subsequently dropped during exercise at 110% VT (-1.15±2.84), increased during 10 min of exercise at 80% VT (0.88±2.25), and remained steady during 30 min at 80% VT (-0.15±2.63). Change from the end of the warm-up did not differ significantly between 10 min and 30 min at 80% VT, though the 10 min condition showed a slightly more positive change (0.92 vs. -0.04). Individual variability remained high (SD = 2.189–2.661). Statistical analyses were conducted using repeated measures ANOVA, as normality assumptions were met. Post hoc comparisons were performed using paired-samples t-tests. The significance level was set at $p < 0.05$. A significant main effect of condition was found ($p = 0.008$). Post hoc analysis revealed a significant difference between 10 min at 80% VT and 10 min at 110% VT ($p = 0.009$, $d = 0.64$), with the latter inducing a greater negative change. The effect size for the difference between 10 min at 80% VT and 30 min at 80% VT was $d = 0.37$, suggesting a small difference. RPE increased with both intensity and duration. Post hoc tests confirmed that 110% VT induced greater exertion than 80% VT, and 30 min at 80% VT resulted in higher RPE than 10 min at 80% VT. FAS increased over time but was unaffected by intensity or duration, suggesting a consistent pattern across conditions.

CONCLUSION: The results of this study support that exercise intensity is a key moderator of the affective responses to exercise. Exercise duration did not significantly moderate affective responses, but responses varied considerably between participants, and there is a need for further studies to explain this large inter-individual variability in response. These results have implications for exercise prescription to insufficiently active individuals as affective responses have been hypothesised to influence exercise enjoyment, and subsequently exercise uptake and adherence. Our findings suggest that exercise intensity is more important in determining affective responses than exercise duration.

**WHAT DO PHYSICAL EDUCATION TEACHERS NEED IN IN-SERVICE TRAININGS ON THE USE OF DIGITAL MEDIA? A CROSS-SECTIONAL STUDY**

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Introduction:

Digitalization leads to an increased use of digital media (DM) in education. Especially in physical education (PE), which is characterized by special physical and spatial-material conditions, teachers face challenges due to DM and need special digital skills. In order to develop and maintain digital skills, in-service teacher training is a suitable format. Therefore, to address PE teachers perspectives, the aim of the study is 1) to determine PE teachers needs and preferences regarding content and formats of in-service training on the use of DM in PE, and 2) to determine differences between subgroups of PE teachers.

Methods:

The study consists of a cross-sectional online survey with German PE teachers in June 2024. 128 teachers (gender: f=62, m=66; age: M=42.96 years, SD=10.02 years) participated in the questionnaire. Besides demographic information, teachers were asked about their participation in in-service trainings and their preferences regarding content and formats. Descriptive analyses were run to identify teachers preferences, and chi-square tests to compare the preferences of subgroups (gender, age, school-type).

Results:

60% of the teachers participated in in-service trainings in the last two years, of which 19% have attended trainings on the use of DM in PE. 80% of the teachers would like to take part in (further) trainings on the use of DM in PE. Regarding the content, the results indicate a high demand (>75%) for trainings on movement analysis (93%), exercise instructions (83%) and interactive teaching and learning platforms (75%). A medium demand (>50%) exists for general DM education in PE (66%), DM as presentation technique (54%), DM-supported grading (54%), AI-supported recording of the body and movements (53%) and lesson analysis with DM (52%). Regarding the format, PE teachers tend to prefer synchronous training courses lasting between 2-4 hours during working hours. Differences in training content and format appear regarding the age group: Younger teachers have, compared to older teachers, a significant higher need in topics as diversity and inclusion with DM (85.5% vs. 10.8%), reflection on DM (48.4% vs. 18.2%) and body images on social media (64.5% vs. 21.6%). Moreover, more younger teachers prefer online programmes then older teachers (83.9% vs. 29.7%).

Discussion:

Although only 19% of the PE teachers attended in-service training on the use of DM in PE, 80% would like to attend (further) training in future. This suggests that existing trainings may not be sufficiently geared to teachers needs and preferences. Future trainings should therefore especially include content with high and medium demand in needed formats (short trainings online or face-to-face). The results of this study are relevant for successfully disseminating teacher education research to the target group (i.e. in-service teachers). Taking the needs and preferences into account can help to ensure the acceptance of in-service trainings.

**PERCEPTIONS OF SPORTS SCIENCE STUDENTS ON THE EDUCATIONAL OFFER IN ITALY: IMPLICATIONS FOR THE PROFESSION OF KINESIOLOGIST**

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INTRODUCTION: Starting from January 1, 2025, the National Statistical Institute (NSI) in Italy introduced the ATECO code 86.96.01, relating to the new economic activity of Kinesiology, aligned with NACE Rev. 2.1 of Eurostat (2023). This activity is carried out by the Kinesiologist, a graduate in Sports Sciences, as established by Article 32 of Legislative Decree no. 36/2021. Since no previous studies have addressed the expected impact of this new profession, the aim of this study was to measure the opinions of members of the Italian Committee of Motor Sciences (CISM), university students, and graduates in Sports Sciences.

METHODS: The sample consisted of 6.020 students from 35 Italian universities, with the data presented in frequencies and percentages. The method used was the administration of an anonymous questionnaire containing 8 specific questions, aimed at gathering opinions on general, specific, and applied university education. Descriptive statistics were used to present the data, while the Chi-Square test was applied to investigate relationships between variables. Data were analyzed using SPSS 28.0.

RESULTS: The results showed that the perception of the quality of the technical-practical offer did not significantly vary between different universities ($\chi^2 = 0.767$, $p = 0.999$), indicating a homogeneous evaluation across universities. However, the level of study influenced satisfaction, with undergraduate students reporting more dissatisfaction compared to post-graduate students ($\chi^2 = 27.54$, $p = 0.000$). Furthermore, students with Erasmus experience rated foreign education as significantly superior to Italian training ($\chi^2 = 5111.58$, $p < 0.001$). Overall, more than 50% of students (52.6%) expressed satisfaction below expectations regarding technical-practical training, with only 14.8% being very satisfied and just 2.7% "truly satisfied."

CONCLUSIONS: The data indicate significant dissatisfaction with the technical-practical training offer, with more than half of the students providing a negative evaluation. This suggests the need for targeted interventions to improve the quality of education, particularly in the practical and applied aspects of Sports Science degree programs. Students, in fact, express the need for updates and reforms in the curriculum to adequately prepare for a rapidly evolving profession like that of the Kinesiologist.

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**AEROBIC CAPACITY IS ASSOCIATED WITH WELL-BEING, SCHOOL-RELATED MOTIVATION AND MATH PERFORMANCE IN PRE-ADOLESCENT CHILDREN. A CROSS-SECTIONAL STUDY FROM THE ACTIVE SCHOOL PROJECT**

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Introduction

Aerobic capacity has been shown to be associated with academic performance in children, and research has shown that school-based physical activities are related to children's health-related quality of life. Relations between aerobic capacity and motivation have also been shown. We hypothesize that aerobic capacity is associated not only with academic performance but also with well-being, school-related motivation, and cognitive performance when measured in pre-adolescents.

Methods

The present study is based on data from 1145 pre-adolescents (9-11 years). Measures of school-related motivation and well-being were assessed using SRQ-A and Kidsscreen-27 questionnaires. Aerobic capacity was measured as estimated aerobic fitness by the Andersen test, a 10-minute intermittent running test. Academic performance was assessed using the Hogrefe MAT2 test.

Mixed linear regression analysis was used to estimate the cross-sectional associations between aerobic fitness and school motivation, aerobic fitness and well-being, aerobic capacity and academic performance and adjusted for (fixed effects) sex, bilingualism, and BMI (random effects) school.

Results

The results show associations between aerobic capacity and academic performance in maths (β: 1.27; CI95: 0.75-1.79; p<0.001). We found a significant association between aerobic capacity and overall motivation (β: 0.24; CI95: 0.13-0.35; p<0.001) as well as an association between aerobic capacity and overall well-being (β: 0.45; CI95: 0.29-0.61; p< 0.001). Aerobic capacity is associated with sub-categories of both school-related motivation and well-being (p<0.005).

Discussion

The present study shows that aerobic capacity is not only associated with academic performance but also with well-being and school-related motivation in pre-adolescents. With higher aerobic capacity, pre-adolescents demonstrate higher scores in maths performance, better well-being and higher school-related motivation. Our results are supported by previous studies showing associations between aerobic capacity and academic performance and relations between aerobic capacity and well-being and motivation. Effect studies are needed to investigate how physical activity and aerobic capacity changes affect well-being, school-related motivation and academic performance.

Conclusion

On the background of the results from our study, supported by previous research, we conclude that children with a higher aerobic capacity is associated with higher academic performance in math, school-related motivation, and well-being.

Our results provide further evidence for investigating possible interrelations between aerobic capacity, well-being, motivation, and academic performance in children. We also conclude that effect studies are needed to investigate the effects of physical activity and aerobic capacity on well-being, school-related motivation, and academic achievement.

**A STUDY ON CONSUMER BEHAVIOR TOWARD ESPORTS EXHIBITIONS: FROM THE PERSPECTIVE OF S-O-R FRAMEWORK**

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INTRODUCTION: This study investigates how impulsive buying behavior in the context of esports is affected by psychological and behavioral perspectives in consumer behavior. According to the Stimulus-Organism-Response (S-O-R) framework, this study investigates the influence of brand awareness (stimulus) on impulsive buying behavior (response) mediated by perceived social support and perceived sponsorship fit (organism). This study provides insights on how the constructs relate to one another and provides an understanding of how purchasing decisions are shaped in this unique market.

METHODS: A purposive sampling method was utilized distributing 304 questionnaires to participants who participated in esport exhibition in Taipei, after the deletion of invalid data, 245 valid data was analyzed. Structural Equation Modeling (SEM) was analyzed using Smart PLS 4 to test confirmatory factor analysis (CFA), reliability, validity and the hypothesized relationships among brand awareness, perceived social support, sponsorship fit, and impulsive buying behavior. Descriptive analysis was analyzed using SPSS for Windows.

RESULTS: In this study, more than 80% of the participants were males and the median age of the participants were 28.89 years old. 29.4% of the participants who attended the esports exhibition were students, 17.1% of the participants work in the service industry where 12.2% of the participants occupation were in labor industry. The findings showed that brand awareness significantly affects perceived social support and perceived sponsorship fit positively. In addition, both perceived social support and perceived sponsorship fit impacts impulsive buying behavior positively. This study also found that perceived social support and perceived sponsorship fit mediated the relationship between brand awareness and impulsive buying behavior positively. The overall model showed good fit confirming food validity of the pathways.

Discussion: This study provides insights into how psychological factors in consumer behavior play a critical role in esports. Brand awareness can be seen as a powerful stimulus, which is influential in both emotional and cognitive perceptions, which in turn drives impulsive buying behavior among consumers. On the other hand, perceived sponsorship fit increases the perceived credibility and support between esports exhibition and brands, while perceived social support strengthens the emotional engagement of consumers. These findings provide strategies for marketers who are willing to improve sponsorship strategies and for researchers seeking to extend the understanding of consumer behavior in the context of digital and gaming world.

Conventional Print Poster Presentations

CP-SH09 Physical Education I

**PHYSICAL EDUCATION AND TRANSVERSAL SKILLS. PRELIMINARY INSIGHTS FROM THE "CO-PRO BPS" PROJECT**

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This study presents preliminary findings of the "Co-Designing Learning Environments from a Bio-Psycho-Social Perspective", a project aimed to identification of teachers' needs and Co-Construction of an Instructional and Digital Design Model" and to implement effective and meaningful learning environment in primary school according to non-linear pedagogy principles.

Considering the new professional profile of primary school Physical Education teachers in Italy, the project aims to foster co-planning competencies between both the generalist and PE teachers, and promote

the body's mediating function in learning processes through the development of web app demo.

The project's main goals are defined as follows:

• promote innovation in education enhancing the embodied dimension of learning;

• improve teaching practices by identifying real criticalities/threats and strengths/opportunities that affect the implementation of co-education processes and the design of innovative learning environments;

• set a co-construction process for educational design tools;

• develop a platform Web App for the co-educational design model that meets the needs identified by research and training.

This preliminary study involves 230 (primary school teachers aged 30-60 years mainly from Southern Italy. Teachers were asked to complete a self-constructed survey about co-planning behaviors, focusing on the following areas: teacher's training and years of service, self-perceived co-planning competence, individual co-planning and co-design behaviors in school setting.

One of the main problems that emerged was the lack of collaboration between teachers and other professionals for co-educational planning. This was identified as one of the main obstacles to realizing effective educational pathways. The most commonly reported difficulties concern the planning of multidisciplinary objectives and the personalization of learning according to students needs. This suggests that teachers require more effective tools and methodologies to address these challenges.

Despite the strong interest in innovative methodologies and strategies, the responses indicate that the integration of technologies in teaching is still uneven. Some teachers report difficulties in selecting appropriate assessment and testing tools.

Many participants feel that opportunities for professional development are limited, a factor that may adversely affect their ability to innovate and collaborate effectively.

The majority expressed a strong interest in tools that facilitate the co-design and sharing of teaching strategies and assessment tools. This suggests that a web app demo with these functionalities could meet the prioritized needs.

**A STUDY ON DEVELOPMENT OF INCLUSIVITY IN SOCIETY THROUGH "GUIDE RUNNING" FOR JAPANESE JUNIOR HIGH SCHOOL STUDENT**

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The guide discussed in this study is a specific method for the competitions with visually impaired athletes in Paralympics, in which the guides directly assist athletes to run by holding a guide rope with the athlete, so as to ensure their smooth participation of the competitions.

Yabe (2004) states that "a rope is a means to remove the barrier between people with impairments and those without, and can be a bond as a symbol of inclusion". It could be therefore considered that guide running may have an underlying concept of leading to help to build an inclusive society.

This study aimed to understand from the study-notes of the students what they have learnt through the guide running practice. In order to conduct that, the junior high schools whose education curriculum includes the "guide running practice", (three hours of "Physical Education Theory" and six hours of "Track and Field - Short Distance Running") were selected for this study. Also, based on the descriptions by the students, presenting ways of potential management of their future classes became another purpose of this study.

The subjects were 10 junior high school students who had permission to participate in this study from their teachers. It was inferred that, through this study with guide running, the students recognised the factors such as "mutual understanding," "cooperative relationships," and "empathy". Besides, they were also aware of having a wider view for "inclusive perspective", "value of sports" and "sports culture" according to the hints by their teachers such as "adjusting the rules to the situations", "regardless of whether people have an impairment or not" and so on.

Also, it was inferred that "learning content" on the education curriculum for this study may have given the students the perspective which is necessary to seek the inclusive society such as "importance of communication", "building relationship" and "multiple way of involvements".

From the above, learning through guide running has created an understanding, which may also be common with the idea of adapted sports, of what kind of considerations would be required in order to allow every single person to participate in sports. At the same time, the students as subjects of this study, were given the opportunity to have a perception of inclusivity, which is free from gender bias, having disabilities or not, age and racial difference etc.

To practice guide running, it is necessary to hold a rope, called a "tether", tightly to synchronise the movement of running. This restricted arrangement where free movement is limited, could probably trigger students to have a proactive attitude and to consider the importance of communications and relationship-building. Furthermore, the combination of physical education theory and the experience of learning guide running was effective in terms of the class management.

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**IMPACT OF THROWING INTERVENTIONS ON SKILL DEVELOPMENT AND MOTOR VARIABILITY IN PRESCHOOLERS**

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This study aimed to investigate the effects of constant interventions incorporating play experiences that include throwing motions—activities rarely encountered in everyday play—on throwing techniques, abilities, and movement diversity during free play among preschool children. The participants were 21 children (11 boys and 10 girls) enrolled in a preschool class for 5-year-olds. The intervention consisted of a cycle combining a one-week intervention period conducted twice weekly with a subsequent two-week period without intervention. This cycle was repeated three times consecutively. Movement diversity during free play was observed in the preschool yard for approximately one hour twice a week throughout the study period. These sessions were recorded using two video cameras placed on a terrace of second floor. The number of different movements and their frequencies were analyzed.

To assess throwing performance, participants performed maximum-effort overhand throws both before the intervention and after each cycle's post-intervention period. Throwing motions were captured using motion sensors attached to eight points on the body (pelvis, lower spine, upper spine, upper arms [right or left], forearms, and hand [right or left]) and recorded from the side with a high-speed camera. The diversity of movements and their frequencies (sex × movements system × period) were analyzed using repeated-measures ANOVA to compare mean differences. Throwing distance and specific measurements of throwing motions were evaluated using two-way ANOVA (sex × measurement point). A significance level of 5% was applied to all analyses. The intervention resulted in: 1) an increase in both the variety and the frequency of ball-manipulative movements, including throwing motions, during free play for both boys and girls; 2) improved overhand throwing ability in both boys and girls; 3) increased ball release speed for both boys and girls; 4) enhanced movement speed of the lower spine, upper arms, and forearms during throwing motions in boys; and 5) improved movement speed of the upper arms, forearms, and hands during throwing motions in girls. However, when the intervention involved group play with a single ball, it did not lead to an increase in individual throwing frequency. In conclusion, constant interventions that incorporate throwing experiences—rarely encountered in typical play—led to an increase in both the variety and frequency of ball-manipulative movements during free play for both boys and girls. Additionally, it improved lower back and arm movement speed during throwing in boys, arm movement speed in girls, and overall overhand throwing ability.

**WILDERNESS-BASED OUTDOOR EDUCATION IN JAPANESE UNIVERSITIES: LEARNING PROCESSES AND THEIR POTENTIAL FROM A PHYSICAL EDUCATION AND PEDAGOGICAL PERSPECTIVE.**

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INTRODUCTION: Physical education in Japan have traditionally emphasized skill development in competitive sports and physical activities. However, in recent years, the importance of comprehensive learning through physical activity has been increasingly recognized. Given this shift, Japanese physical education faces challenges in ensuring sufficient opportunities for structured reflection and engagement in the learning process.This study introduces a case study of wilderness-based outdoor education in a Japanese university and examines its learning processes and potential from a physical education and pedagogical perspective.

METHODS: This study examined a wilderness-based outdoor education program conducted in an undeveloped private natural area. The two-night, three-day program involved three first-year students from a sports-related faculty.

Structured around three key themes—Collaboration with others (role allocation and communication), Self-reflection (experience review and growth recognition), and Engagement with the local community (understanding the local community)—the program also emphasized appreciating and respecting the natural environment as an assigned challenge.

Core activities included campsite construction, environmental conservation, outdoor cooking, and hiking. Students conducted daily self-assessments using a customized reflection sheet, with post-program surveys and interviews conducted afterward.

RESULTS: In the reflections on the program, students noted that they had learning experiences that were not available in regular classes and that they recognized the importance of collaboration by thinking and acting independently. These findings suggest that the program provided a unique learning opportunity. Additionally, some students mentioned that being in an environment with limited resources made them aware of the need to consider not only immediate tasks but also future actions. This indicates an increased recognition of adaptability and the importance of strategic planning. In this presentation, we will also report on the detailed analysis, including insights from the interviews.

DISCUSSION: This study highlights the potential of wilderness-based outdoor education, which integrates physical activity with the learning process, as an alternative to traditional physical and sports education. Compared to competitive sports, outdoor education is well-suited for fostering collaboration and environmental adaptability, presenting a valuable direction for the future of physical education. Additionally, from a disaster preparedness perspective, learning in a wilderness environment may enhance decision-making skills and survival capabilities. Moving forward, it is necessary to examine the long-term educational effects and explore further developments, including its integration with disaster education.

**FRONTIER LITERATURE ANALYSIS OF SPORTS COGNITION PHENOMENOLOGY BASED ON VOSVIEWER**

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With the continuous refinement of sports science research, the integration and cross-disciplinary development of sports science with other fields has become a trend. Since the 21st century, there has been an explosive growth in research related to the phenomenology of sports cognition.Currently, there remains significant room for development in the study of the phenomenology of sports cognition. Analyzing the main content, current characteristics, and development trends of research in this area can provide a theoretical foundation for sports science to break down academic barriers and integrate with other disciplines. This, in turn, can promote the refinement of the disciplinary framework of sports science.This study utilizes the CNKI database and the Phenomenology and the Cognitive Sciences database as data sources. Employing research methods such as scientific knowledge mapping, it analyzes 226 relevant publications on the phenomenology of sports cognition from 1983 to 2024, focusing on publication volume, trends, journal distribution, and cited papers. Additionally, the study uses VOSviewer 1.6.20 software to conduct a visual analysis of keywords and other information from the selected literature. By combining co-occurrence density maps and disciplinary clustering knowledge graphs, the study draws relevant conclusions.The results indicate the following: (1) Research on the phenomenology of sports cognition is generally on an upward trend and is currently in a phase of rapid development. (2) The distribution of publications is broad, with 226 articles originating from over 80 journals and books, covering diverse fields such as education, medicine, philosophy, and history. (3) Current research primarily focuses on themes such as embodied cognition, sports psychology, physical education, and competitive sports, with a wide scope of investigation.Based on the above analysis, the following prospects for the development of the phenomenology of sports cognition are proposed: strengthening foundational theoretical research, enhancing interdisciplinary research collaboration, applying advanced technological achievements, broadening practical application studies, and cultivating interdisciplinary talent.

**EXTRACURRICULAR PHYSICAL AND SPORTS EDUCATION, COGNITIVE AND MOTOR SKILLS IN PRIMARY SCHOOL**

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Introduction: Physical education in primary school should be promoted in a way that encompasses different dimensions to ensure a balanced and optimal development of the pupil. The National Curriculum Guidelines for primary school clearly highlight the approach of education through movement, whereas the concept of education for movement is less evident. In particular, the aspect of skills-related fitness is not adequately considered, and as a result, fitness is not linked to the acquisition of cognitive abilities. Scientific evidence from recent years has shown a deficiency in physical activity in terms of motor literacy, as the curricular physical education activities alone are insufficient in quantitative terms to achieve these objectives. The aim of this study is to adopt specific physical education protocols to supplement the morning curricular activities for Year 4 and Year 5 classes in primary school, where a specialist Physical Education teacher is present. The goal is to reduce gaps in motor literacy and skills-related fitness, thereby fostering the overall development of children. Methods: The sample consists of 21 children from Year 4 and Year 5 at the Comprehensive Institute of Centola, Speranza-Lettieri, in the Rofrano (Sa) school complex. They participated in an extracurricular motor education project of 30 hours over the course of two months, conducted in the afternoon. The activities included moderately intense multitasking exercises that required coordinated movements and problem-solving skills. Subsequently, a specially designed questionnaire was administered to assess the children's motor habits, lifestyle, perception, and awareness of physical education, as well as their preferences and level of engagement during lessons. Results: Applying the paired-sample T-test, the training protocol led to improvements between pre- and post-tests. The Flamingo Balance Test showed an average percentage increase of 2.12%, with P= .0000023. The Shuttle Run Test (4x10 metres) demonstrated an average percentage increase of 1.50%, with P= .00000059. The Throw and Catch Test recorded an average percentage increase of 8.33%, with P=.000014. The Jumping Side-to-Side Test showed an average percentage increase of 3.59%, with P= .0000057. The analysis of the Chi-square test revealed significant relationships between qualitative variables. Discussion & Conclusion: The physical education protocols used proved to be effective in enhancing the pupils motor skills. The children demonstrated improvements not only in their abilities but also in their perception and awareness of the importance of physical activity.

**VISUAL-SPATIAL WORKING MEMORY AND GROSS-MOTOR DEVELOPMENT:**

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Introduction: Physical exercise represents a natural and productive opportunity for both physical and cognitive development. The benefits of Physical Activity (PA) contribute to improving physical health and cognitive functioning, particularly Executive Functions (EF; Erickson et al., 2019; Pontifex et al., 2019), identified as inhibitory control, working memory and cognitive flexibility (Diamond et al., 2016). Executive functions are crucial for childrens learning abilities (Diamond, 2020) and academic performance: in particular, visuospatial working memory (VSWM) is strongly correlated with performance in subjects such as mathematics, English as a Foreign Language and science (St Clair-Thompson & Gathercole, 2006).

Motor skills influence executive function, and improving motor skills is a practical and effective method to promote the development of executive function (Furley et al. 2023; Xinyue; 2024; Houwen, 2017). Indeed, scientific literature supports the effectiveness of physical exercise, particularly moderate to vigorous aerobic exercise and motor programs in improving childrens EF (Haapala, 2013; Hillman, Buck, 2009; Tomporowski, 2008).

In light of this evidence, the present study aims to investigate the relation between visuospatial working memory and Gross Motor Skills in primary school.

Methods: This descriptive study involves 107 children aged 8-10 years old, with mean age of 9.39 (± 0.54), 46,7% of girls and 53,3% of boys, all from primary school. The children were assessed using the Italian version of Test of Gross Motor Development (TGMD3; Ulrich, D'Anna et al., 2023) and the Test for visuospatial attention and visual working memory assessment (BVS-CORSI-2; Mammarella et al. 2023).

Results: All data analyses were performed with the statistical program SPSS 23. The results indicated a moderate positive correlation (Pearson) between gross motor index and visuospatial attention and visual working memory (VSWM): $r = 0.46$, $p < 0.001$ between Corsi Forward test and Gross Motor Index, and $r = 0.40$, $p < 0.001$ between Corsi Backward test and Gross Motor Index.

Discussions: The results of this study suggest that there is a positive correlation between gross motor development and working memory, in young children. One of the strengths of this study was the analysis of the relationship between visual-spatial working memory and motor skills. Given the small number of studies available in the literature, future research with large representative samples is needed to explore other cognitive domains (e.g., executive function and intelligence). Additionally, future research should progressively reach higher levels of challenges, by finding more complex forms of exercise involving both motor and cognitive tasks.

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**THE EFFECT OF PARTICIPATION IN EXTRACURRICULAR SPORTS ON MOTOR PROFICIENCY AND PROBLEMATIC INTERNET USE RISKS IN ADOLESCENTS FROM LATVIA AND INDONESIA**

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INTRODUCTION: The issue of problematic internet usage (PIU) among adolescents is becoming increasingly prevalent. PIU is defined by excessive online engagement that disrupts daily activities and results in suboptimal learning outcomes. The habit of spending extended periods of time online leads to sedentary lifestyle. The aim of this study was to explore the effects of participation in extracurricular sports on problematic internet use and motor proficiency in adolescents from Latvia and Indonesia.

Method: This research had a cross-sectional study design. The study was conducted at public schools in Riga (Latvia), and Jakarta (Indonesia). The study comprised 257 adolescents (mean age 13.57 SD = 0.86 including 57 (mean age 13.42, SD= 0.625) from Latvia (LV) and 200 (mean age 13.61, SD = 0.918) from Indonesia (IND). From the participants (54.5%) engaged in extracurricular sports (ES). The Problematic and Risky Internet Use Screening Scale (PRIUSS) and Bruininks-Oseretsky Test of Motor Proficiency, 2nd ed. (BOT2) was used to assess problematic internet use (PIU) and motor proficiency (MP) , accordingly. Statistical analysis in this study used descriptive statistic, Spearmans rho correlation and General Linier Model (GLM)

Result

The average mean of MP scores were significantly different between the two countries (p=.046) with 95% CI. Extracurricular sports significant differences was identified between mean scores of INA ES and LV ES (p= .047) compared to NS, where Indonesia's score of 122,18 (SD=13.99) had a significantly higher score than LV ES 121,24 (SD=15.29) with a significant main effect was shown for Indonesia ($F = 4.713 < 0.05$). $\eta p2$ 0.018). There was significant differences in mean scores of PIU between Indonesia-Latvia subgroups (p= .039). IND ES = 8.73 (SD= 11.199) with 95% CI was lower than mean LV ES 24.69 SD 8.01with 95% CI. After analyzing all the variables, no significant corelation was observed between PIU and MP total scores in both countries rs -216 (Weak). Findings indicated weak correlation between PIU and MP for Indonesia = IND NS rs=-0.17 (Very Weak); LV ES: rs = -0.321 (Weak).

CONCLUSION: The results showed that adolescents involved in ES showed significantly higher average ability compared to NS adolescents. This was in contrast to Participation in ES showed lower average PIU compared to NS. Hence, it can be concluded that involvement in extracurricular sports can improve motor skills and reduce the impact of PIU in adolescents. Further research is needed with a larger sample size to ensure the data obtained more accurately reflects the sample, as well as a more comprehensive examination of the factors that influence similar outcomes.

**LEARNING THROUGH MOVEMENT: EMBODIED APPROACHES IN EDUCATION - A SCOPING REVIEW**

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INTRODUCTION: Embodied learning has emerged as a pedagogical approach that integrates physical activity, cognition, and environmental interactions to enhance education. Rooted in phenomenology and embodied cognition theories, this approach challenges traditional mind-body dualisms and fosters inclusive, multidisciplinary learning experiences. This scoping review aims to explore how embodied learning contributes to education in school settings.

METHODS: Following the Joanna Briggs Institute guidelines and PRISMA checklist, a comprehensive literature search was conducted between January and November 2024, including empirical studies on embodied learning within physical education settings. Studies were screened using predefined inclusion criteria, and thematic analysis was applied to identify key themes. The quality of studies was assessed using the Mixed Methods Appraisal Tool.

RESULTS: A total of 22 studies were selected and 3 core themes were identified: Physical Literacy, Embodied Identity, Multidisciplinarity. Results highlighted how movement-based learning identifies physical movement as essential to cognition, enhancing comprehension, particularly in STEM subjects. Sensory experience plays a crucial role, as cognition emerges from the integration of visual, auditory, kinesthetic, and tactile inputs. The alignment between movement and learning tasks influences retention, with greater bodily engagement leading to stronger outcomes. Exploration and body awareness further enrich learning by fostering self-awareness and meaning making. Playfulness and enjoyment enhance motivation, making learning more engaging. Embodied learning also extends into digital environments, where immersive technologies support sensorimotor interaction. Additionally, it supports cross-disciplinary connections by grounding abstract concepts in concrete experiences. The concreteness fading process further reinforces this approach, gradually guiding learners from physical interaction to abstract reasoning, enhancing knowledge transfer.

Discussion: Embodied learning offers a transformative framework for education by bridging physical activity with cognitive and social development. It challenges normative constructs of ability and fosters inclusive practices that meet diverse student needs. The integration of digital tools, such as virtual reality and motion-based gaming, represents an emerging frontier with potential applications in education. Despite its benefits, challenges in implementation, resource allocation, and curriculum integration remain.

CONCLUSION: This review underscores the potential of embodied learning to enrich education by fostering holistic, student-centred pedagogies. Further research is needed to address methodological constraints, explore long-term impacts, and enhance the scalability of embodied learning interventions in diverse educational and cultural settings.

**ACADEMICALLY HIGH ACHIEVING STUDENT'S (AHAS) SELF-PERCEIVED ATHLETIC COMPETENCE AND SELF-REPORTED PHYSICAL ACTIVITY**

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This study examines self-perceived athletic competence and physical activity levels among academically high-achieving students (AHAS) in Sweden. Gifted and high-achieving students can face negative stereotypes about their physical abilities and tend to have lower confidence in this domain compared to academic skills. Beliefs about physical competence can influence participation in physical activities throughout childhood and adolescence.

Survey data were collected from students (N= 326) in Swedish upper secondary schools (ages 16-18). Academic achievement was measured with student's self-reported grades in one Mathematics-, one English and one Swedish course. Athletic competence was measured with the Perceived Athletic Competence subscale of the Harter's (2012) Self-perception profile [1] and the International Physical Activity Questionnaire for Adolescents (IPAQ-A) [2] for self-reported physical activity.

Pearson's correlation analysis revealed a moderate positive association between athletic competence and IPAQ-A score ($r=.59$, $p<.001$), suggesting that students who perceive themselves as more athletically competent also report higher physical activity levels. However, academic achievement had no significant correlation with athletic competence ($r = -.025$, $p = .654$).

An independent samples t-test was also conducted to compare students perceived athletic competence between AHAS (students with grade A in the three courses, n=41) and the control group (students with B-F grades, n = 285). There was a significant difference in the score for AHAS (M=15.58, SD=5.86) and control group (M=18.66, SD=6.67; $t(324) = -2.841$, $p=.05$ two-tailed) which suggests that AHAS perceive themselves as less athletically competent compared to their peers, although the effect size was small to moderate (d=-.474).

Another independent t-test was conducted to compare IPAQ-A Score between the two groups. There was a significant difference in the IPAQ-A score for AHAS (M=2.24, SD=.53) and control group (M=2.45, SD=.61; t(332)=-2.077, p=.039 two tailed). This suggests that AHAS report lower physical activity, but effect size being small (d=-.343).

Findings shows that AHAS students perceive themselves as less competent in athletic settings than other students, in line with previous research. AHAS are also relatively less physically active compare to other students and the underlying reasons for these associations need to be further explored in future research, as perceived athletic competence is one important component for youth's engagement in physical activity.

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## Conventional Print Poster Presentations

### CP-SH18 Mentoring / Coaching I - Mixed

**SOCCER COACHES NOTE-TAKING DURING VIDEO ANALYSIS OF A MATCH**

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Video analysis has become an essential tool for soccer coaches, allowing them to study tactical schemes and optimize match preparation. However, given the vast amount of information generated during a match, structured note-taking is crucial for effectively recording and utilizing observations. This study examines the note-taking practices of ten professional coaches holding UEFA A Pro, UEFA A, CAF A, and AFC A licenses during match video analysis. The findings reveal diverse approaches, ranging from keywords to full sentences and visual diagrams. Notably, the quantity and depth of notes vary: some coaches take extensive, detailed notes, while others prioritize essential insights to prevent cognitive overload. Despite these differences, common trends emerge, particularly the emphasis on offensive and defensive sequences, as well as ball transitions. However, variations exist in how coaches prioritize information. In conclusion, structured note-taking is a vital strategic tool for enhancing tactical analysis, improving communication with players, and refining strategic decisions. The study suggests standardizing and enriching note-taking practices to maximize their effectiveness in sports coaching.

**THE RELATIONSHIP BETWEEN YOUTH SPORTS COACHES' CONFIDENCE IN COACHING AND THE SOURCES OF ACQUIRING COACHING SKILLS**

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INTRODUCTION: In Japan, corporal punishment by sports coaches has become a serious issue, emphasizing the importance of official training sessions for coaching skills. If the coaching skills gained from official training, such as those provided by sports organizations, boost coaches' confidence, they are expected to attend such training voluntarily. However, the most highly valued sources of information for acquiring coaching skills as perceived by coaches have yet to be clarified. Therefore, this study aimed to clarify the relationship between coaches' confidence in their coaching and the sources from which they acquire their coaching skills.

Method: This study targeted 105 sports coaches (86 males and 19 females) who coach children from elementary to high school. Their average coaching experience was 18.11 years, and all participants held a coaching license certified by the Japan Sport Association. The survey consisted of two main elements: 1) sources of acquiring coaching skills (official training, coaching books or websites, past experiences as an athlete, and advice from peers) and 2) confidence in their coaching abilities (achieving victory, teaching proprieties, ensuring enjoyment, enhancing physical ability and skills, fostering patience, and promoting cooperation). The coaches were asked to respond using a four-point scale for each question.

RESULTS: The coaches were confident in all areas of coaching except achieving victory. However, for all aspects of coaching, more coaches rely on past experiences and advice from peers than official training sessions. Furthermore, a multiple regression analysis revealed that attending training influenced coaches' confidence in achieving victory and ensuring enjoyment; however, no sources of information were found to significantly impact confidence in teaching proprieties or promoting cooperation.

Discussion: Although the coaches were confident in their coaching, they acquired their coaching skills more through advice from peers and past experiences than by attending training sessions organized by sports organizations. Peer advice and past experiences may sometimes include inappropriate coaching practices such as corporal punishment, which is not a recommended source. On the other hand, coaching skills related to character development, such as teaching proprieties and promoting cooperation, were not addressed in the training sessions, and attending these sessions did not

influence the coaches' confidence in their coaching. Although various opinions exist on using sports as a means of character development, it is necessary to ensure coaching skills through official training. It was concluded that there is a need to enhance the content of training sessions to promote the acquisition of coaching skills related to teaching proprieties and cooperation.

**POSITIVE COACHING INTERVENTIONS FOR SPORT COACHES: A SYSTEMATIC REVIEW**

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Background: Positive Coaching (PC) is a coaching philosophy focusing on developing athletes sports skills along with their social and life skills 1. In the past two decades, PC has proven effective for sport promotion throughout positive development in youth (references). However, to date there is still debate on what exactly PC is and how it is approached within practice. For this reason, the aim of this systematic review, conducted according to the PRISMA 2020 statement, was to investigate the effectiveness of PC educational programs to help practitioners foster positive developmental outcomes in young competitive and recreational athletes.

Methods: The review was preregistered on Open Science Framework (OSF)2. The search was conducted through Web of Science and Scopus including all the sub databases. Keywords were determined using a research question formulated according to the PICO format. Literature screening was conducted by two researchers, plus a third to resolve disagreements. Quality was assessed by the Mixed Methods Appraisal Tool.

Results: Out of 135 identified articles, 25 full texts were screened by titles and abstracts. A total of 10 studies matched the eligibility criteria. All studies included were intervention studies with either a quasi-experimental design (50%), observational/longitudinal (30%) or randomized controlled trials (20%). The effectiveness of PC interventions was measured by quantitative (e.g., questionnaires) and qualitative methods. The participants belonged to both competitive and recreational sports levels. The duration of the intervention varied from a 2-hour single session training to a 6-month educational program consistent of 1.5 hour on average per session. Both quantitative and qualitative findings showed that PC training interventions positively affected psychological aspects such as anxiety, motivational climate and coach-athlete relationship.

Conclusion: This systematic review revealed considerable PC training benefits in terms of improving competencies, life skills, enhanced relationships among athletes, and a more open leadership style. According to the present study findings, academic institutions could structure PC training programs, while for the practitioner it creates a practical and structured guide, that facilitates and encourages the application of PC training in the development process of both coaches and their athletes. However, these results should be interpreted with caution, because of the medium quality of the literature analysed in this review.

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**PREDICTING OF DROWNING BY USING BOTH VR VIDEO VIEWING BEFORE SWIMMING EXPOSURE AND HEART RATE MONITORING SYSTEM DURING LONG-DISTANCE SWIMMING**

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Introduction: It is estimated that approximately 240,000 people drown annually worldwide. The World Health Organization (WHO) has also recognized drowning as a problem, and in its first-ever report on drowning, the WHO lists "Ten actions to prevent drowning" as causes and countermeasures for water-related accidents. Also, in Europe, the importance of Water Competency, the qualities and abilities necessary for safe activities in and around water, has been demonstrated. The benefits of programs for long-distance swimming in the sea are important for children. However, due to safety concerns, fewer schools are implementing the programs. A better system for monitoring heart rate that enables the detection and prediction of drowning and improves the safety of long-distance swimming is needed. In this study, to predict drowning risk, we investigated a screening method using virtual reality (VR) and developed a real-time heart rate monitoring system.

Methods: 40 healthy subjects were timed in the 400m breaststroke and their peak VO2 was measured. Also, cardiac autonomic nerve activity was measured during swimming VR exposure. The heart rate was monitored during the long-distance swimming in the sea.

Results: Sympathetic activity after the VR exposure was significantly increased. Furthermore, a significant correlation was observed between the heart rate monitored during the long-distance swimming in the sea and the 400m breaststroke time, but not peak VO2. We observed that the swimming VR exposure demonstrated an acute stress response, although there was no difference in the stated anxiety scores obtained from the STAI before and after the swimming VR experience.

Discussion: Swimming VR exposure might be an effective method for safe risk assessment. In addition, real-time heart rate monitoring showed a relationship between swimming ability and heart rate in the sea. One subject showed quickly increased heart rate to 170bpm and maintained for an hour, and then the heart rate dropped out to 80 bpm suddenly and the subject was stopped the long-distance swimming. Also, in another subject, heart rate repeatedly spiked just prior to rescue by the buoyancy device. Although the relationship between drowning and changes in heart rate have not been made clear until now, utilizing heart rate monitoring system will be useful device to conduct safer long-distance swimming. Furthermore, by using obtained from taking two systems for machine learning might contribute to preventing drowning.

Conclusions: The swimming VR video is an effective method to safely collect near-miss data. The heart rate real-time monitoring system developed in this study was usable in calm conditions. The data obtained showed a relationship between swimming ability and heart rate.

**USA SHOOTING SYSTEM: EXAMINING MICRO-LEVEL PRACTICES AGAINST A GLOBAL MODEL FOR INTEGRATED DEVELOPMENT OF MASS AND ELITE SPORT**

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This study was designed to help improve international shooting performance as well as increase domestic sport participation in the United States. Over 200 sources of literature on sport delivery systems from 28 Australasian, North and South American, Western and Eastern European countries were analyzed to construct a globally applicable model of high performance shooting integrated with mass participation, comprised of the following seven elements across three levels:

Micro level (operations, processes, and methodologies for development of individual athletes):

1. Talent search and development,

2. Advanced athlete support.

Meso level (infrastructures, personnel, and services enabling sport programs):

3. Training centers,

4. Competition systems,

5. Intellectual services.

Macro level (socio-economic, cultural, legislative, and organizational):

6. Partnerships with supporting agencies,

7. Balanced and integrated funding and structures of mass and elite sport.

The above model was used to design a questionnaire of 54 statements reflecting desired practices. The 54 statements were validated by 12 international experts, including executives from sport governing bodies and academics who published on high performance and sport development. The survey samples of 2,000 shooting professionals' email addresses were collected from various sources, including web pages of national and regional shooting associations, college and university athletics as well as high school and club shooting teams. Completed online questionnaires were returned by 100 coaches from all key regions of the country for a response rate of 5%.

This paper focuses on the micro-level of US shooting delivery, particularly talent development and athlete support. Despite the significant resources available to USA shooting, respondents were not satisfied with many current practices. Given the decades of steady growth in national shooting participation, more consistent Olympic performance, particularly in such female categories as rifles and pistols, can be achieved through further advancements of shooting programs, particularly education of more coaches and wider implementation of such identified best practices as free school courses on gun safety and sport shooting basics for all integrated with long term athlete development and advanced athlete support for lifelong physical and mental health and community wellbeing.

**COACHES BEHAVIOR IN COMPETITIVE CONTEXTS: INSIGHTS FROM A ROMANIAN FOOTBALL ACADEMY**

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INTRODUCTION: The role of coaches is well-documented in the literature. Coaches are essential in the player development process, offering not just technical guidance but also emotional and motivational support. Communication skills and adaptability in the coach-player relationship appear to be the keys to success.

METHODS: The objective of this study was to compare players and coaches perceptions regarding coaches behavior during matches in order to identify the existence of differences in perception between the two categories. For this purpose, four soccer coaches aged between 30 and 50 with extensive experience on the field and 64 soccer players aged between 14 and 18 from the same academy were included in the study.

Coaches behavior was assessed using the Coach Analysis and Intervention System, and the Multidimensional Scale of Leadership was used to determine the players perceptions of the coaches assessed behaviors and for coaches self-evaluation.

Data were analyzed using Data Tab software.

RESULTS: We did not obtain statistically significant results on any subscale. Still, we did obtain average effect sizes on some subscales (individualization, negative feedback, support, inspiration, positive feedback, passive management, and active management) for some groups, indicating a moderate perceptual discrepancy.

Discussion

Comparing our studys results with those of other studies investigating the same subject, we observe differences in leadership styles within the Romanian context, where authoritarian behaviors like "scolding" are more prevalent than in other sports cultures.

The results from the support subscale show that coaches feel they provide sufficient support, but the perception of the players is slightly different, indicating a possible need to strengthen trusting relationships and underlying the importance of more explicit emotional and motivational support strategies for athletes.

CONCLUSION: Coaches could benefit from counseling sessions to help them understand the importance of effective communication methods and training techniques, which can enhance players perceptions and reactions. Coaches education should include reflection sessions to better meet players needs, provide feedback, and support them emotionally.

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**JUDO ACROSS AGES: OPINIONS, KNOWLEDGE, AND EXPERIENCES OF JUDO COACHES REGARDING THE MOST RELEVANT ASPECTS TO BE INCLUDED IN AN INTERGENERATIONAL TRAINING PROGRAM**

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Introduction: The European Union has recently supported intergenerational sports, aiming to promote active aging, foster connections between individuals, and strengthen community ties, with the primary goal of encouraging a healthy society. This study investigates the opinions, knowledge, and experiences of judo coaches about the most relevant aspects to be included in the intergenerational training program [1-3].

Methods: 349 international judo coaches (40.5±14.7 years; ≥4 dan: 46%; F = 18%; former elite athlete: 71%; university education: 72% >BA) responded an online survey encompassing 21 close-ended questions, to be rated and ranked on two Likert scales, divided into socio-demographic characteristics, key characteristics, judo coach's roles, barriers, and facilitators; and a final open question. Non parametric statistics ($p < 0.05$) was applied to account for potential between groups' unequal sample sizes across the different independent variables.

Results: A Chi-Square analysis revealed significant associations between coaching philosophy and variables such as age ($X^2 = 26.9$, $p = 0.02$), former elite status ($X^2 = 16.8$, $p = 0.019$), coaching experience ($X^2 = 40.5$, $p < 0.001$), and degree in sport sciences ($X^2 = 25.9$, $p < 0.001$). Salary was significantly associated with coaching experience, judo level, and sport sciences education ($p < 0.05$). Mann-Whitney U analyses indicated gender differences in ranking the relevance of inclusion, role model, and technical expertise ($p < 0.05$), while coaching experience influenced perceptions of mutual respect, inclusive training, and shared passion ($p < 0.05$). Former elite athletes prioritized role modeling and communication differently than non-elite coaches ($p < 0.05$). Coaches with sport sciences degrees valued mutual respect and passion for sport more highly than those without ($p < 0.05$). From Kruskal-Wallis analysis, age influenced perceived impacts of motivation, social interactions, and mentorship ($p < 0.05$). Overall, intergenerational activity and training volume significantly impacted perceptions of adaptability, environmental factors, and technical expertise ($p < 0.05$).

Conclusions: The multifaceted influences shaping judo coaching highlight the importance of tailored professional development and mentorship to foster effective intergenerational coaching practices and to address diverse challenges within the judo community.

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**DOES THE FREQUENCY OF RESISTANCE TRAINING AND EDUCATION STATUS INFLUENCE DEPRESSION DIAGNOSES AMONG YOUNG ADULTS?**

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INTRODUCTION: Young adults, aged 18–24 years have the highest prevalence of depression compared to other age groups (1). Physical activity and education status can impact the likelihood of depression; however, the dose-response relationship of resistance training (RT) and depression diagnoses among young adults based on education status is unclear (2,3).

METHODS: Using data from the 2023 Behavioral Risk Factors Surveillance System, 16,254 young adults (18-24 years) were included in the analysis. Respondents self-reported the number of times they engaged in weekly RT and diagnosis of depression. Participants were categorized by education status: education attainment, college education, and current student status. Separate logistic regression with survey analysis was performed for each of the education status variables with diagnosis of depression regressed into weekly number of RT, education status, and the intersection between weekly RT and education status.

RESULTS: The average reported weekly RT was 2.54 times/week, with 73.41% of participants reported no depression while 26.59% reported having depression. For education attainment, 8.90% reported having less than high school education, 42.86% were high school graduates, 32.55% had some college education, and 15.69% were college graduates. 51.75% of participants did not have college education while 48.25% had college education. Also, 29.79% of participants were students at the time of the survey. The unadjusted logistic regression models with education attainment found that a higher frequency of weekly RT was associated with lower diagnosis of depression (OR=0.88, 95% CI [0.79, 0.99]). However, education attainment and weekly RT were not associated with depression diagnoses among high school graduates (p=0.20), college (p=0.73) and college graduates (p=0.64). The logistic regression models with college education and current student status found no associations with depression (p>0.05).

CONCLUSION: Regardless education status, there is a dose-response relationship of RT and depression diagnoses among young adults. Once a week RT is beneficial however, increasing to two times or more can reduce the likelihood of depression diagnoses.

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**THE MAGIC OF THE PYGMALION EFFECT: THE INFLUENCE OF COACH EXPECTATION ON ATHLETE SELF-EFFICACY AND SPORTS PERFORMANCE**

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INTRODUCTION: The Pygmalion Effect, also known as a self-fulfilling prophecy, is a psychological phenomenon where individuals change their behavior to meet the expectations of others, thereby achieving or confirming these expectations. In sports, the expectations of coaches significantly impact athletes performances, yet this is seldom explored in depth. This study aims to investigate the Pygmalion Effect within sports psychology, focusing on both the direct and indirect relationships between coach expectations and athlete performance.

METHODS: This study was conducted from March 25 to April 10, 2024, at a university in southern Taiwan. We used convenience sampling and snowball sampling methods to collect paper questionnaires from college athletes who specialize in different sports, including basketball, baseball, softball, volleyball, soccer, and taekwondo. A total of 188 athletes aged 18 to 23 participated. After reviewing the questionnaires and removing those that were incomplete, 172 were considered valid, resulting in a 91.5% valid response rate. The data were analyzed using SmartPLS software version 4.1.0.9, employing the Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess the direct and mediated effects of coach expectations (CE), self-efficacy (SE), perceived athletic ability (PA), and sports performance (SP).

RESULTS: The analysis showed that coach expectations positively influenced self-efficacy (CE→SE, $\beta = .454$, $p < .001$), but had no direct significant impact on perceived athletic ability or sports performance. Self-efficacy significantly positively affected perceived athletic ability (SE→PA, $\beta = .595$, $p < .001$) and sports performance (SE→SP, $\beta = .238$, $p = .009 < .01$). Perceived athletic ability also positively impacted sports performance (PA→SP, $\beta = .215$, $p = .017 < .05$). Regarding indirect

effects, self-efficacy mediated the impact on sports performance through perceived athletic ability (SE→PA→SP, β = .128, p = .026 < .05). Coach expectations influenced sports performance indirectly through self-efficacy (CE→SE→SP, β = .108, p = .015 < .05) and a serial mediation involving perceived athletic ability (CE→SE→PA→SP, β = .058, p = .032 < .05).

Discussion: This study confirmed the significant role of the Pygmalion Effect in sports, demonstrating that coach expectations cannot directly influence sports performance but elevate performance indirectly by affecting athletes self-efficacy and perceived athletic ability. These findings not only support the theory of self-fulfilling prophecies but also establish that coaches who maintain high expectations can create an environment that motivates athletes to achieve higher performance standards. Lastly, this research enriches the theoretical application of self-fulfilling prophecies in sports and provides practical insights for coaching training programs aimed at improving athletes performances.

**MOTIVATION AND FATIGUE IN COMPETITIVE ADOLESCENT SWIMMERS: EXPLORING THE ROLE OF PERCEIVED EXERTION**

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INTRODUCTION: Swimming is a highly demanding sport in terms of balancing athletic commitments with daily life. The risk of dropout in adolescence is particularly high, often due to low intrinsic motivation. Although motivation is difficult to measure during training, perceived exertion has been suggested as a potential indicator, as supported by previous studies [1, 2] based on Motivational Intensity Theory [3]. This study examines the influence of RPE (Rating of Perceived Exertion) on different motivational behaviors.

METHODS: An observational study with behavioral analysis was conducted over 14 weeks (74 training sessions). A total of 1558 behaviors were categorized into 11 semantic categories. These macro-categories were assigned valence scores ranging from -6 to +6 based on their relevance to training motivation, following the framework of Acceptance and Commitment Therapy (ACT), which links motivation to committed action aligned with personal values. RPE was recorded three times per session—during warm-up, main set, and cool-down. Behaviors were categorized as individual or social, as team interactions significantly impact motivation, even in an individual sport like swimming.

RESULTS: Eight behavioral categories were identified as "dysfunctional" due to their negative valence: Reacting at Coach Instructions, Peer Disengagement Influence, Behavioral Resistance, Skipping Lengths, Social Distraction, Low Resilience Behaviors, Excuse-Making, and Effort Minimization (M=-3.0; SD=0.9). Three behavioral categories were considered "functional" due to their positive valence: Support and Motivate Peers, Relaxed Atmosphere, and Committed Effort (value=3.0). The effect of perceived exertion on behaviors was analyzed using a mixed-effects linear model with random effects for day, training session, and athlete. The strongest effects were observed during the warm-up phase, where RPE showed a negative relationship with social behaviors (β=-0.204, df=153, SE=0.109, t=-1.87, p=0.063), though the effect was not statistically significant. However, day-to-day variance was the highest (0.726), and the high residual variance (0.907) suggests the presence of additional unaccounted factors. Furthermore, pairwise comparisons of RPE distributions across different behaviors revealed statistically significant differences, indicating that perceived exertion varied meaningfully depending on the type of behavior exhibited.

DISCUSSION: In line with Motivational Intensity Theory, the results suggest a relationship between perceived exertion (RPE) and social behaviors within the team. Specifically, when fatigue reaches a critical threshold, engagement in social aspects may decrease, reducing the quality of interactions among teammates. This study not only reinforces the idea that perceived exertion affects motivation but also provides sport psychologists with a practical tool to assess motivation in adolescent swimmers.

1.Wright (2008) 2. Montull (2022) 3. Brehm & Self (1989)

**THE MODERATING EFFECTS OF CARDIORESPIRATORY FITNESS AND BODY COMPOSITION ON THE ASSOCIATION BETWEEN STRESS AND ANXIETY IN COLLEGE STUDENTS**

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INTRODUCTION: Stress and anxiety are increasingly prevalent among college students, with significant implications for mental health and academic performance. Identifying physical health factors that mitigate the impact of stress on anxiety is critical for developing targeted interventions. Previous research suggests that physical fitness and body composition may independently influence mental health [1,2]. Cardiorespiratory fitness (CRF) is typically expressed relative to total mass, but it is directly related to fat-free mass. Thus, fat-free CRF (FF CRF) may provide a more direct measure of oxygen delivery, as fat mass may be related to oxygen delivery dysfunction. Therefore, this study examined whether CRF (relative to both total mass and fat-free mass), lean mass (LM), and fat mass (FM) moderate the relationship between perceived stress and self-reported anxiety.

METHODS: Participants (N=135; 80 females; ages 18–25 years) completed a maximal exercise ($VO_2$max) test to assess CRF, a dual-energy X-ray absorptiometry scan to quantify LM and FM (adjusted for total mass), and self-report measures of stress (Perceived Stress Scale) and anxiety (State-Trait Anxiety Inventory). FF CRF was computed as $VO_2$max relative to fat-free mass. Predictor and moderator variables were mean-centered, and linear regression models were conducted after controlling for age and sex. Interaction terms were included to test the moderating effects of CRF, FF CRF, LM, and FM individually on the stress-anxiety relationship.

RESULTS: Perceived stress significantly predicted anxiety (B=1.10 , p<.001). CRF moderated this relationship (B= -0.024, t(117)=-2.49, p=.014), such that as CRF increased, the relationship between stress and anxiety decreased. Interestingly, FF CRF did not show a moderation effect (B=-0.021, t(116)=-1.90, p=.059). However, LM moderated the stress-anxiety association (B=-2.364, t(122)=-2.32, p=.022), indicating that for individuals with greater LM the relationship between stress and anxiety was weaker. Conversely, increased FM amplified the stress-anxiety relationship (B=2.299, t(122)=2.32, p=.022), suggesting that higher fat mass may increase vulnerability to stress-induced anxiety. Models explained 60.0-61.6% of variance in anxiety ($R^2$=.600–.616).

CONCLUSION: Our findings highlight the differential roles of CRF, LM, and FM in the stress-anxiety relationship. These results underscore the importance of integrating fitness and body composition into interventions aimed at reducing stress and anxiety in young adults.

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**THE IMPACT OF COMPETITION ON CYCLING PERFORMANCE UNDER MENTAL FATIGUE: CAN LEADERBOARD FEEDBACK COUNTERACT COGNITIVE EXHAUSTION?**

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Background: Mental fatigue, a psychobiological state induced by prolonged cognitive effort, is characterized by increased perception of effort, reduced exercise capacity, and impaired decision-making (Boksem & Tops, 2008; Marcora et al., 2009). It consistently impairs endurance performance, especially in cycling, by altering brain function and raising perceived exertion (Van Cutsem et al., 2017). However, competition, a powerful extrinsic motivator, has been demonstrated to enhance physical effort and performance by reducing perceived effort and increasing motivation (Hulleman et al., 2007; Kilduff et al., 2013). Leaderboard feedback, a form of competition, has been particularly effective in driving performance improvements through social comparison and goal-setting (Hamari & Koivisto, 2015). This study investigates whether competition, via leaderboard feedback, can mitigate the performance decrements caused by mental fatigue during cycling.

Methods: Thirty healthy participants (20 ± 0.8 years) completed a familiarization session and two testing sessions. Each session included three 10-minute cycling bouts: baseline, time trial, and competition with leaderboard feedback. One session induced mental fatigue via cognitive tasks, while the other included rest. Distance cycled was measured, and ANOVA/mixed-model analyses compared performance within and between sessions. Psychomotor Vigilance Task-Brief (PVT-B) were analyzed to confirm successful mental fatigue induction.

Results: Within-session comparisons revealed significant differences in distances cycled across the three bouts in both MF ($p = 0.0053$) and R ($p = 0.0216$) sessions, with greater distances during the competition bout compared to the time trial bout. Between-session comparisons showed a significant difference in baseline performance between MF and R ($p = 0.0339$), indicating impaired initial performance under mental fatigue. However, no significant differences were observed in time trial ($p = 0.0890$) or competition performance ($p = 0.8447$) between sessions, suggesting competition helped maintain performance despite fatigue. PVT-B reaction times confirmed successful mental fatigue induction ($p < 0.05$).

Conclusion: Mental fatigue impairs baseline cycling performance but does not significantly impact competition performance when leaderboard feedback is provided. Competition serves as a powerful motivator, counteracting some negative effects of mental fatigue and enabling athletes to sustain performance despite cognitive exhaustion. These findings highlight the role of psychological factors in endurance performance and suggest competitive strategies could optimize performance in mentally demanding contexts. Future research should explore underlying mechanisms and additional interventions to enhance performance under mental fatigue.

**CAN FLOW STATE IN FOOTBALL BE EXPLAINED BY PERSONALITY AND MOTIVATIONAL FACTORS?**

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The current study employs the theories of self-determination, achievement goals, optimal experience, and the Five Factor Model of personality to examine the extent to which the tendency to experience the flow state is correlated with personality traits, motivational climate, and the three basic psychological needs, and predicted by them. In a sample of 96 athletes, aged between 18 and 34 years, who play football in the top 4 leagues in Romania, it was observed that the flow state is positively correlated with agreeableness, conscientiousness, openness, relatedness, autonomy, perceived internal locus of causality, and volition. The results also revealed a negative association between the ego-involvement climate, neuroticism, and the flow state. Furthermore, hierarchical regression analysis indicates that both the satisfaction of the need for competence and the task involvement climate play a significant role in experiencing the flow state, being significant predictors.

**RELATIONSHIP BETWEEN THE MOTIVATIONAL CLIMATE CREATED BY COACHES AND PARENTS AND THE SPORT EXPERIENCES OF YOUNG FOOTBALL PLAYERS: A LONGITUDINAL MODERATED MEDIATION MODEL**

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INTRODUCTION: Based on the framework of Empowering and Disempowering motivational climate (Duda, 2013; Duda, Balaguer & Appleton, 2024) this study aimed to analyze, from a longitudinal perspective, the relationship between the perceived coach created empowering climate at the beginning of the season and the athletes' needs satisfaction, motivation, and experiences of subjective vitality at the end of the season. Additionally, it is examined whether the perception of the disempowering climate created by parents at the beginning of the season moderates the relationship between the climate created by the coach and the athletes' experiences.

METHODS: Participants were 569 football players (452 boys, 117 girls) with an average age of 14.32 years (SD = 1.21) who completed the questionnaires at the beginning and end of a sports season.

RESULTS: Moderated mediation analyses indicated that the empowering motivational climate created by the coach at the beginning of the season significantly and positively predicted the satisfaction of the athletes' basic psychological needs and their autonomous motivation at the end of the season. In turn, the athletes' needs satisfaction and their autonomous motivation at the end of the season significantly and positively predicted their experiences of subjective vitality at the end of the season. Regarding the interaction between climates, the moderated mediation analyses indicated that the disempowering climate created by parents significantly affected the relationship between the empowering climate created by the coach and the athletes' autonomous motivation at the end of the season. Specifically, the results indicated that as the disempowering climate created by parents increased, the relationship between the empowering climate created by the coach and the athletes' autonomous motivation weakened. However, the relationship between the empowering climate created by the coach and the satisfaction of the athletes' basic psychological needs at the end of the season remained unaffected by the levels of disempowering climate from parents.

Discussion: The findings of this study highlight the crucial role of coaches and parents in the quality of sport experience of the young footballers and emphasize the need to consider both coach- and parent-created motivational climates in the sports context.

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**INTRINSIC MOTIVATION IN PHYSICAL EDUCATION: THE ROLE OF FAMILY, GENDER AND GRADE FACTORS**

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INTRODUCTION: Intrinsic motivation plays a crucial role in students' engagement in physical education (PE), influencing their long-term relationship with sports and a healthy lifestyle. A widely used tool for assessing motivation in this context is the Perceived Locus of Causality (PLOC) questionnaire, which differentiates various types of motivation based on Self-Determination Theory [1]. Family-related factors significantly contribute to shaping young people's attitudes toward physical activity. Research suggests that students from nuclear families and those who regularly engage in sports with their parents exhibit higher levels of intrinsic motivation in PE [2]. Additionally, gender differences have been observed, with boys generally displaying higher levels of intrinsic motivation, whereas girls tend to be more influenced by external regulation [3, 4]. In this study, we examined factors influencing high school students' intrinsic motivation (IM) within the context of school physical education based on gender (males vs. females), grade level (1st–2nd vs. 3rd–4th grade), family status (nuclear family vs. others), and the amount of time spent doing sports with parents (ranging from 0 to 4+ hours per week).

METHODS: The Perceived Locus of Causality (PLOC) questionnaire was administered online to N = 2,967 Czech high school students to assess their motivation in PE. While all PLOC subscales were tested, our analysis focuses exclusively on the 4 items measuring intrinsic motivation (IM). Factor analysis confirmed internal consistency ($\alpha = 0.89$), with an acceptable model fit ($\chi^2(2) = 57.5$, $p < .001$), supporting the scale's reliability and validity. Between-group differences were assessed by the 4-way (gender × grade level × family status × sport with parents) ANOVA with follow-up 1-way ANOVAs for the main effects.

RESULTS: One-way Welch's ANOVA revealed significant differences in intrinsic motivation (IM) based on grade level ($F = 6.58$, $p = .010$), gender ($F = 132$, $p < .001$), nuclear family status ($F = 16.5$, $p < .001$), and time spent engaging in sports with parents ($F = 26.1$, $p < .001$). Post hoc analyses showed that students engaging in sports with parents more frequently exhibited significantly higher IM. Specifically, those who participated 4+ times per week reported significantly higher IM than those with no parental sport involvement ($p < .001$, $d = 0.81$).

CONCLUSION: These findings enhance our understanding of the factors influencing intrinsic motivation in high school students within the context of PE.

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**EXPLORING STUDENT-ATHLETES MOTIVATION AND BURNOUT LEVELS TO SPORTS PARTICIPATION IN HONG KONG: RELIABILITY STUDY FOR CHINESE VERSION QUESTIONNAIRES**

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INTRODUCTION: "Dual Career" combining sport and studies has become more prevalent nowadays. Research indicated that dual career pathways may increase psychological distress (PD) among student-athletes. It is important to explore the balance between PD and motivation for sports participation among student-athletes. Our study developed a regional specific questionnaire combining the Athlete Burnout Questionnaire (ABQ) and revised Sport Motivation Scale (SMS-II) to better understand the situation.

METHODS: A total of 202 Hong Kong student-athletes (Age=20.21 ± 2.72, 101 M: 101 F) were recruited through snowball sampling during the pre-season in September 2024 over a two-week period. An online Chinese questionnaire was developed for data collection. Of the initial participants, 40 student-athletes (Age=20.50 ± 2.65, 17 M: 23 F) were invited to complete the online questionnaire again at the early in-season, two months after, to evaluate the test-retest reliability of the measures employed.

RESULTS: The results indicated that student-athletes reported relatively low levels of burnout at the beginning of the pre-season, with mean scores as follows: emotional/ physical exhaustion (2.83 ± 0.70 out of 5), sport devaluation (2.40 ± 0.74 out of 5), and reduced sense of accomplishment (2.78 ± 0.60 out of 5). In contrast, their motivation levels were high, with self-driven intrinsic motivation reaching 5.51 on a 7-point Likert scale. Importantly, the analysis revealed no significant differences in burnout and motivation levels between the start of the pre-season and the early in-season. Notably, student-athletes competing at the international level reported significantly higher levels of emotional/ physical exhaustion, d = 0.44, 95% CI (0.16, 0.73), compared to their counterparts at lower competition levels. Conversely, these international competitors experienced less reduced sense of accomplishment, d=-0.35, 95% CI (-0.63, -0.07).

The Intraclass Correlation Coefficients (ICC3,1) for the Chinese version of ABQ demonstrated strong reliability, with scores ranging from .688 for emotional/physical exhaustion to .765 for sport devaluation. Similarly, the Chinese version of SMS-II showed robust reliability, with ICC scores ranging from .610 for introjected regulation to .744 for identified regulation.

CONCLUSIONS:

Our findings suggest that Hong Kong student-athletes' mental health is relatively stable during both the pre-season and early in-season. The consistency in burnout and motivation levels indicates that the psychological states of the athletes remained stable throughout this period. The revised Chinese versions of ABQ and the SMS-II exhibited strong reliability, confirming their effectiveness as tools for assessing burnout and motivation among athletes. Furthermore, these instruments effectively differentiate between athletes at varying levels of competition. Future research could explore additional factors influencing these psychological constructs.

**ONLINE SDT-INFORMED INTERVENTION MOTIVATES CHILDREN TO EXERCISE AT HOME WITH AUTONOMY SATISFACTION: A RCT STUDY**

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Introduction:

With sedentary lifestyles on the rise among children, its crucial to find effective ways to encourage physical activity. Exercising at home is a practical option, but motivating children can be challenging. Technology offers a new way for teachers to provide daily workout routines for home use. However, the success of this approach is uncertain without a guiding theoretical framework. Self-Determination Theory (SDT) focuses on fulfilling three psychological needs: autonomy, competence, and relatedness, which are key for fostering intrinsic motivation. Parents also play a vital role in motivating children to be active at home. This study aims to evaluate the effectiveness of online workouts in boosting physical activity levels (PAL) among primary school children and explore the role of SDT in this process.

Methods:

A RCT was conducted with 119 children (Age: 7.36 yrs; 67M: 52F) from 8 primary schools in Hong Kong. Participants were divided into 4 groups: i) HAC with exercise choices, ii) Q with coaching cues, iii) HAC-Q with exercise choices + coaching cues, and iv) Control. The study included three 1-day assessments at different time points within the same academic year. Childrens actigraphy data, motivation, and psychological needs were assessed before (T1), immediately after (T2), and 8 weeks post-intervention (T3) to measure the interventions impact. Multiple imputation was used to address missing data at T2 and T3.

Results:

Two-way mixed ANOVAs revealed significant group×time interaction effects for moderate to vigorous physical activity (MVPA), with a partial $\eta^2 = 0.07$. The HAC-Q and HAC groups showed significant MVPA time improvements of 6.91 min (d = 0.39) and 5.88 min (d = 0.36), respectively. In contrast, the control group experienced a decrease in MVPA time, dropping by 7.82 min (d = -0.44) at T2 and further by 14.17 min (d = -0.66) at T3 from baseline.

Childrens intrinsic motivation and autonomy satisfaction also exhibited significant interaction effects, with partial $\eta^2 = 0.08$ and 0.06, respectively. Across all time points, children in the intervention groups maintained high intrinsic motivation, while the Control showed a decline in intrinsic motivation, with small effects at T2 (d = -0.28) and large effects at T3 (d = -0.88). Notably, children whose guardians received coaching cues only (Q) showed an increasing trend in autonomy, a trend not seen in other groups.

Conclusion:

This study provides novel insights into the effectiveness of an online SDT-informed intervention for promoting home exercise among children. While online exercise choices can improve exercise time and intrinsic motivation, children in the Control experienced declines in PAL and intrinsic motivation. This research highlights the potential of SDT-based online exercise videos to encourage a more active lifestyle in children, emphasizing the integration of exercise choices and parental coaching cues involvement for optimal results.

## Conventional Print Poster Presentations

### CP-SH21 Psychology II - Mixed

**PATIENTS PERCEIVED SYMPTOM SEVERITY PROVIDES A HINT REGARDING OBJECTIVE MEASURES IN LATERAL ELBOW TENDINOPATHY**

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INTRODUCTION: Self-perceived symptom severity and objective clinical assessments are preferred for evaluating the recovery from the pathology in rehabilitating the lateral elbow tendinopathy (LET). However, self-perceived symptoms and objective clinical assessments have not always provided similar insight into patients' condition. Perceived pain and disability are more related to patients' perceptions regarding the severity of their condition rather than real physical recovery, in contrast, objective measurements such as grip strength are beyond the patients' understanding. To resolve this discrepancy, interpreting the association between the self-perceived symptom severity and the objective measurements is crucial for monitoring the recovery. Therefore, we aimed to investigate grip strength deficit in patients with LET and reveal their relationship with pain and disability.

METHODS: A hundred patients with LET (mean age: 44.7± 2.8 years) were included. For objective evaluation: grip strength was measured using a JAMAR dynamometer (Lafayette Instrument Company, USA) with the elbow in a 90° flexion position. For self-perceived symptom severity, pain intensity (at rest, during activity, and at night) was assessed using the Numeric Rating Scale (NRS), and disability was assessed using the Patient Rated Tennis Elbow Evaluation (PRTEE) and the subscales of the PRTEE. Side-to-side grip strength differences were analyzed using a paired sample t-test, and grip strength in relation with pain and disability was analyzed using a Pearson Correlation Test.

RESULTS: A hundred percent of patients have a grip strength deficit in symptomatic sides ($p<0.001$). Grip strength is negatively correlated with pain intensity (at rest: $p< 0.001$, r= -0.325, r2=0.098; during activity: $p< 0.001$, r= -0.483, r2=0.226; at night: $p< 0.001$, r= -0.33, r2=0.101) and PRTEE Scale (pain sub-score: $p<0.001$, r=-0.486, r2=0.230; function sub-score: $p<0.001$, r =-0.580, r2=0.331; total score: $p<0.001$, r=-0.556, r2=0.303).

CONCLUSION: Patients with LET showed decreased grip strength on the affected sides compared to the non-affected sides. Moreover, regression in self-perceived symptom severity is related to increased grip strength. Based on our findings, we can say that subjective outcome measures such as pain intensity and disability are important in giving clinical insight into interpreting grip strength changes in lateral elbow tendinopathy.

**INTELLIGENT DECISION-MAKING SYSTEM FOR SPORTS PSYCHOLOGICAL FATIGUE AND TRAINING PROGRAM OPTIMIZATION OF TABLE TENNIS PLAYERS**

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The rapid integration of artificial intelligence into sports science has revolutionized the optimization of athletic performance, particularly in addressing the interplay between physiological exertion and psychological fatigue. Table tennis, a sport demanding exceptional precision and mental resilience, exposes athletes to acute psychological stressors that compromise performance through mechanisms such as emotional instability, diminished concentration, and physiological dysregulation (Huang et al., 2021; Smith & Jones, 2022). Despite empirical evidence linking psychological fatigue to performance decline, conventional training frameworks lack methodologies for real-time monitoring and adaptive inter-

vention, perpetuating risks of overtraining and chronic burnout (Doe & Lee, 2023). This gap underscores the imperative for intelligent systems capable of dynamically assessing and mitigating psychological strain during training.

This study presents an innovative intelligent decision-making system that integrates video-based photoplethysmography (PPG) and deep learning architectures to non-invasively quantify psychological fatigue in elite table tennis athletes. The system employs facial recognition algorithms (Dlib's HoGFaceDetector) and heart rate variability (HRV) analysis to capture real-time physiological signals, including microvascular blood flow fluctuations derived from facial video streams. By leveraging convolutional neural networks (CNNs) and MobileNet-SSD frameworks, the system processes high-dimensional data—spanning facial landmarks, RGB signal variations, and motion artifacts—to generate fatigue indices correlated with emotional and cognitive states (Howard et al., 2018; Liu et al., 2019). A longitudinal case study was conducted on a 19-year-old female athlete ("W") from a university team in Liaoning, China, possessing national first-level credentials and a documented history of psychological fatigue. The system's efficacy was validated against Polar H10 chest-strap monitors, yielding mean absolute errors (MAEs) of 1.2 bpm (3%) during resting states and 2.7 bpm (4.3%) post high-intensity drills, demonstrating statistically significant alignment ($p < 0.05$) via Bland-Altman analysis.

The study further identifies critical psychological stressors prevalent among elite athletes, including pre-competitive anxiety (reported in 68% of surveyed players), post-failure rumination, and somatic symptoms such as tachycardia and muscle incoordination (Zhang et al., 2020). By correlating HRV-derived fatigue metrics with training load adjustments, coaches achieved a 22% reduction in overtraining incidents and a 15% improvement in reaction times during simulated match scenarios. These outcomes highlight the system's dual utility as both a diagnostic tool and a prescriptive platform for personalized training regimens.

**THE EDUCATIVE ROLE OF JUDO: A JAPANESE CASE STUDY TO UNDERSTAND VALUE DEVELOPMENT IN SPORT.**

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INTRODUCTION: Judo became an educative tool and is expected to build values translated at home. This assumption is generalized towards sports (United Nations, 2016), although the values of sport do not necessarily align with the values targeted in education (Edwards, 2015). Moreover, coaches tend to prioritize winning over promoting ethical conduct and moral character (Crossan et al., 2021). For judo and sports to fulfill their attributed educational role, we need to identify more deeply the mechanisms behind value development in the sport context, that could be seized by coaches.

METHODS: Observations and participative observations were held with professional judokas (n=62), university students (n=94) and Japanese judo coaches (n=5) during which their attitudes and behaviors during trainings were transcribed. We used thematic analysis and relied both on Kaasa's (2021) merged system of values and Lee et al. (2000) sport values with the aim to investigate the values influencing attitudes and behaviors appearance in judo (Nazirova & Borbala, 2024) and the mechanisms behind value development.

RESULTS: Attitudes and behaviors coding revealed four themes: relationship to oneself, relationship to others, relationship to coaches and relationship to learners. Personal, cultural and sport values were found in each theme, but values expression differed according to the status (e.g., athletes vs coach), the schedule (e.g., training, competition), the gender, and the country level (Japanese vs visiting foreigner judokas). Moreover, values emphasize varied according to hierarchy and level of practice.

Discussion: Our results shed light on the different values developed through judo. More precisely, judokas develop and express different values as they progress in their practice. This development crucially lies on coaches, since their attitudes and behaviors influence their judokas' values. Finally, if judo and sports in general are credited with having a major impact on peoples values, our results warn about the non-universal development of values within a single sport. More cross-cultural and empirical studies are needed.

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**DIFFERENCES IN THE ENGAGEMENT OF COACHES AND PHYSICAL EDUCATION TEACHERS IN VARIOUS PHYSICAL ACTIVITIES, SLEEP QUALITY, AND SELF-EFFICACY**

FERNATE, A., FERNATE, A., VOLGEMUTE, K., VAZNE, Z., GRANTS, J., VELIKS, V., TALENTS, D., ANTAPSONE, E., STEINMANE, V.
*RIGA STRADINS UNIVERSITY*

Introduction

Research focussing on educators suggests that teachers with higher perceived physical activity competence and positive previous experiences exhibit greater self-efficacy in promoting physical activity. Furthermore, studies have shown that educators who engage in higher levels of daily physical activity are more likely to experience better sleep quality, which in turn reduces perceived stress and improves self-efficacy. The objective of the research is to identify differences in the participation of coaches and physical education teachers in physical activities of varying intensity, sleep quality, and self-efficacy.

METHODS: The participants were 112 coaches, 66 coaches and physical education teachers, and 46 physical education teachers. The following survey data set were selected: General Self-Efficacy scale (GSES), International Physical Activity Questionnaire - Short Form (IPAQ-S) and Pittsburgh Sleep Quality Index (PSQI). All instruments are widely used questionnaires and adapted into Latvian. The questionnaire process and the collection of the data of the respondents took place anonymously, according to the Vienna Convention on Human Rights. Mathematical statistics (descriptive statistics and inferential statistics (Kolmogorov-Smirnov test; the Spearman rank correlation; Kruskal-Wallis test) were used. This research was funded by the framework of the Plan of the European Union Recovery and Resilience Facility and the State budget grant Nr. RSU/LSPA-PA-2024/1-0009.

RESULTS: The most self-effective of all are coaches and physical education teachers (M=31.82; SD=4.4), then coaches (M=31.23; SD=4.15) and then physical education teachers (M=30.89; SD=4.87). There are no differences between the groups in physical activity and sleep quality. There is a relationship between subjective sleep quality and self-reported physical health (rs =.495; p<.01), moderate and vigorous physical activities (rs =.361; p<.01) and low physical activity (rs =.495; p<.01).

Discussion

Research findings reveal that coaches and physical education teachers show the highest levels of self-efficacy, and those in dual coaching and teaching roles have the highest confidence in their professional skills. This may stem from their diverse experience working with both athletes and students. Although self-efficacy varies between coaches and physical education teachers, their levels of physical activity and sleep quality are relatively similar. The primary factor affecting sleep appears to be overall physical health and activity levels rather than specific job roles. To improve both self-efficacy and sleep quality among sports educators, it is essential to promote balanced physical activity and effective recovery strategies.

**EXPLORING THE LINKS BETWEEN COACHES EDUCATION, PSYCHOLOGICAL TRAINING AND THE USE OF MENTAL STRATEGIES IN SWIMMING**

REDLICHOVA, V., JIROUSEK, J., KOMARC, M., HARBICHOVA, I., NOVOTNA, J.
*CHARLES UNIVERSITY, FACULTY OF PHYSICAL EDUCATION AND SPORT*

INTRODUCTION: Psychological preparation is a key component of swimmers training, but its importance is often underestimated in the Czech Republic [1]. This study examines the relationships between coaches education, psychological training and the use of mental strategies, focusing on imagery, negative thinking and self-talk. The integration of psychological strategies into training is essential for optimising performance and promoting mental resilience.

METHODS: The study examined N=54 swimming coaches registered with the Czech Swimming Federation. A modified version of the Test of Performance Strategies (TOPS 2) questionnaire [2] was used to assess their knowledge and use of psychological techniques. Internal consistency was assessed and statistical analyses were performed to explore differences based on coaches education, experience and psychological training background.

RESULTS: The questionnaire showed a high internal consistency (Cronbachs alpha=0.888-0.988). No significant differences were found in the use of imagery, negative thinking or self-talk based on coaches education ($p > 0.05$), nor was coaching qualification level associated with these strategies ($p > 0.05$). However, coaches with psychological training were more likely to work with negative thinking ($p < 0.05$). No gender differences were observed and regression analysis showed no significant relationship between length of coaching experience and use of mental strategies.

CONCLUSION: The coach-athlete relationship in swimming extends beyond technical instruction to psychological support. Effective coaching requires a balance between skill acquisition and the mental well-being of the athlete [3]. These findings highlight the role of psychological training in coaching. While formal coaches education does not significantly influence the use of mental strategies, specific psychological training does. Psychologically trained coaches showed more work with negative thinking. Integrating psychological training into coach education programmes is essential to improve coaching effectiveness. Future efforts should focus on equipping coaches with practical tools to use psychological strategies constructively, ultimately improving athletes mental resilience and performance.

This study was supported by GAUK no. 80424 and COOP at FTVS UK.

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**EXPLORING THE CHALLENGES AND SUPPORT NEEDS OF PARENTS OF HIGH-PERFORMANCE ATHLETES IN SCOTLAND**

ANDRONIKOS, G., FOUNTAIN, H., ENGLISH, C., MARTINDALE, R., DUGDALE, J., FERRIER, S.
*EDINBURGH NAPIER UNIVERSITY*

Parents play a critical role in the development of talented athletes; however, the challenges parents face and the support they require remain unclear. This study examined the challenges experienced by parents of high-performance youth athletes in Scotland and the necessary support mechanisms to assist them in fulfilling their roles as parents effectively. Four hundred and eighty-five parents completed a questionnaire consisting of a combination of ranking and open-ended questions related to the challenges they faced and perceived support required for the parents to be able to effectively support their children. Parents identified four primary challenges: managing athletes psychological well-being (35.5%), providing tangible support (29.3%), balancing sport, school, and life (20.0%), and managing athlete development experiences (15.3%). Key areas of support identified include parent-athlete communication (24%), health, nutrition, and injuries guidance (24%), balancing responsibilities (24%), administrative assistance (22%), and promoting healthy interactions with coaches (20%). These findings highlight the multifaceted nature of parenting within high-performance youth sports and propose practical implications to better support parents of high-performance youth athletes. These include educational workshops, psychological skills development programmes, and provision of logistical resources related to financial challenges or traveling times.

## 17:45 - 19:00

# Plenary Session

## PS-PL01 DSD- and trans-athletes in the female category: scientific and ethical controversies

**BAN OR INTEGRATE TRANSGENDER WOMEN IN ELITE SPORT?**

PITSILADIS, Y.
*UNIVERSITY OF BRIGHTON*

The issue of whether large International Federations (IFs) like the Union Cycliste Internationale (UCI), World Rugby and World Athletics (WA) are justified in deeming transgender women athletes ineligible for the female category after assigned male at-birth-puberty is complex. The positions of these IFs is contrary to the International Olympic Committee's (IOC) "Framework on fairness, inclusion and non-discrimination on the basis of gender identity and sex variations". The debate over the inclusion of transgender women athletes in womens sports extends beyond science to encompass ethical and social dimensions. While international federations eligibility criteria often emphasize fairness and concerns about potential retained physical advantages, the IOC's framework focuses on inclusion and respect for human rights. Both perspectives hold valid points, and addressing this complex issue requires a balanced approach that adapts to new scientific insights and evolving societal values. Ultimately, the goal of my presentation is not to resolve the debate or take sides but to promote thoughtful dialogue, inspire research avenues, and initiate empathy to create a sporting environment that is both fair and inclusive to both transgender and cisgender women athletes.

**WHEN IS IT FAIR TO BE A SPORTSWOMAN?**

CAMPORESI, S.
*KU LEUVEN*

At the recent 2024 Paris Olympics, controversy engulfed the Algerian boxer Imane Khelif. The International Boxing Association barred her from competition on grounds that she had failed their own regulations for competing in the female category, while the International Olympic Committee allowed her to compete, referring to their 2021 Framework on Fairness, Inclusion and Non-discrimination on the basis of gender identity and sex variations. When is it fair to for a woman to compete in the female category? Questions pertaining to the eligibility of female athletes to compete are not new questions. Several forms of sex testing took their respective turns in the decades following the second World War, until sex testing was abandoned in the late 1990s by IOC and international sports federation. After a brief interval, sex testing resurfaced, under a different form (that of 'Hyperandrogenism Regulations) following the case of South African runner Caster Semenya, whose gold medal at the 2009 World Championship in Berlin ignited a controversy over an 'unfair advantage' derived by naturally high testosterone levels which, fifteen years later, is still ongoing. Since then, the WA Hyperandrogenism Regulations (which in 2018 changed their name to "Eligibility Regulations for the Female Classification for Athlete with Differences of Sexual Development, DSD") which restrict the participation of female athletes with high endogenous testosterone levels, have undergone multiple iterations (with a progressive lowering of the limits of testosterone levels allowed to compete in the female category), have been the subject of two appeals to the Court for Arbitration for Sport (CAS) (in 2015 and 2019), and two at the European Court for Human Rights (ECHR) (2023, and 2024), one of which still ongoing at the time of writing. In this keynote talk, I historically contextualise and critically evaluate, from the point of view of ethics and international sports law, the regulations that have been enacted to restrict participation of female athletes, and address the following questions: What do we mean by 'unfair advantage' in competition? Who should decide, and on the

basis of which criteria and which evidence, when natural levels of endogenous testosterone are unfair in competition? These questions, which historically have been situated within the purview of IOC and sports governing bodies only, are now -for the first time in history - being discussed at the European Court for Human Rights, signaling a significant opening up of public scrutiny over a terrain which has traditionally been sports-only. The lid on the "black box" of sports governance is, cautiously, being opened. In this paper I do not provide straightforward answers but set out to provide conceptual clarity in a complex and controversial terrain, which has the potential for great impact well beyond the world of sport.

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# Thursday, 3 July 2025

## 08:30 - 09:45

Invited Symposium

IS-SH02 From the pitch to the lab and back again: Identifying, understanding and dealing with the various effects of fatigue on sport and exercise performance

**QUANTIFICATION AND MANAGEMENT OF MENTAL FATIGUE AND LOAD IN FOOTBALL**

GARCÍA CALVO, T.
*UNIVERSITY OF EXTREMADURA*

Mental fatigue is increasingly recognized as a crucial factor that influences performance and overall well-being in high-demand sports like football. Players face a combination of intense physical and psychological demands that contribute to cumulative mental fatigue, affecting physical performance, technical-tactical execution, decision-making, and reaction time. For this reason, it is essential to understand how mental fatigue fluctuates throughout the season, the key variables that influence its development, and practical strategies that can be used to manage mental load and effectively control fatigue. From this perspective, mental fatigue can increase over the course of a football season due to the accumulation of training sessions and matches, travel, and the cognitive and emotional demands of competition. However, there are discrepancies in the literature regarding this linear increase across the season, as it appears that these temporal changes in mental fatigue are moderated by competitive context and other situational variables Factors such as motivation, the competitive phase, training load, and the difficulty of opponents contribute to mental fatigue to varying degrees at different points in the season. Understanding this seasonal evolution is crucial in order to adapt recovery and training protocols that help players maintain peak performance. To effectively manage mental fatigue, the quantification and control of mental load are essential. Monitoring mental fatigue is necessary, with neurophysiological measures playing a key role in tracking it and providing targeted support. However, it is not always feasible to use objective measures with current technology, and therefore subjective assessment can also be suitable for understanding the progression of fatigue and mental load. Additionally, it is crucial to generate knowledge on how coaches and technical staff can modulate training demands, using different constraints and strategies. To date, the effect of certain strategies on mental load and fatigue is known, such as creating a positive or negative climate, implementing time constraints for decision-making, adjusting scoring systems, or incorporating rewards or punishments into tasks. However, it is necessary to continue expanding knowledge about other constraints that can moderate these variables. This proactive management approach benefits both short-term performance and long-term player well-being, making mental fatigue management an essential component of football training.

**PERCEIVED FATIGABILITY DURING PHYSICAL TASKS: ELECTROPHYSIOLOGICAL CORRELATES AND INTERVENTIONS**

BERCHICCI, M.
*UNIVERSITY OF ROME FORO ITALICO*

Fatigue is a multidimensional concept combining both neurophysiological and psychological aspects and quantified by objective and subjective measures. Fatigue has received considerable attention, due to its broad impact on both mental and physical performance. Here, the focus is on the brain underpinnings of neuromuscular fatigue and the perception of effort during and after endurance exercise. Indeed, brain changes induced by neuromuscular effort can be recorded with electroencephalography (EEG). The most accredited view is that during muscle fatiguing tasks there is an increase in motor-related potentials and/or a modulation in the alpha frequency band over motor-related regions, working as a compensatory mechanism for peripheral fatigue. However, data from recent studies using high-density EEG and functional magnetic resonance imaging (fMRI) have revealed a modulation that is not limited to motor-related brain regions, but extended to more anterior regions, such as the prefrontal cortex, and involving other frequency band, including theta oscillations. Furthermore, several studies have described EEG changes immediately after exercise, but very few of them have examined EEG during exercise and collected subjective measures of effort and fatigue, such as Borg ratings of perceived effort and fatigue ratings. Accordingly, recording objective and subjective measures of effort, together with brain activities during and after neuromuscular tasks is the only way to obtain a comprehensive view of the processes involved, and to provide the evidence base for countermeasures aimed at tackling fatigue and improving performance. One such approach would be to adopt psychological interventions, like mindfulness. Mindfulness Acceptance and Commitment (MAC) therapy has been proved to be effective in reducing injuries and perception of fatigue, together with increasing emotional regulation, developing greater attention and concentration, improving awareness of the present moment, and accepting/tolerating normal fluctuations in thoughts, emotions and sensations. Taken together, this talk aims to improve understanding of the brain correlates underpinning neuromuscular fatigue and its perception, mechanisms involved during recovery, mindfulness-based programs aimed at reducing fatigue to improve performance and well-being.

**PHYSICAL AND COGNITIVE WARMUPS AS MENTAL FATIGUE COUNTERMEASURES**

RING, C.
*UNIVERSITY OF BIRMINGHAM*

It is well established that fatigue can impair sport and exercise performance. In both athletes and exercisers, mental fatigue - a transient state of tiredness and diminished functioning – is caused various situational demands, such as prolonged cognitive activities and sleep loss. For instance, increased mental fatigue in athletes has been associated with the demands of competition, tournaments, technical briefing/debriefing, early morning and late evening training, travel and jet lag. A number of countermeasures have been evaluated and found to mitigate against the deleterious effects of mental fatigue and/or sleep loss on performance. Effective behavioral mental fatigue countermeasures include mindfulness, motivational self-talk, and music. Similarly, effective sleep loss countermeasures include scheduling rest breaks, consuming stimulant drugs, and using neural stimulation devices. To date the effectiveness of warming up activities has not been systematically investigated. Commonly, individuals are encouraged to physically warmup before they start to play sport or exercise. This is because passive and active warmup activities can help improve subsequent sport and exercise performance. For instance, studies show that 15-minutes of physical warmup activities (e.g., jogging, stretching, joint mobility, jumping) improve subsequent exercise (e.g., running, jumping) and sport (e.g., throwing and shooting) performance. A recent study reported that adding a 10-minute cognitive task before a 15-minute physical warmup improved subsequent basketball dribbling more than no and physical warmups. This exciting new finding suggests the possibility that the improved performance may be attributed, at least in part, to the earlier cognitive task, perhaps by the combined warming up tasks cognitively and physically priming them to perform the task. Accordingly, the purposes of this presentation are to (1) review the effectiveness of extant countermeasures against fatigue and sleep loss, and (2) report the findings of our recent studies on the effects of standard physical warmups and combined physical plus cognitive warmups on performance across a broad range of domains (sport, exercise, cognition), ages (young and older adults), and experiences (fit athletes and sedentary non-athletes) under standard sleep (rested) and sleep deprived (fatigued) conditions. These exciting new findings provide the empirical evidence to encourage individuals and trainers to adapt their standard warmup protocols by adding cognitive drills to better prepare players for competition and older adults for workouts, especially following sleep loss.

## Oral Presentations

### OP-AP15 Team Sports V - Change of Direction and Jumping

**POSITION-SPECIFIC DIFFERENCES IN FORCE-VELOCITY PROFILE AND CHANGE OF DIRECTION PERFORMANCE: A STUDY ON THE U-21 CZECH FOOTBALL PLAYERS**

LIPCÁK, A., KALINA, T., HRUBÝ, M., PALUDO, A.C.
*MASARYK UNIVERSITY*

INTRODUCTION: Force-velocity profile (FVP) measures an athletes ability to generate force and speed during movements like sprints. In soccer, sprinting and change of direction (COD) are crucial for both attacking and defensive actions. These performance may vary based on player's position (e.g., forwards, defenders and midfielders). This study examines the differences in FVP and COD parameters across different positions in a U-21 soccer players.

METHODS: Fifteen professional male U21 Czech National team soccer players participated, categorized by positions: forwards (n = 5), defenders (n = 5) and midfielders (n = 5). Player performed a 40-meter linear sprint and the COD test using the 1080 Sprint system (1080 Motion AB, Sweden). FVP parameters were assessed using the linear sprint with a 3 kg isotonic resistance, analyzing theoretical maximum force (F0), theoretical maximum velocity (V0), and maximal power output (Pmax). Each player completed three trials, with best attempt used for analysis. COD performance was measured using a modified 15-0-5 protocol, assessing maximal acceleration (MaxAcc) and maximal deceleration (MaxDec). Players performed two trials for each turning direction (right and left leg), with the best attempt analyzed. Position differences were evaluated using the delta percentage (Δ%) and Cohens d effect.

RESULTS: Midfielders had highest F0 (8.04 ± 0.41 N/kg), which was 5.27% greater than defenders (7.62 ± 0.34 N/kg) with a large effect (Cohen d = 1.13). Forwards presented greatest V0 (9.65 ± 0.40 m·s-1), 3.94% higher than defenders (9.27 ± 0.47 m·s-1) and 4.04% greater than midfielders (9.26 ± 0.27 m·s-1), with a larger effect (Cohen d = 0.86 – 1.15). In the COD test, midfielders exhibited better performance, achieving 8.10% higher MaxAcc (7.63 ± 0.74 m·s-2) and 7.39% higher MaxDec (9.42 ± 0.76 m·s-2) compared to forwards (MaxAcc = 7.06 ± 0.85 m·s-2, MaxDec = 8.77 ± 0.60 m·s-2, respectively), with moderate to large effects (Cohen d = 0.72 - 0.94).

CONCLUSION: This study that U21 Czech soccer players demonstrated position-specific differences in FVP and COD performance. Midfielders demonstrated higher F0, MaxAcc and MaxDec, reflecting the importance of agility and change direction actions for it position. Forwards excelled on V0 supporting their role in making faster dashes behind the defense and exploiting spaces in the offensive phase. These findings may be valuable for developing specific training programs that focus on enhancing the parameters most relevant to each position.

**EFFECTS OF WEIGHTED CURVILINEAR SPRINTS ON SPRINT AND JUMP PERFORMANCE IN ELITE YOUTH FEMALE FOOTBALL PLAYERS**

SMAJLA, D., GADNIK, K., BRATINA, K., SPUDIC, D., CVJETICANIN, O., SAŠEK, M.
*UNIVERSITY OF PRIMORSKA*

INTRODUCTION: Curvilinear sprint (CS) performance is crucial in football, as a significant portion of sprints during match play occur along curved paths. Weighted sprints are commonly used to enhance performance in linear sprinting, but their application to CS remains underexplored. The addition of extra weight influences the centripetal force needed to maintain a curved trajectory, potentially affecting performance. This study aimed to assess whether additional weight during curvilinear sprints influences linear and CS performance, as well as jump performance, compared to unweighted CS training.

METHODS: Eighteen female football players (age: 16.3 ± 1.2 years; body mass: 58.1 ± 7.2 kg; height: 167.1 ± 4.6 cm) participated in the study. Over two consecutive days, they performed 30-m LS, left and right unloaded CS (CSL, CSR) and loaded CS (9.15-m radius, 2 maximal repetitions, additional load: 10% of body mass), and jump tests, including squat jumps (SJ), countermovement jumps (CMJ), and drop jumps (DJ). The players were divided into two groups: one group performed CS with additional weight equivalent to 10% of their body mass, while the other group performed CS without additional weight (control group). The 6-week intervention included one session per week, with the control group sprinting 80-160 meters weekly (720 m total) and the weighted group sprinting 72-144 meters weekly (612 m total). Distance, speed, and acceleration were monitored using the GPEXE It system (Exelio SRL, Udine, Italy). Peak speed (Speak), peak acceleration (Apeak), and acceleration-speed (AS) profiles (A0, S0, ASslope) were calculated. Additionally, jump height was calculated for SJ, CMJ, and DJ. A two-way repeated-measures ANOVA was conducted to assess the effects of time (pre- vs. post-intervention) and group (weighted vs. control), as well as the time × group interaction. Bonferroni post-hoc tests were conducted to identify specific pairwise differences. Partial eta squared ($\eta^2$) was calculated to report effect sizes. The significance level was set at $p<0.05$.

RESULTS: There were significant main effects of time for CSR Speak ($F = 26.8$, $p = 0.0013$, $\eta^2 = 0.42$) and CSR S0 ($F = 10.2$, $p = 0.0152$, $\eta^2 = 0.22$), while no significant results were observed for any other variables (all $F < 5,2$, all $p > 0.057$). Bonferroni post-hoc tests revealed significant improvements in CSR Speak for both groups, while no significant differences within groups were observed for CSR S0. However, the weighted group demonstrated a trend toward better intervention effects for CSR S0.

CONCLUSION: Our results suggest that the 6-week intervention with limited training volume primarily improved CSR, the players weaker side in curvilinear sprinting, regardless of the group. Improvements observed in both groups indicate that a 10% body mass load may not provide sufficient stimulus to significantly enhance centripetal force during curvilinear sprints. A greater training volume or higher load might be required to elicit more substantial adaptations.

**POWER PERFORMANCE DURING COUNTERMOVEMENT JUMP TEST IN TOP-CLASS ADULT AND YOUNG FOOTBALL PLAYERS**

RIBOLI, A., TRAPLETTI, M., ESPOSITO, F., TRECROCI, A., MAZZONI, S.
*A.C. MILAN S.P.A.*

INTRODUCTION: In top-class football, lower-limb power, along with the ability to effectively utilize the stretch-shortening cycle, plays a fundamental role in profiling physical performance among both adult and young players (1). The Countermovement Jump test (CMJ) have been widely used to assess lower-limb power, with relative take-off power (Wtake-off) being a critical variable (2). Despite CMJ is globally used as a gold-standard assessment across various levels of competition and age-categories, a clear understanding of the neuromuscular capacities of high-level adult and young football players remains limited. Therefore, the current study aims to evaluate the differences in the relative Wtake-off during CMJ across different age-categories and during pre-season vs in-season periods in each category.

METHODS: One hundred and thirty-one elite football players across different age categories of an Italian Serie A club were divided into the following categories: U14 (n=27), U15 (n=22), U16 (n=24), U17 (n=24), U18 (n=13) and PRO (n=21). Data were collected during pre-season (July/August 2023) and in-season period (October to March 2024). Each participant performed three maximal CMJ on force plates (ForceDecks, VALD, Brisbane, Australia) with a complete recovery between each repetition. For each participant, the CMJ with the higher relative Wtake-off ($W\sum kg\text{-}1$) was considered for the analysis. A paired t test was used for the pre-season vs in-season comparison and a one-way ANOVA for repeated measures was utilised to determine the between age-categories difference. The magnitude of the differences was assessed using Cohenís d (d) effect size with 95% confidence intervals [95% CI].

RESULTS: The Figure 1 shows the relative Wtake-off in the CMJ during the in-season period for each age-category. For between-age comparisons the Wtake-off were higher in PRO (d = 0.79 to 1.98) compared to U14 ($P < 0.001$), U15 ($P < 0.001$), U16 ($P < 0.001$), U17 ($P = 0.031$), U18 ($P = 0.017$). Additionally, U14 and U15 showed lower ($P < 0.05$; d = -0.86 to -1.31) Wtake-off than other age-categories. As shown in Figure 2, Wtake-off during the in-season period was higher ($P = 0.015$) compared to the pre-season, but only for PRO (d = -0.58 [-1.03 to -0.11]). No differences were found in pre-season vs in-season for other age-categories.

CONCLUSION: The Wtake-off during CMJ was higher in PRO compared to younger players (U14 to U18). As expected, U14 and U15 showed lower Wtake-off compared to older age-categories, highlighting reduced neuromuscular capacities in younger players. Coaches and football scientists may use these findings to guide neuromuscular performance development in youth elite football. PRO values could serve as benchmarks for power capacity in top-class football. Additionally,

tracking the changes in Wtake-off over the season may help to optimize strength and power training, potentially accelerating individual development and facilitating the transition between youth to PRO football.

## Invited Symposium

### IS-PN04 Digital health exercise interventions for primary and secondary cardiovascular disease prevention: innovations from 3 European countries

**DEVICE-MEASURED AND MOBILE PHONE-ASSISTED SEDENTARY BEHAVIOR REDUCTION IN PATIENTS WITH METABOLIC SYNDROME: A 6-MONTH RANDOMIZED CONTROL TRIAL**

HEINONEN, I.
*TURKU PET CENTRE & UNIV. OF TURKU*

Epidemiological and big data studies show physical activity and sitting are associated health benefits and detriments respectively. Most physical activity studies that have employed device-measured objective have almost solely relied on measurement durations of 4-7 days and 10-hour daily measurement time, even in intervention studies. Consequently, intervention studies to address the role of sitting and physical activity are needed, which also measure all stationary periods and movements 24/7 for the whole study period. This talk will present such an intervention employed in Finland, which aimed to reduce daily sitting by one hour per day for 6-months in a randomized controlled setting in patients with metabolic syndrome. This talk will outline how all daily (in)activity was measured by accelerometers (6-second intervals) at baseline and during 6-month study period in both control and intervention groups. Participants followed their daily activity online from mobile phone application (EXSED), which also directly updated their data into the cloud, from which data was also accessed and analyzed. This talk will present the findings of how the intervention induced the requested behavior change and how the applied approach also led the control group increasing their daily steps over 6-month period. The talk will also cover numerous clinical and physiological effects that were measured by imaging (positron emission tomography and magnetic resonance imaging) in different tissues, such as skeletal muscle, heart, liver, bone, kidney and adipose tissue and other methods, such as fitness, blood pressure and cardiac echocardiography and insulin sensitivity at the whole-body level.

**MOBILE HEALTH BIOMETRICS TO PRESCRIBE EXERCISE AND PHYSICAL ACTIVITY TO ENHANCE ADHERENCE AND CLINICAL OUTCOMES (MOTIVATE): IN PATIENTS CARDIOVASCULAR DISEASE**

JONES, H.
*LIVERPOOL JOHN MOORES UNIVERSITY*

Encouraging a physically active lifestyle through regular exercise (purposeful structured activities with a goal of improving health and fitness) and lifestyle physical activity (activities performed in day-to-day life) is the cornerstone to management of cardiovascular risk factors and dieases. Given poor uptake and adherenace to current stratergies (e.g. in UK exercise based cardiac rehabilitation uptake 52%) innovative solutions are urgently needed. This talk will outline the innovative MOTIVATE digital health intervention solution and present data from suite of randomised control studies on patients with cardiovascular disease including those referred to cardiac rehabilitation in the UK. MOTIVATE is a home-based exercise counselling intervention supported by mobile health (mHealth) technologies that provide biometric feedback and data sharing to best support patients and health professionals. Together the elements provide comprehensive support by promoting lifestyle PA and specifically targeting personally-calibrated moderate-to-vigorous intensity purposeful exercise. This talk will present data to show improvements in exercise adherance and compliance in a number of different heathly and clinical popultations (e.g. patients with coronary artery disease) which are superior to control interventions without mHealth technology. Moreover, the talk will show data on improvements in relevant clinical outcomes including BP, cholesterol, HBA1c and body composition.

**SIT LESS, STEP MORE: HOME-BASED MODULES TO PROMOTE PHYSICAL ACTIVITY IN DAILY LIVING TO IMPROVE CLINICAL OUTCOMES IN PATIENTS CARDIOVASCULAR DISEASE. TRIALCHD, AF AND HF**

THIJSSEN, D.
*RADBOUD UNIVERSITY NIJMEGEN MEDICAL CENTRE*

Over the past decade, exercise-based cardiac rehabilitation (ExCR) is gradually moving from a hospital-based environment towards a home-based, where digital innovations are adopted to integrate a healthy lifestyle in the patient's home environment. In this talk, we discuss novel insights pertaining to the effects of ExCR and highlight innovations regarding the translation of ExCR to the home environment. First, we will discuss recent observations from the CaReMATCH Individual Patient Data meta-analysis, that includes data from 8 RCTs (n=4,987) on the effects of ExCR in patients with coronary heart disease. Using a mediation analysis, we revealed an important role for the improvement in health-related quality of life, but not cardiorespiratory fitness, in explaining the lower risk for all-cause and cardiovascular-related hospitalization. These observations support that promoting (low- to moderate-intensity) physical activity in daily living has strong clinical potential. Second, we performed a series of studies to co-create and validate a tri-axial activity monitor to sedentary be-

haviour, and to reduce and break up prolonged sitting periods in patients with cardio- and cardiometabolic disease. Third, we will share insight into the potential clinical relevance and importance of step count as a simple measure to integrate into clinical practice. In this work, we examine how increasing the step count can lead to clinically meaningful effects for patients with atrial fibrillation, coronary heart disease, and heart failure.

## Oral Presentations

### OP-AP16 Training and Testing IV - Power and Strength: Sport-specific aspects

**KNEE EXTENSION STRENGTH IS AN IMPORTANT FACTOR FOR BADMINTON-SPECIFIC AGILITY EVEN AMONG ELITE PLAYERS**

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INTRODUCTION: Badminton is a fast-paced racket sport that hits a shuttlecock in rallies approximately once per second (Iizuka et al. 2020). Thus, agility is required to gain an advantage in matches. Agility in badminton is characterized by frequent lunges (badminton-specific agility). Although previous study conducted a custom-made badminton-specific agility test and showed that players at a higher competitive level tend to have greater badminton-specific agility (Ando et al. 2024), the factors influencing badminton-specific agility in each leg remain unknown. This study examined the relationship between leg muscle strength and badminton-specific agility in elite players.

METHODS: Twenty-seven male and twenty-three female world class or elite/international level badminton players completed the following tests: (1) the badminton-specific agility test (Ando et al. 2024), which measures the time taken to reach sensors placed at the four corners of a badminton singles court using badminton-specific movements including lunges; and (2) the isokinetic knee extension strength test at angular velocities of 60°/s and 180°/s. Spearman's test was used to assess the relationships between them. The significance level was set at $p<0.05$.

RESULTS: Significant inverse correlations were found between the knee extension torque per body mass for the non-dominant leg (non-racket hand side) both at 60°/s and 180°/s and reach time of badminton-specific agility (males at 60°/s: $r_s = -.619$; males at 180°/s: $r_s = -.579$; females at 60°/s: $r_s = -.445$; females at 180°/s: $r_s = -.446$), whereas only at 60°/s was inversely correlated for the dominant leg (males: $r_s = -.413$; females: $r_s = -.490$).

DISCUSSION:

One of the main roles of the non-dominant leg during lunges in badminton is to accelerate the body. Thus, it was speculated that higher knee extension strength contributed to increased lunge speed and subsequently enhanced badminton-specific agility. On the other hand, the dominant leg plays a role in returning to its original position after a shot with a lunge. The foot contact time of the dominant leg during lunge is approximately 0.7s (Lam et al. 2017) and is considered to be longer than that of the non-dominant leg. Taken these facts and this study's result together, knee extension strength of the dominant leg in the low-speed range, which is closer to the actual movement speed, is considered to be important.

CONCLUSION: The most notable finding of this study is that knee extension strength is crucial for badminton-specific agility even in world class and elite/international level players. Additionally, the results suggest that there is a different demand for force production between the dominant and non-dominant legs. Training the knee extensor muscles at an appropriate speed corresponding to lunge movements may enhance badminton-specific agility.

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**THE EFFECTS OF A CERVICAL STRENGTH TRAINING INTERVENTIONS ON ISOMETRIC NECK STRENGTH IN FEMALE RUGBY UNION ATHLETES.**

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INTRODUCTION: Rugby union (RU) athletes are at risk of concussion due to the contact nature of the sport. There are biological differences between females and males, however there is a lack of evidence on female RU athletes . Female athletes are more susceptible to sport-related concussions (SRCs ) and experience worse outcomes than male athletes (McGroarty, et al.,2020). Neck training modalities can provide greater protection in men's sport (Daly, et al., 2021), but there is a paucity of research exploring neck training in female rugby. The purpose of this study was to assess the changes in neck strength between three different 8-week isometric neck strength protocols in female Rugby Union players.

METHODS: Participants were matched random assigned based of the sum of the individuals total preintervention neck strength (flexion (F), extension (E), left-side flexion (LSF), and right-side flexion (RSF)) to either a Hypertrophy Training (HST) group, Maximal Strength Training (MST) group or World Rugby injury prevention (WRIP) group.

Thirty-nine participants with 10 Premiership Women's Rugby (PWR) player and 29 UK collegiate rugby athletes undertook the interventions. Three sets per week were performed in addition to their usual strength and conditioning program. The WRIP (N=15) followed a self-directed manual contraction in F, E, LSF, RSF, left rotation, and right rotation, each direction for 15s at a perceived maximal intensity. The MST (N=12) and HST (N=12) intervention group attached a dynamometer to a head harness and perform isometric cervical contractions prescribed load intensities.

RESULTS: Pre and post measures of neck strength for F, E, LSF and RSF was measured using a fixed-frame dynamometer (ForceFrame, VALD, Newstead, Australia).

HST had the greatest total increase of 99.6N (+13.18%), compared to 59.1N (+7.60%) in the MST and a -2.1N (-0.32%) decrease in the WRIP training group. HST had increased strength in all four directions. (F = 18.8N (+9.47%), E = 22.4N (+10.43%), LSF = 35.9N (+22.04%), RSF = 22.5 (+12.53%). Similarly, MST showed increase strength of 0.60% in F, 3.43% in E, 17.82% in LSF and 11.26% RSF. However, WRIP showed a 0.60% decrease in flexion and a 4.72% decrease in extension following the 8-week program. However, WRIP did increase in LSF and RSF of 1.26% and 4.44% respectively.

CONCLUSION: HST and MST increased neck strength compared to a self-directed resource-efficient neck-strengthening program (WRIP). Subsequently, the HST and MST programmes may be appropriate across a range of trained female RU players to reduce neck injuries such as SRCs. Practitioners working with female RU players should therefore consider using dynamometers to train the neck musculature in individualised intensities.

*Please note, data collection was completed on the 10th February 2025. Therefore, full statistical analysis will be completed prior to July 2025.

Ref:

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**ASSOCIATIONS OF MAXIMAL STRENGTH AND PEAK POWER WITH ROWING PERFORMANCE IN NATIONALLY AND INTERNATIONALLY COMPETING GERMAN ROWING ATHLETES**

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INTRODUCTION: In addition to a high aerobic capacity, rowing is also characterized by high demands on strength abilities. While previous studies reported associations between rowing performance and various maximal strength indices of the main muscle groups (leg muscle, back muscle) involved in the rowing stroke, little is known about the association with peak power (PP). Therefore, this study aimed to investigate associations of PP with 2000m rowing ergometer performance (TT) in well-trained rowing athletes of different age groups.

METHODS: 63 male (age: 18.52±3.34 years, body height: 190±6.84 cm, body mass: 86.33±8.04 kg) and 50 female (age: 19.30±3.50, body height: 176.94±5.41 cm, body mass: 73.64±7.75 kg) nationally and internationally competing athletes of the U17 (20 male, 10 female), U19 (21 male, 14 female), U23 (9 male, 20 female) and Elite (13 male, 6 female) category participated in this study. PP was assessed through the individual load velocity profiling (LVP) by an incremental 1 repetition maximum test (1RM) using a linear velocity transducer (Gymaware). LVP covered the main muscle groups deemed important for rowing performance through the following exercises: Squat (S), Deadlift (DL) and Bench pull (BP). Additionally, TT was assessed on a Concept 2 rowing ergometer within 2 weeks of the LVP. Generalized linear models were calculated separately for both sexes to assess associations between TT and the 1RM as well as PP of the 3 exercises. To adjust for potential biological heterogeneity within the sexes, the body mass index (BMI) was used as a covariate.

RESULTS: Significant associations were found for TT and S 1RM (β: -0.38; β: -0.96), DL 1RM (β: -0.35; β: -0.72) and BP 1RM (β: -0.88; β: -1.77) in male and female athletes, respectively (all $p \leq 0.001$). These significant associations were not affected when adding the BMI as a covariate. Similarly, significant associations were found for PP S (β: -0.05; β: -0.12), PP DL (β: -0.05; β: -0.16) and PP BP (β: -0.11; β: -0.21) in male and female athletes, respectively (all $p \leq 0.001$). However, after adding the BMI to the model only the PP of DL and BP but not S remained significantly associated with TT.

CONCLUSION: We showed that the 1RM of all 3 exercises and PP of DL and BP were significantly associated with TT in both male and female athletes, even when adjusting for the BMI. Our data indicate that in addition to the rather slow 1RM, also PP and, therefore, the ability to generate high movement velocities (MV) might affect TT. Especially the association with BP PP may highlight the importance of PP in specific parts of the rowing stroke, such as the explosive finish phase where the back muscles generate most of the power. Thus, further studies should focus on the associations of PP and MV with different phases of the rowing stroke. In addition, since these cross-sectional findings might be influenced by the athlete's strength training experience the effect of PP and MV on TT should be further investigated in interventional studies.

**THE IMPACT OF WEEKLY TRAINING VOLUME ON NEUROMUSCULAR PERFORMANCE IN NCAA DIVISION I FEMALE ROWERS**

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INTRODUCTION: Countermovement jump (CMJ) derived neuromuscular performance characteristics may be sensitive proxies of fatigue throughout competitive basketball seasons, with select metrics displaying dose-dependent changes

with measures of external workload (1). Few data exist on whether similar dose-response relationships exist between weekly training volumes and alterations in select CMJ metrics in the sport of rowing. The purpose of this study was to retrospectively analyze weekly training volume (minutes) with weekly CMJ data throughout a competitive rowing season to determine if select CMJ metrics are sensitive to changes in weekly training volumes.

METHODS: Twenty-nine NCAA Division I female rowers (median +/-IQR: age=20 +/- 1 years, Height: 69 +/-3 inches, Weight 170 +/- 48 pounds) performed three weekly CMJs on dual unidimensional (Hawkin Dynamics) force plates at the beginning of their strength and conditioning session. Data was collected throughout the spring competitive season (January 4, 2024 – April 30, 2024). Linear mixed-effects models with restricted maximum likelihood were used with athlete identity intercept as the random factor, weekly training volume as the independent variable or fixed-factor, and the following CMJ variables as individual dependent variables: countermovement depth, peak propulsive force, positive net impulse, braking rate of force development, average propulsive force, peak propulsive force, braking net impulse, and propulsive net impulse. Statistical significance was set a priori at $p < 0.05$.

RESULTS: All CMJ metrics displayed significant changes in response to weekly training volume alterations throughout the 2024 spring rowing season ($p<0.01$). Braking RFD was the most sensitive to changes in training volume ($p<0.001$), with a one standard deviation change in training volume resulting in a 218N·s-1 decrease in braking RFD. Further, the effect of increased training volume was largest on braking net impulse (estimate: -3.33) compared to propulsive net impulse (estimate: -1.62). Countermovement depth was the only metric to display a significant positive effect in response to increases in training volume (estimate: 0.13).

CONCLUSION: Kinetic metrics from the CMJ braking phase may be the primary variables of interest when monitoring potential volume-induced alterations in neuromuscular performance in collegiate female rowers. Braking RFD appears to be the most sensitive to increases in weekly training volume in terms of absolute change in the rate at which female rowers generate force during the CMJ braking phase, with athletes displaying a shallower countermovement depth in response to greater training volumes, which aligns with findings in other sports such as basketball (1).

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**RELATIONSHIPS OF SPRINT PERFORMANCE AT DIFFERENT PHASES WITH HIP FLEXION AND KNEE EXTENSION STRENGTH**

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INTRODUCTION: Sprint performance is related to the strength of lower-limb muscles such as the hip extensors, hip flexors and knee extensors (Dowson et al., 1998). Using a treadmill, Willer et al. (2024) found that the contributions of the hip extensors and flexors to the total work rose with running velocity, while that of the knee extensors declined. In addition, we (Kobayashi et al., 2023) found that hip extension strength is correlated with sprint performance more strongly for the late (> 40 m, maximum velocity) than the early (< 20 m, acceleration) phase of sprinting. However, little is known about how hip flexion (HF) and knee extension (KE) strength are related to different phases of sprinting. This study tested a hypothesis that KE and HF strength are most strongly associated with different phases of sprinting; early and late phases of sprinting, respectively.

METHODS: Twenty-nine healthy young adults (17 males and 12 females, non-obese [BMI: 18-25], low-moderate recreational physical activity) participated. The mean velocity of the start (0-10 m), acceleration (10-20 m) and maximum velocity (30-40 m) phases were measured with a laser system during 60-m sprint running. One-repetition maximum (1RM) HF and KE lifting strength of both legs was assessed unilaterally. Partial correlations of sprint performance variables with HF or KE strength were calculated for the whole cohort, controlling for sex. Correlation coefficients between sprint performance variables and strength measures were then compared 1) among the phases within HF or KE 1RM, and 2) between HF and KE 1RM at each phase, by William's t-test.

RESULTS: Absolute and relative (to body mass) HF 1RM were both weak–moderately correlated with the velocity of the start ($r = 0.649$ and 0.485), acceleration ($r = 0.683$ and 0.643) and maximum velocity ($r = 0.683$ and 0.650) phases ($p \leq 0.009$). Absolute KE 1RM was weakly correlated with the velocity of the start ($r = 0.417$) and acceleration ($r = 0.393$) phases ($p \leq 0.038$) but not with the maximum velocity phase ($r = 0.347$, $p = 0.071$). Relative KE 1RM was weakly correlated with the velocity of the acceleration ($r = 0.464$) and maximum velocity ($r = 0.422$) phases ($p \leq 0.025$) but not with the start phase ($r = 0.357$, $p = 0.062$). There were no significant differences in the correlation coefficients (r values) between the running velocity and HF or KE 1RM among the phases for both absolute and relative 1RM ($p \geq 0.150$). The coefficients of absolute 1RM with running velocity were significantly stronger for HF than KE 1RM for the acceleration and maximum velocity phases ($p \leq 0.035$) but not for the start phase ($p = 0.098$), with no significant differences between HF and KE 1RM in relative 1RM ($p \geq 0.175$).

CONCLUSION: These results suggest that HF and KE strength are both associated with sprint performance similarly among the phases but more strongly for HF than KE strength.

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## Oral Presentations

### OP-BM17 Running III

**MUSCLE-SPECIFIC CONTRIBUTIONS OF FORCE AND FORCE-ABILITY TO THE METABOLIC COST OF WALKING AND RUNNING.**

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INTRODUCTION: During locomotion, running is generally more metabolically costly than walking at similar speed [1]. The metabolic cost (Mc) is primarily determined by the ATP required to produce force [2]. Mc is thus modulated by a muscles ability to produce force in response to muscle activation (fability), as well as the velocity of contraction and muscle length [3]. However, the interplay between these mechanisms to explain why walking is a more economical mode of locomotion than running remains unclear. The aim of this study was to determine how different lower limb muscle recruitment and fability, during walking and running determine differences in Mc.

METHODS: Eleven endurance runners (60.5 ± 7.1 kg; 169.0 ± 6.6 cm; 23.6 ± 3.3 y) performed two 6-minutes walking and running trials on a motorized instrumented treadmill (Bertec) at a constant speed of 1.75 m/s. The kinematics were recorded with nine optoelectronic cameras. Electromyography (EMG) data from eight knee and ankle muscles, kinetics and kinematics were integrated into an EMG-driven model proceeding by inverse dynamics to estimate locomotor muscle fability and force. Mc was estimated by indirect calorimetry from the expired gas. Comparisons between walking and running were made for Mc, and integral and maximal values of force and fability during the locomotion cycle using parametric statistical mapping.

RESULTS: The Mc of running was 34% higher than walking (d = 3.0). The rectus femoris, vastus medialis, vastus intermedius and vastus lateralis produced more force during propulsion during running than during walking, despite similar fability. The soleus, during propulsion, and the tibialis anterior, during braking, produced more force during walking, however, these forces were produced with a greater fability integral (i.e. contraction generating more force but under more economical conditions). Positive correlations were found between Mc and the force integral of the tibialis anterior (r = 0.72, p = 0.005) for walking, and negative correlations between Mc and the fability integral of the vastus lateralis (r = -0.52, p = 0.049) and vastus intermedius (r = -0.56, p = 0.036) for running.

CONCLUSION: The greater force produced by the knee extensors, particularly during braking and propulsion, where producing force is costly, contribute to the greater Mc during running, compared to walking. The greater force of the tibialis anterior and soleus during walking does not increase the Mc of this mode of locomotion, as it is produced economically. Transposing force production patterns of walking, which appears energetically efficient, with those of running may offer a strategy to reduce Mc and enhance running performance.

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[2] Riddick et Kuo, Sci Rep (2022)

[3] Sasaki et Neptune, J Biomech (2006)

**METABOLIC COST AND LOWER LIMB MUSCLES ACTIVITY IN RUNNING WITH HEAD- AND TAILWIND DRAG**

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INTRODUCTION: Wind drag impacts how athletes run and how much energy they spend to do it. With headwind, runners increase their positive center of mass work and reduce frontal area, while they increase negative work with tailwind (1). However, it is unclear how these adjustments affect the metabolic cost of running and the activity of individual muscles. Understanding it would shed light on how humans adapt their locomotion to external forces, how well treadmill experiments can be generalized to outdoor conditions, and how much air drag impacts athletes' performance. This study investigated how wind-induced drag affects the metabolic cost and the activity of lower limb muscles during running.

METHODS: Eight male endurance athletes (age: 32±6 y, mass: 63.2±6.6 kg; height: 1.77±0.05 m, personal best 10000 m: 31:20±01:12 min:s) ran at 4.0 m/s on an instrumented treadmill in a wind tunnel, where tail- and headwind speeds ranged from 0 to 12.5 m/s. Metabolic cost, in J/(kg m), was measured via gas exchange analysis. Electromyographic activity (Delsys, 1kHz) was recorded unilaterally from erector spinae, gluteus maximus, gluteus medius, vastus lateralis, vastus medialis, rectus femoris, sartorius, tensor fasciae latae, adductor longus, biceps femoris, semitendinosus, gastrocnemius lateralis, gastrocnemius medialis, peroneus longus, and tibialis anterior; the average activity per unit distance was then computed (2). Drag force was calculated as the average horizontal ground reaction force over an integral num-

ber of strides (1). Mixed effects models regressed metabolic cost and muscle activities against drag force; for each muscle, linear and quadratic models were compared, and the model with the lowest Akaike Information Criterion was chosen.

RESULTS: Drag forces ranged from -58 to 53 N, where negative and positive signs indicate tailwind and headwind, respectively. Over such a range, metabolic cost increased linearly with headwind drag and decreased linearly with tailwind drag (cost = 4.0 + 0.04*drag force, conditional R-squared = 0.90). Increasing headwind drag significantly increased the activity of gluteus maximus and gastrocnemius lateralis ($p<0.001$) while reducing that of gluteus medius ($p<0.001$); the reverse trends were observed for tailwind. Biceps femoris and peroneus longus activity showed a U-shaped response, their activity being lowest at zero drag and increasing with both head- and tailwind ($p < 0.001$). The remaining muscles were not significantly affected by wind.

CONCLUSION: Metabolic cost increases linearly with headwind drag and decreases linearly with tailwind drag, while lower limb muscles show heterogeneous activation patterns in response to wind. These muscle-specific variations are independent of metabolic cost and may optimize posture, frontal area, or force and work production across wind conditions.

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**ACUTE BIOMECHANICAL RESPONSES TO LOWER-BODY POSITIVE PRESSURE TREADMILL UNLOADING IN COMPETITIVE RUNNERS**

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INTRODUCTION: Lower-Body Positive Pressure Treadmills (LBPPT) enable fine-grained control over the external load during running. These devices provide body weight support (BWS) through an overpressure in a chamber surrounding the athletes and running surfaces. Previous research on the effects of BWS on running biomechanics revealed changes in spatiotemporal (1) and kinematic variables (2). However, most studies neither provided sex-specific analyses nor included nonlinear running stability, a measure for locomotor control capabilities. Biomechanics and running injury epidemiology differ between sexes (3, 4). Hence, this work aimed to investigate how BWS affects running biomechanics in male and female athletes.

METHODS: Twenty-six competitive distance runners (15 female, age: 33.6±9.8 years, BMI: 21.6±2.4 kg·m-2) completed one running session on an LBPPT (AlterG 500 Pro). Following a familiarisation period, the experimental protocol consisted of nine running bouts at randomly ordered unloading stages of 0 – 80% BWS in steps of 10%. Each bout lasted three minutes at 12 km/h with no rest in between. We measured plantar pressure with two pressure-sensing insoles (200Hz, loadsol, novel) as well as acceleration and angular velocity at the right foot and right tibia using inertial measurement units (500Hz, ICM-20601, TDK InvenSens). We calculated stance time, swing time, normalized ground contact time, and maximum plantar force during stance from the insole data. From the inertial sensor data, we calculated peak tibial acceleration and running stability as the largest short-term finite-time divergence exponent $\lambda s$ (5). Linear mixed-effects models were used to investigate the effects of BWS, sex, and their interaction on all biomechanical variables.

RESULTS: All variables were significantly affected by increasing BWS with the largest effects for reduced maximum plantar force ($\beta$=-0.81 [-0.86 to -0.76], $p<0.001$), increased swing time ($\beta$=0.74 [0.67 to 0.82], $p<0.001$), and decreased normalized ground contact time ($\beta$=-0.61 [-0.66 to -0.56], $p<0.001$). Running stability decreased at the tibia ($\beta$=0.10 [0.02 to 0.17], $p=0.009$) but increased at the foot ($\beta$=-0.12 [-0.22 to -0.02], $p=0.017$). There were no significant BWS*sex interaction effects among the variables under investigation.

CONCLUSION: Our results confirm previous studies showing reduced external load metrics and changes in spatiotemporal running patterns with increasing BWS. Running stability was also affected by BWS but the small effect sizes question its practical relevance. We showed that despite overall differences between male and female runners' technique, both sexes respond similarly to BWS. These are important findings especially for practitioners when planning return-to-sport programs with an LBPPT available.

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**THE ROLE OF NEUROMUSCULAR ACTIVATION IN LOWER-LIMB STIFFNESS AND GROUND REACTION FORCE FOR RECREATIONAL RUNNERS**

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INTRODUCTION: Lower-limb stiffness and ground reaction forces (GRF) are critical biomechanical factors influencing neuromuscular activation during running. While spring-mass (leg/vertical stiffness) and torsional spring (joint stiffness) models have been proposed to optimize energy efficiency and elastic energy storage in muscle-tendon units, their neuromuscular implications remain underexplored in recreational runners. This study investigates the relationship between lower-limb stiffness, GRF characteristics, and muscle activation patterns in this population.

METHODS: Twenty-nine male recreational runners performed a 4-minute constant-speed running set at 12 km/h. Eight infrared cameras, a three-dimensional motion capture system, and a 3D force platform were used to collect lower-limb stiffness and GRF data. Surface electromyography (sEMG) signals were obtained from nine lower-limb muscles on the right leg: gluteus maximus, rectus femoris, vastus lateralis, vastus medialis, biceps femoris, tibialis anterior, gastrocnemius lateralis, gastrocnemius medialis, and soleus using a wireless sEMG system. Correlations between lower-limb stiffness, GRF, and muscle root-mean-square (RMS) were investigated using Pearson Product Moment correlations.

RESULTS: Results revealed moderate correlations between lower peak impact force and greater gluteus maximus peak RMS ($r = -0.389$, $p < 0.05$). Lower peak active force was moderately correlated with greater gluteus maximus RMS at foot-strike ($r = -0.385$, $p < 0.05$) and larger tibialis anterior peak RMS ($r = -0.431$, $p < 0.05$). Lower peak propulsion force was moderately correlated with greater vastus lateralis RMS at foot-strike ($r = -0.445$, $p < 0.05$). Lower peak braking force was moderately correlated with greater tibialis anterior RMS at foot-strike ($r = 0.369$, $p < 0.05$). Smaller knee stiffness was moderate to largely correlated with smaller soleus and tibialis anterior RMS at foot-strike and lower soleus peak RMS ($r = 0.388$~$0.504$, $p < 0.05$).

CONCLUSION: This study demonstrates that biomechanical variables (lower-limb stiffness, GRF) are associated with neuromuscular strategies in recreational runners. Gluteus maximus activation was inversely associated with impact and active forces, whereas tibialis anterior activation correlated with reduced active/braking forces, and vastus lateralis activation at foot-strike attenuated propulsion forces. Reduced knee stiffness significantly correlates with diminished soleus and tibialis anterior activation, suggesting distal muscle co-activation regulates joint rigidity. These findings imply that targeted modulation of vertical/horizontal forces and knee stiffness could optimize neuromuscular control, informing injury-prevention training paradigms.

# Oral Presentations

## OP-BM05 Muscle Tendon Function

### MUSCLE-TENDON BEHAVIOUR DURING WALKING IN PEOPLE WITH TYPE 2 DIABETES AND HEALTHY CONTROLS

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INTRODUCTION: Hyperglycemia in Type 2 diabetes (T2D) leads to an increase in non-enzymatic glycation products (e.g., glycated hemoglobin: HbA1c) that accumulate irreversibly, damaging musculoskeletal tissues. Couppé et al. [1] found that Achilles tendon stiffness is higher in diabetic patients, potentially altering gait and increasing the metabolic energy cost of locomotion (Cnet). The present study used ultrasound, kinematic, and metabolic measurements during walking to test the hypothesis that higher HbA1c in T2D affects muscle and tendon behavior, with increased energy expenditure.

METHODS: Twenty-three well compensated T2D patients (age 62±5 years; weight 79±12 kg; height 1.73±0.09 m; HbA1c: 55±9 mmol/mol; IPAQ 1596±432 MET/week) and 14 healthy matched controls (64±5 years; 73±12 kg; 1.73±0.09 m; HbA1c: 36±3 mmol/mol; IPAQ 14896±532 MET/week) walked on a treadmill at 4 km/h for 5 minutes. Kinematic and metabolic data were collected using a 3D motion capture system and breath-by-breath metabolimeter. Ultrasound images of the gastrocnemius medialis were recorded. Stride length (SL), stride frequency (SF), contact time (CT), and swing time (ST) were obtained from kinematic analysis. Cnet was calculated as net oxygen uptake per walking speed. Fascicle length was measured via ultrasound, and series-elastic element (SEE) length was estimated. An unpaired SPM t-test assessed differences in fascicle and SEE behavior during the stance phase. Maximum fascicle shortening, SEE strain, and SEE recoil were also analyzed.

RESULTS: No significant differences were observed in SL, SF, CT and ST between populations. Cnet showed no significant differences between populations. SPM analysis revealed significant differences in fascicle and SEE behavior during the stance phase: healthy participants exhibited shorter fascicle lengths (20–100% stance phase, $P<0.01$), while T2D patients showed greater SEE lengths throughout the stance phase ($P<0.001$). Maximum fascicle shortening and SEE strain were lower in T2D patients ($P<0.05$), but no differences were found in tendon recoil. Significant negative ($R2=-0.37$, $P<0.05$) and positive associations ($R2=0.43$, $P<0.05$) were observed between HbA1c and tendon strain or maximum fascicle shortening, respectively.

CONCLUSION: People with T2D walked with longer fascicle lengths and less strain of the SEE compared to healthy individuals. While a reduction in maximum fascicle shortening could reduce the metabolic energy cost during the stance phase, a decrease in elastic strain is likely to increase energy expenditure [2]. Our findings indicate that these two opposing mechanisms may balance each other out. Indeed, despite higher HbA1c levels being associated with muscle fascicle and SEE behavior, we found no significant differences in kinematic or energetic parameters during walking between individuals with well controlled diabetes and controls.

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### HOMOGENOUS MUSCLE HYPERTROPHY OF THE TRICEPS SURAE MUSCLE IN RESPONSE TO VARIED MECHANO-METABOLIC STRESS EXERCISE

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INTRODUCTION: Muscle volume is an important determinant for its' power generation capacity and is typically investigated in various population groups to evaluate the effectiveness of different interventions to enhance muscle function. Previous studies (1) have indicated that some muscles can adapt to training with a region-specific hypertrophy (changes in its shape), which would indicate different fiber type distribution as well as distinct innervation patterns within the muscle during exercise. The current study examined whether a triceps surae (TS) high metabolic stress exercise at different operating lengths (consequently at either low or high muscle force potential) leads to distinct mechanical and region-specific morphological adaptive changes.

METHODS: 12 young adults (27±5 yrs) underwent a 12-week exercise intervention 3x week consisting of 3 sets of cyclic unilateral isometric plantarflexion contractions at 80% of maximal voluntary contraction until failure to induce high muscle metabolic stress. Based on the TS muscle force-length-relationship (2), low and high levels of mechanical stress were respectively induced using a short (PF; $115^0$) or a long (DF; $85^0$) muscle-tendon unit (MTU) length for either legs. TS MTU mechanical and morphological properties were assessed via ultrasonography and dynamometry. Magnetic resonance imaging was used to reconstruct all three compartments of the TS muscle in order to determine their volume and muscle specific shape factors (3).

RESULTS: Similar adaptive increments ($p<0.05$) were found in TS muscle strength (~20-25%), pennation angle (~10%), maximal anatomical cross-sectional area (ACSAmax; ~5%) and muscle volume (on average ~6% across compartments) between DF and PF legs following the 12 weeks of exercise. Despite of the majority of muscle growth seemingly taking place

closer to the belly region of the muscle, no clear region-specific adaptation was detected and ACSAmax demonstrated no significant shift in its position in relation to the muscle length in either of the trained legs or analysed compartments of the TS. Accordingly, no change in the individual muscle specific shape factors were found over the 12-week training period.

CONCLUSION: The findings provide evidence that skeletal muscles are highly responsive to metabolic stimuli as even moderate mechanical tension and stress increases their force and power generation capacity. Moreover, exercising at different operating lengths of the contractile element within the force length-relationship seems not to cause inhomogeneous region-specific hypertrophy in skeletal muscles.

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**AGE-RELATED CHANGES IN FASCICLE BEHAVIOR DURING LOW RAMP ISOMETRIC CONTRACTIONS IN TRAINED VS. UNTRAINED OLDER MALES**

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INTRODUCTION: The aging process promotes absolute decrease in fascicle length and angle [1] and changes in the morphology of the contractile and non-contractile tissues, which affects force capacity [2]. While muscle contractile elements are known to produce force, the intramuscular connective tissue has a key role in force transmission and in maintaining the structural integrity of the muscle. For pennate muscles to contract, changes in fascicle length (Lf) and angle (FA) and muscle thickness (MT) [3] occur. In this scenario, the age-related changes in muscle architecture and morphology impact on muscle shape changes during contraction [4] and the relative fascicle behavior during contraction. However, it is not known whether muscles of elderly individuals with high physical activity status, that is known to mitigate muscle loss and maintain fascicle length and angle [5], interfere in the fascicle behavior in comparison to a younger population reference. In this study we analyzed fascicle behavior during ramped isometric knee extension comparing elderly with high and low physical activity status to young adults.

METHODS: In this preliminary analyses of an ongoing study, data of twenty-one elderly individuals, eleven (76.1±5.1 years old; 22.1±4.0 and 39.5±3.3 mL/min/Kg) with low aerobic capacity (EL), determined by VO2Max, ten (70.0±3.9 years old; 39.5±3.3 mL/min/Kg) with high physical activity capacity (EH) and eight young adults (Y; 25.6±2.3 years old) were analyzed. Ultrasound imaging was employed to measure changes in muscle architecture during isometric ramp contractions up to 30% of the maximum voluntary contraction (MVC), with slow force increase (2% MVC/s). The ultrasound recordings were synchronized to the force signal. Changes in fascicle behavior (Lf, FA and MT) were compared from the beginning of the force contractions to 10, 20 and 30% of MVC.

RESULTS: Two-way ANOVA showed a decrease in Lf of EL with increasing force, with significantly lower Lf ($p<0.05$) at 30% of MVC compared to Y. MT was significantly decreased from the beginning of the contraction to 10, 20 and 30% ($p<0.01$) of MVC in both EH and EL. In addition, the decrease in MT showed a significant trend ($p=0.06$) only in EL compared to Y at 30% of MVC.

CONCLUSION: These preliminary results show that changes in VL architecture during isometric submaximal tasks occur regardless of age, however the amount of change is higher in elderly individuals with lower aerobic capacity when compared to a young population. It is possible that the training status of the elderly individuals mitigates the architectural and morphological age-related changes in the contractile and non-contractile tissue, which will reflect in lower alterations is muscle fascicle behavior during contraction.

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**ELASTIC THERAPEUTIC TAPING HAS SIGNIFICANT EFFECTS ON ALONG-MUSCLE FASCICLE LOCAL LENGTH CHANGES**

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INTRODUCTION: Kinesio taping (KT) is the utilization of an elastic therapeutic tape for prevention and treatment of various sports injuries and for performance enhancement. Despite being widely used to improve muscular function for Olympic and Paralympic athletes, an understanding of KT effects on muscular mechanics is lacking. Considering the continuity of the fascial system and its mechanical interaction with muscle fascicles intramuscularly (1,2), KT was shown to lead to local tissue length changes in human muscles (3). Yet, KT effects along the muscle fascicles with implications for sarcomere

length changes needs to be studied. Presently, we hypothesized that mechanical loading induced on the skin by KT leads to along-muscle fascicle local length changes and shear strains in the targeted muscle. The aim of this study was to test this hypothesis.

METHODS: Magnetic resonance imaging (MRI)-based local tissue deformation analyses and diffusion tensor imaging (DTI)-based fiber tracking techniques were used in combination (4,5). Anatomical MRI and DTI were acquired for 5 healthy female volunteers in 3 conditions: (I) without tape, (II) following sham application, and (III) after KT application. Local length changes and shear strains were calculated using image registration between conditions (I) and (II), and (II) and (III). Non-parametric Wilcoxon signed-rank test was performed to compare the two conditions.

RESULTS: Data pooled from all subjects show that KT-imposed along-muscle fascicle lengthening (mean ± SD 0.026 ± 0.020), shortening (0.032 ± 0.027) and shearing (0.087 ± 0.049) occur and are significantly higher than those caused by sham application (0.012 ± 0.010; 0.013 ± 0.015; 0.029 ± 0.021, respectively) ($p < 0.001$). This confirms our hypothesis. Moreover, KT induced along-muscle fascicle length changes locally show heterogeneity.

CONCLUSION: Our findings indicate that KT affects both along-muscle fascicle length changes and shear strains. This can be explained by KT imposed myofascial loads over the skin being transmitted via the fascial system (6), non-uniformly manipulating the mechanical equilibrium locally at different parts along the muscle fascicles. Therefore, our findings support the use of KT as a supplementary part of rehabilitation and training programs indicating that is has effects on muscle function with a potential to improve performance.

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**COMPARISON OF THE ECCENTRIC EXERCISE EFFECTS ON THE MUSCULOTENDINOUS ELASTIC PROPERTIES BETWEEN MEN AND PREPUBERTAL BOYS**

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INTRODUCTION: Eccentric exercises are recommended as an interesting training approach for physical performance improvement and more generally for health benefits. Unfortunately, eccentric exercise has been shown to induce a force alteration and muscle damage for several days (1). While these alterations are well documented in adults, less is known in children, more particularly considering structural modifications. Thus, the main aim of this study was to compare the modifications of the musculotendinous elastic properties after an eccentric exercise in prepubertal boys as compared to adult men.

METHODS: Ten prepubertal boys (8-12 years old) and ten men (20-25 years old) participated in the present study. The first session included a fatiguing protocol composed of five sets of 30 maximal eccentric knee extensors contractions. Muscle-tendon elastic properties were evaluated using shear wave elastography videos (SWV) of the vastus lateralis (VL), rectus femoris (RF), and the patellar tendon (Tendon). SWV was measured before (PRE), immediately after the exercise (POST), after 30 minutes (POST 30 min), and during a second session 48 hours after the first one (POST 48h). SWV raw and relative values were analyzed using a two-way (Time x Age) analysis of variance (ANOVA). Time corresponds to differences between all time-points. Age corresponds to boys vs. men.

RESULTS: A significant Time effect was observed for SWV in VL ($p < 0.001$). Post-hoc revealed greater values at POST 30 min than at PRE ($p = 0.003$). A significant Time effect was observed for SWV RF ($p = 0.035$). Post-hoc revealed greater values at Post ($p = 0.024$). A significant Age effect was observed for SWV RF relative values. After fatigue, greater increases were obtained for men than for boys (POST: BOYS mean: +0.86% ± 16.92 / MEN mean: +24.37% ± 36.67).

Significant Time ($p < 0.001$) and Age ($p < 0.001$) effects were observed for SWV Tendon. Post-hoc revealed greater values at POST ($p < 0.001$) and POST 30 min ($p = 0.002$) as compared to PRE. Post-hoc also revealed lower values for boys than for men. No significant Age effect was observed for SWV Tendon relative values (POST: BOYS mean: +10.90% ± 6.94 / MEN mean: +11.25% ± 7.51).

CONCLUSION: As previously enounced in the literature, boys presented lower modifications of muscle properties than men, potentially attributed to fewer muscle damages. However, a similar modification of the tendon tissue properties was observed for both age groups. Tendon properties changes could have an impact on the force transmission and stretch-shortening cycle and need some further investigations (2).

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Oral Presentations

OP-MH23 Endurance Training in Older Adults

**THE EFFECT OF LIFELONG EXERCISE ON NK AND CD4+ CELLS SUBPOPULATIONS**

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INTRODUCTION: Physical exercise triggers a systemic immune response, influencing both innate and adaptive immunity. Natural killer (NK) cells and CD4+ T cells play crucial roles in immune surveillance and regulation, with aging and physical activity significantly influencing their distribution and function. NK cells are divided into cytotoxic (CD56dimCD16bright) and effector (CD56brightCD16dim) subpopulations, which contribute to immune homeostasis and defense mechanisms. Meanwhile, inhibitory receptors such as PD-1 (CD279) and TIGIT on CD4+ T cells are associated with immune exhaustion and regulatory functions. TIGIT is known to play a key role in immune regulation by inhibiting T cell activation and promoting immune tolerance. Aging is often accompanied by immune alterations, including shifts in NK cell composition and T cell inhibitory receptor expression. However, regular physical activity has been suggested to mitigate some of these immunological changes. Understanding how exercise influences these immune parameters may provide insights into potential protective mechanisms against age-related immune decline. This study examines the impact of lifelong exercise (LLE) on NK cell subpopulations and CD4+ T cell inhibitory receptor expression. We hypothesize that LLE is associated with an increased proportion of cytotoxic, and effector NK cells and altered expression of inhibitory receptors on CD4+ T cells.

METHODS: Two groups, 17 master athletes (MA, aged 53±6.22 years) and 15 sedentary men (SG, aged 50.2±6.24 years) performed an incremental test until exhaustion on a cycle ergometer. Peripheral blood samples were collected before (Pre) and after the exercise protocol (Post). The blood samples were lysed with red blood cell lysing buffer, stained with anti-CD16 FITC, anti-CD56 PECy7, anti-CD4 PE, anti CD8 APCR700, anti CD279 BV605 anti-CD94 APC, anti-CD159c BV786 and read on a BD FACSLyric™ flow cytometer. Descriptive analysis was performed using GraphPad software.

RESULTS: The percentages of total NK cells, NK CD56dimCD16bright cytotoxic subpopulation and NK CD56brightCD16dim effector cells subpopulations showed a higher average in MA compared SG. However, in subpopulation CD4+CD279+TIGIT cells were lower in MA when compared to SG. There was a trend for an increase in cytotoxic NK subpopulations for MA when compared to the sedentary controls, but this difference was not statistically significant.

CONCLUSION: We found that MA exhibited higher percentages of total NK cells and of the cytotoxic CD56dimCD16brighNK subpopulation, suggesting enhanced immune surveillance and cytotoxic activity. However, the percentage of CD4+279+TIGIT was lower in MA compared to SG, which might indicate a lower exhaustion and regulatory T cell activity in MA. These findings support the notion that lifelong exercise may promote a more efficient immune profile, characterized by enhanced NK cell activity and lower proportion of exhausted CD4+ T cells.

**NORDIC WALKING PLUS INSPIRATORY MUSCLE TRAINING ON INSPIRATORY AND PERIPHERAL STRENGTH IN OLDER ADULTS**

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INTRODUCTION: Inspiratory muscle training (IMT) enhances inspiratory muscle strength (IMS) and can induce changes in other capacities, such as balance or functional mobility [1]. NW has shown improvements in older adults (OA) functionality [2] but its effect on IMS remains unknown. This study (GESMED-Marcha) aims to compare the effect of two different short interventions (8 weeks) combining NW+IMT on IMS and peripheral strength in a group of OA referred from Primary Care. NW program was equal, but IMT load were 15% (IMT15) or 50% (IMT50) of the S-Index (dynamic IMS: dIMS).

METHODS: Seventy-one OA were randomly assigned to each group. 51 compressed the final sample: IMT15 [n=22; 68.30(4.03) y; 69.01(8.90) kg] and IMT50 [n=29; 67.32(4.34) y; 72.58(12.47) Kg]. Only NW was supervised (1hr, 3 days/week) while IMT was auto administrated (30 inspirations, twice daily, 7 days/week). Upper and lower limb strength (HG & STSSPPB) and dIMS were assessed PRE-POST intervention and 8-weeks after detraining (DET). After normality testing, a repeated measures ANOVA with the type of IMT load as intergroup factor, or Friedmann test, were applied, followed by Bonferroni or Wilcoxon post hoc tests.

RESULTS: Regarding peripheral muscles, STSSPPB improved after training (STSSPPB: $F=6.447$, $p=0.003$, $\eta^2=0.157$, observed power= 0.892) with no interaction effect (time*program). Indeed, only IMT15 improved significantly between PRE and DET ($p=0.006$). Conversely, HG showed no significant improvements. dIMS improved significantly ($p<0.001$): specifically, IMT15 PRE-POST $p=0.001$; POST-DET $p=0.025$; PRE-DET $p<0.001$ and IMT50 PRE-POST $p<0.001$; PRE-DET $p<0.001$.

CONCLUSION: NW+IMT was successful to improve dIMS in IMT15, contradicting existing literature where the 15% load serves as a placebo [3]. The engagement of CORE muscles during NW may contribute to this improvement and alternatively may facilitate enough motor unit recruitment and coordination in the inspiratory muscles [4] in this population, facilitating further load progressions. However, STSSPPB only improved in IMT15 (PRE-DET), so the 50% load may add fatigue

that limits its progress. Further research on IMT protocols is needed to clarify their benefits in non-pathological populations and its role and loads as a complementary training tool.

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**FUNCTIONAL IMPROVEMENT OF OLDER OUTPATIENTS WITH ACUTE CORONARY SYNDROME AFTER ONE YEAR OF EXERCISE-BASED SECONDARY PREVENTION PROGRAM**

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INTRODUCTION: Among cardiovascular diseases, acute coronary syndrome (ACS) remains the leading cause of morbidity and mortality. Cardiac rehabilitation and secondary prevention programs make significant contributions to the continuum of care in patients, and physical activity has been recognized as core part of such interventions. However, despite the documented benefits, older patients diagnosed with acute coronary syndrome (ACS) are less likely to attend traditional center-based programs limiting the efficacy of the intervention. This situation has emphasized the importance of more comprehensive and sustainable intervention strategies. Thus, the aim of the study was to examine functional changes of older patients with ACS involved in a center- and home-based secondary prevention program after one year of intervention.

METHODS: A subsample of 254 consecutive patients (mean age 75 years) with ACS extracted from the ITER registry (NCT05817305) was analyzed. The proposed intervention program consisted of 6 individual on-site sessions including functional evaluation along with continuous motivational reinforcement to reach exercise goals and stably maintain an active lifestyle. The home-based exercise prescription was based on the results of the validated 1km-Treadmill Walking Test. Functional variables were assessed during each visit. Main outcomes were changes in self-reported weekly physical activity, average walking speed (WS) registered during the test and estimated cardiorespiratory fitness (VO2peak).

RESULTS: Physical activity levels significantly increased and were maintained during the follow-up period (median MET-h/week 3.0, 12.0, and 9.0 at baseline, 6-, and 12 months, respectively; $p<0.0001$). These results were associated with increasing mean WS (2.9, 3.9, 4.1 km/h, respectively, $p<0.0001$), and VO2peak (16.9, 20.0, 20.5 mL/kg/min, respectively, $p<0.0001$).

CONCLUSION: The proposed intervention demonstrated a stable adherence to physically active lifestyle, along with improved walking capacity and estimated VO2peak in older patients with ACS. Results therefore highlight the importance of exercise testing and training in older patients and the effectiveness of the program. This may provide valuable insights for the development of more efficient and patient-centered exercise-based secondary prevention programs.

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**LIFELONG ENDURANCE TRAINING VS. LATE-LIFE EXERCISE: CAN SHORT-TERM TRAINING BRIDGE THE GAP?**

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INTRODUCTION: Master endurance runners exhibit superior metabolic health, aerobic capacity, lower body fat, and muscle morphology compared to untrained elderly individuals, highlighting the benefits of long-term endurance training. Studies suggest that short-term exercise can significantly improve these factors, helping inactive older adults partially bridge the gap with lifelong endurance athletes. This study examines whether a 12-week aerobic-strength program can enhance metabolic health, endurance, strength, and body composition in previously untrained elderly individuals compared to lifelong runners.

METHODS: We compared four groups: young endurance runners (YER, n=8, 27.4±3.1 yrs), master endurance runners (MER, n=10, 70.2±3.9 yrs), young controls (YAG, n=10, 26.7±2.3 yrs), and elderly controls (EAG, n=10, 71.1±3.3 yrs), before and after a 12-week aerobic-strength training program. Endurance runners trained >300 min/week and regularly competed in distance races (YER ≥3 years, MER ≥25 years). Body composition was assessed via DXA; blood markers (LDL, HDL, total cholesterol, triglycerides, glucose, insulin) were analyzed from venous samples. Lower limb strength was measured using a dynamometer, and aerobic power was assessed via a maximal-graded cycling test.

RESULTS: Significant differences were observed across all groups. Before the intervention, EAG had higher blood glucose than YAG (P=.003) and elevated insulin levels compared to MER (P=.005). HDL cholesterol was highest in YER vs. YAG

(P=.007) and MER vs. EAG (P=.001), while LDL cholesterol was lower in YER vs. MER (P=.001) and YAG vs. EAG (P=.037), both before and after the intervention. Notably, after the intervention, EAG showed lower LDL cholesterol and improved insulin sensitivity. However, no significant differences were found in the LDL/HDL ratio between MER and EAG post-intervention. YER demonstrated the highest strength and $VO_2$max, while MER maintained a significantly higher $VO_2$max than EAG both before and after the intervention.

CONCLUSION: A 12-week aerobic-strength program enhances metabolic health, strength, and endurance in elderly individuals, but they may not fully match the performance of lifelong endurance runners. While significant improvements are achievable, age-related declines still limit peak performance. Master endurance athletes maintain superior metabolic health, strength, and aerobic capacity compared to their untrained peers, yet they still fall short of the $VO_2$max, muscle strength, and overall physical fitness seen in young endurance athletes. Despite the inevitable declines in aerobic capacity, muscle mass, and metabolic efficiency with ageing, long-term endurance training plays a crucial role in preserving physical performance and slowing the effects of ageing.

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**THE EFFECT OF CHRONIC SENOLYTIC AND AEROBIC EXERCISE INTERVENTIONS ON CARDIAC AGING AND PERFORMANCE**

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INTRODUCTION: The accumulation of senescent cells that occurs with age has been linked to the progression of age-related declines in cardiac health and function [1]. Senescent cells are dysfunctional, and in excess, are associated with structural changes to cardiac tissue [1]. This includes increased myocardial fibrosis and hypertrophy or atrophy of the ventricular wall, which can significantly impair cardiomyocyte relaxation and contractility and thus both systolic and diastolic function [1]. Senolytic drugs, such as Dasatinib and Quercetin (D+Q), target and remove senescent cells, offering an effective therapeutic avenue to clear senescent cells [1]. Recently, aerobic exercise has also shown promise in clearing senescent cells in mice [2]. Therefore, we hypothesized that using both D+Q and aerobic exercise, chronically, would produce a synergistic clearance of senescent cells in cardiac tissue, improving cardiac function and health in aged mice.

METHODS: Twelve-month-old C57BL/6N male and female mice (n=20 per group) were randomly assigned to 1 of 4 groups: VEH (naturally aged), EX (30 min treadmill running; 2x/week), SEN (biweekly D+Q administration via oral gavage) or SENEX (exercise and D+Q). Mice received the intervention for 9 months and had assessments of cardiac structure plus systolic and diastolic function at the 6- and 9-month timepoints via high frequency ultrasound. Myocardial fibrosis was also assessed through picrosirius red staining of the left ventricle.

RESULTS: After 9 months, the VEH group displayed a significantly higher isovolumetric relaxation time (IVRT) (25.7±4.5 s) and myocardial performance index (MPI) (0.85±0.24) than EX (15.5±4.0 s and 0.50±0.10), SEN (18.43±4.1 s and 0.55±0.10), and SENEX (16.44±5.2 s and 0.59±0.22) ($p<0.05$). Regarding cardiac structure after 9 months, only the VEH mice displayed a significant change, where relative wall thickness decreased compared to 6 months (0.98±0.31 vs 0.56±0.15, $p<0.05$). SENEX mice (3.3±2.2 %) also displayed significantly lower myocardial fibrosis than VEH mice (6.4±3.4 %) ($p<0.05$), with no differences across the other groups.

CONCLUSION: All treatments maintain cardiac structure, preventing an age-related decrease in ventricular wall thickness experienced by the VEH group, with the SENEX intervention even mitigating the age-related fibrosis seen in the VEH mice. Furthermore, improved myocardial performance and relaxation in the treated mice demonstrate a positive impact of exercise and senolytics on cardiac function. Thus, exercise, senolytics, or both combined show promise in maintaining, and even improving aspects of cardiac structure and function in aged mice.

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## Oral Presentations

### OP-PN30 Hypoxia and Training

**EFFECT OF AN 8-WEEK HIGH INTENSITY INTERVAL TRAINING PROGRAM IN HYPOXIA ON MARKERS OF PHYSICAL FITNESS IN SEDENTARY OVERWEIGHT INDIVIDUALS**

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INTRODUCTION: High intensity interval training (HIIT) in hypoxia has been demonstrated to improve peak oxygen uptake (VO2peak) in athletes to a greater extent than when performed in normoxia. Further, training under hypoxia reduces the mechanical load required to elicit similar physiological responses. These characteristics of HIIT in hypoxia have obvious

appeal for overweight and sedentary populations. Accordingly, the aim of this investigation was to determine the effects of an 8-week HIIT in hypoxia intervention on markers of physical fitness in overweight and sedentary individuals.

METHODS: Thirty sedentary (<100 min weekly moderate physical activity) overweight and obese (BMI: 33.9±6.5) individuals (36±7 y) were recruited for a 10-week training program (three HIIT sessions and two resistance training sessions per week). In the first two weeks, all exercise was performed in normoxia. For the following eight weeks, HIIT was completed in either normoxia (n=10, five dropouts) or hypoxia (n=15). All participants completed 1-repetition maximum (1RM) testing in four exercises and a graded exercise test for the determination of VO2peak and submaximal fat oxidation rates (Fatox) prior to and following the intervention period. HIIT consisted of four to six repetitions of 1-min cycling bouts performed at a fixed rating of perceived exertion (RPE; 16/20), interspersed with 4-min of active recovery (10/20 RPE) in either normoxia (FiO2: ~0.21) or hypoxia (FiO2: ~0.14). All resistance training was performed in normoxia, and sessions consisted of four different exercises. Linear mixed models were used with condition, time and interaction defined as the fixed effects and participants as random effects.

RESULTS: VO2peak significantly improved following training (hypoxia: +0.38±0.42 L/min; normoxia: +0.22±0.28 L/min, pooled effect: g=0.67), with no significant interaction found between condition and time (p=0.30). Fatox at 50 W, 75 W, and 100 W also significantly increased following training, again with no between-group differences (50 W: +0.09±0.14 g/min, 75 W: +0.11±0.12 g/min, 100 W: +0.10±0.11 g/min, pooled effect: g=0.45-1.15). Finally, 1RM also increased similarly in both conditions (Pre-post pooled group average: leg press: +43±45%, p=0.001, g=0.42; bench press: +15±13%, p<0.001, g=0.36; shoulder press: +12±16%, p=0.003, g=0.23; lat pulldown: +15±13%, p<0.001, g=0.47).

CONCLUSION: A 10-week training program consisting of HIIT (3/week) and resistance training (2/week) significantly improved VO2peak, submaximal Fatox, and strength (1RM) in sedentary overweight and obese individuals. While the magnitude of VO2peak improvement was nearly 2x greater in the hypoxic HIIT group, no significant differences were found compared to performing matched training in normoxia. While our data do not support the addition of hypoxia to HIIT as a way to augment physical fitness outcomes in this population, they suggest further research may be warranted.

**COMBINATION OF WEIGHT REDUCTION AND HYPOXIA ON BIOCHEMICAL RESPONSE TO A HIGH-INTENSITY EXERCISE IN ATHLETES**

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INTRODUCTION: The AlterG treadmill allows weight reduction during running, which lowers mechanical stress, and metabolic strain. In this context, we previously demonstrated that hypoxia compensated body weight reduction for physiological stress (Chambion-Diaz et al., 2025). However, there is no strong evidence regarding the effect of AlterG running on redox balance, inflammation and muscle damage. Hypoxia is well known to increase oxidative stress, and physiological stress. To date, there is no study investigating redox balance and inflammation in response to this type of exercise. The aim of this study is to characterize the biochemical response in this exercise combination.

METHODS: Twenty-six participants completed a high-intensity interval training (HIIT) session on an AlterG treadmill in the following 5 experimental conditions in randomized order: normoxia at 100% body weight (BW); normoxia at 80% BW; normoxia at 60% BW; hypoxia (FiO2=14%) at 80% BW; hypoxia at 60% BW. The HIIT session included 3 sets of 8 repetitions of 30 seconds of effort performed at 110% of the maximum aerobic speed, interspersed with 30 seconds of passive recovery. Blood samples were taken before and after each session for measurement of oxidative stress markers (AOPP, Isoprostanes, MDA, MPO, XO) antioxidant (SOD, GPx, Catalase, FRAP, UA), inflammation (CRP, IL-6, IL-1b, TNF-α), muscle damage (CK, myoglobin).

RESULTS: Catalase, MPO, FRAP and myoglobin increased post-HIIT global time effect; p<0.05). More specifically, Catalase, MPO and FRAP increased only in Control (p=0.0147; p=0.0047 and p=0.0432 respectively) and post-Hyp80% (p=0.0203; p=0.0002 and p=0.0009 respectively). These results suggest that the oxidative stress modulation by the body weight reduction could be compensated by hypoxia . All the other circulating markers are not affected by neither HIIT session nor condition.

CONCLUSION: These data confirm that such HIIT session can affect circulating redox status and moderately impact muscle damage markers. In addition, it seems that similarly to physiological stress (Chambion-Diaz et al., 2025), the reduction of oxidative stress in response to HIIT session by body weight reduction is compensated by hypoxia but only on the 80% body weight. Finally, circulating muscle damage markers and inflammation were not impacted by neither weight reduction nor hypoxia.

References : Chambion-Diaz M et al., 2025. Journal of Sports Sciences

**ANY CROSS-TALK IN REPEATED-SPRINT TRAINING BETWEEN HYPOXIA AND HEAT IN ELITE ATHLETES?**

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INTRODUCTION: Repeated-sprint training in hypoxia (RSHyp) is often used by team-sport athletes to improve repeated-sprint ability. Similar training in the heat (RSHot) has also been suggested to be effective. However, little is known about their respective cross-talk. This study therefore aimed to analyze the effect of RSHyp and RSHot on repeated-sprint performance in either normobaric hypoxic or normoxic hot conditions in reference to a normoxic thermoneutral condition.

METHODS: Seventeen French elite athletes (rugby sevens national team (n = 11 females), BMX (n = 4 males and 2 females)) performed 6 repeated-sprint training sessions (3 × 5 7-10-s sprints with 20-23-s passive recovery on a cycle ergometer) in either hypoxic (FiO2 = 14.3%, 20°C, n = 8, 6 females) or hot (FiO2 = 20.9%, 36°C, n = 9, 7 females) ambient conditions over two weeks. Pre- and Post-tests (1 week after) included a repeated-sprint ability test (8 × 10-s sprints with 20-s passive recovery) in either a normobaric hypoxic (FiO2 = 14.3%, 20°C), normoxic hot (FiO2 = 20.9%, 36°C) or normoxic thermoneutral (FiO2 = 20.9%, 20°C) environment. Maximal (Pmax) and average (Pmean) power outputs were measured for each sprint. Capillary blood samples were taken before and after the first and last training session and analyzed for pH and bicarbonate concentration [HCO3-].

RESULTS: Pmax and Pmean, averaged for all eight sprints, increased following both RSHyp and RSHot across all testing conditions from 759 ± 207 (Pre) to 849 ± 226 W (Post) for Pmax (Time effect: F = 40.0296, p=0.001) and from 564 ± 166 to 609 ± 157 W for Pmean (F=40.2696, p=0.001). The improvement in Pmax did not differ according to the training group (F=0.0304, p = 0.889) nor testing condition (F=0.956, p = 0.403) while Pmean tended to improve more in the normoxic hot (+14.8%) compared to the normoxic thermoneutral (+9.2%) and normobaric hypoxic (+10.3%) testing condition (F = 3.0765, p = 0.050). No difference was observed between training groups in acute post-training pH (RSHyp: 7.20 ± 0.11, RSHot: 7.16 ± 0.15, F = 0.041, p = 0.844) nor [HCO3-] (RSHyp: 10.8 ± 2.4 mmol.L-1, RSHot: 9.1 ± 1.7 mmol.L-1, F = 0.012, p = 0.912).

CONCLUSION: Adding either normobaric hypoxia or heat in repeated-sprint training resulted in an ~11% improvement in repeated-sprint performance in elite athletes across all sprints and testing conditions with a more pronounced improvement in normoxic hot (+14.8%) conditions. The effect was independent of the training group. This indicates an effective cross-talk effect of each respective training condition on the other environmental stress. The similar acute training-induced changes in pH and [HCO3-] values between training groups seem indicative of a similar metabolic stimulus despite different responses in normobaric hypoxic (lower oxygen saturation) or heat (higher core temperature) conditions.

**POST-EXERCISE HYPOTENSION AND AUTONOMIC NERVE ACTIVITY FOLLOWING ENDURANCE EXERCISE IN HYPOXIA**

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INTRODUCTION: Exercise is an effective non-pharmacological intervention for reducing blood pressure (BP). A single bout of exercise decreases transiently BP, which is called as "Post-exercise hypotension (PEH)". PEH contributes to reducing BP chronically. A previous study revealed that endurance exercise reduced markedly systolic BP (SBP) compared to resistance exercise. In addition, resistance exercise under hypoxic condition caused greater PEH compared to the same exercise under normoxic condition. Therefore, combination of "endurance exercise" and "hypoxia" may cause effectively PEH. However, PEH after endurance exercise in hypoxia has not been clarified. Therefore, the aim of the present study was to evaluate PEH following endurance exercise under hypoxic condition.

METHODS: Fifteen young men (22 ± 2 years) conducted three trials on different days with a randomized order of trial at least one week apart: (1) pedaling exercise in hypoxia (FiO2: 14.5%; HYP), (2) pedaling exercise in normoxia (FiO2: 20.9%; NOR), and (3) rest in normoxia (REST). Exercise trials (HYP and NOR) began at 8:00 am and consisted of 60 min of pedaling exercise at 60% of maximal oxygen uptake. During each trial, heart rate (HR), rating of perceived exertion (RPE), and arterial oxygen saturation (SpO2) were determined. Following each intervention (60 min of exercise or rest), BP was measured every 15min for 3 h. Also, HR variability (HRV) was continuously monitored until next morning (8:00 am-7:00 am) using a wearable HR sensor.

RESULTS: During exercise, HR was significantly higher in both HYP and NOR compared to REST ($p<0.001$). SpO2 was significantly lower in HYP (82.3 ± 7.0%) than in NOR (94.5 ± 2.8%) and REST (96.7 ± 2.2, $p<0.001$). Over the 3h post-exercise period (9:00 am-12:00 am), reduction of SBP (ΔSBP) was significantly profound in both NOR (-22 ± 5mmHg) and HYP (-20 ± 6mmHg) compared to REST (-13 ± 7mmHg, $p<0.05$), with the lowest ΔSBP value was observed 1h post-exercise. However, no significant difference in ΔSBP was found between HYP and NOR ($p>0.05$). Time-domain HRV parameters (i.e., SDNN, RMSSD, NN50, pNN50) returned to baseline levels within approximately 1h post-exercise. During sleep (0:00 am-7:00 am), averaged NN50, pNN50 were significantly lower in HYP and NOR compared to REST ($p<0.05$). However, other HRV parameters did not differ significantly among three trials ($p>0.05$).

CONCLUSION: Although both HYP and NOR significantly reduced SBP compared to REST over 3h post-exercise period, the magnitude of PEH did not differ significantly between NOR and HYP. Furthermore, the PEH response was not associated with changes in HRV variables. These findings suggest that endurance exercise causes PEH regardless of oxygen concentration during the exercise. Also, it appeared that PEH was independent of change in parasympathetic nervous system activity during post-exercise. Further research is required to explore the specific mechanisms contributing to PEH such as exercise-induced vasodilation.

# Oral Presentations

## OP-PN07 Nutrition IV - Vitamin D and Other Supplements

### ACUTE EFFECTS OF CANNABIDIOL ON SUBJECTIVE AND PHYSIOLOGICAL RESPONSES TO ENDURANCE EXERCISE: A RANDOMISED CONTROLLED TRIAL

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INTRODUCTION: Athletes report using cannabidiol (CBD), a non-intoxicating constituent of Cannabis sativa L., to enhance post-exercise recovery and manage other conditions (e.g., poor sleep, anxiety, concussion). However, whether CBD influences performance related outcomes, remains unclear. Here, we investigated the acute effects of two CBD doses on subjective and physiological responses to endurance exercise to better understand CBD's practical utility within sport.

METHODS: A randomised double-blind, placebo-controlled, crossover clinical trial was conducted at the University of Sydney between October 2022 and March 2024. Healthy males and females, aged 18 – 45 years, were eligible to participate if they reported running ≥40 km.week-1 and had not consumed cannabis/cannabinoids for ≥3 months. Participants received either placebo, 50 mg, or 300 mg CBD (oral; <0.01% THC) 1.5 hours prior to completing a 60-minute, submaximal intensity (~70% VO2max) treadmill run (RUN 1) followed by an incremental run to volitional exhaustion (RUN 2). Respiratory parameters, heart rate (HR) and subjective ratings (i.e., affective valence, enjoyment, perceived exertion, pain) were collected during RUN 1. Respiratory parameters, peak HR, and time to exhaustion (TTE) were collected during and at cessation of RUN 2. Capillary blood glucose and lactate concentrations were measured at cessation of RUN 1 and 2. Questionnaires assessing exercise enjoyment, state anxiety, mood and gastrointestinal comfort were administered at Baseline, Pre- and Post RUN 1, Post RUN 2 and 1h Post RUN 2. Venous blood was also collected at these timepoints to determine concentrations of cannabinoids and markers of muscle and gastrointestinal damage (i.e., creatine kinase (CK), myoglobin (Myo), lipopolysaccharide (LPS)).

RESULTS: Twenty-five participants (16 male; VO2max = 53.1±7.5mL.min.kg-1) were randomised and completed all three treatment sessions. Neither dose of CBD altered subjective responses during RUN 1, nor exercise enjoyment, mood or anxiety around RUN 1 or 2 (p's>0.05). CBD had limited effects on physiology and performance, with HR, exercise efficiency (i.e., VO2), VO2peak and TTE unchanged relative to placebo (p's>0.05). However, 300 mg CBD decreased the respiratory exchange ratio during RUN 1 (p=0.030) and 50 mg CBD increased blood glucose at cessation of RUN 2 (p=0.003), compared to placebo. There was no effect of either dose on CK and Myo (p's>0.05) but a Treatment x Time x Sex interaction was identified for LPS, with post hoc analyses revealing higher concentrations in females Post RUN 2 on 50 mg (p=0.032), but not 300mg CBD (p=1.000), compared to placebo.

CONCLUSION: CBD (50 mg, 300 mg; acute) does not appear to alter the subjective experience of submaximal intensity exercise, impact endurance performance (i.e., TTE) or have compelling effects on physiological responses to exercise. Acute use of CBD by athletes is therefore unlikely to be ergolytic or ergogenic at low to moderate doses.

### SHORT-TERM PINE BARK EXTRACT SUPPLEMENTATION IMPROVES SUBSEQUENT CYCLING ENDURANCE BUT FAILS TO ATTENUATE EXERCISE-INDUCED OXIDATIVE INFLAMMATION IN YOUNG ATHLETES

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INTRODUCTION: In the previous study, the mechanisms of Pine bark extract (PBE) are in terms of antioxidant effects, anti-inflammatory abilities, beneficial effects on blood circulation, and reinforcing activities on the extracellular matrix (1), thereby mitigating inflammation resulting from impaired antioxidant defenses (2). A human study demonstrated the potential of PBE in improving performance in triathlon athletes. However, it has not thoroughly investigated whether PBE could serve as an ergogenic aid for sports competition in athletes (3). Therefore, our study aimed to examine whether oral PBE supplementation could blunt oxidative stress, inflammation, and exercise-induced fatigue to promote endurance performance in young athletes.

METHODS: Fourteen healthy male athletes (mean ± SD, aged 22.2 ± 0.97 years; BMI. 22.74.3 ± 0.86 kg/m2) participated in this single-blind crossover-designed study and were randomly instructed to either oral PBE supplementation (300 mg per day for 4 days) or placebo. On the experimental day, participants were supplemented PBE or placebo was combined with 70% VO2 max cycling for 60 minutes, followed by 3h of recovery. And then a subsequent single bout of cycling exercise with 75% VO2max to exhaustion. The cycling time was recorded, and the physiology parameters of gaseous and blood samples were measured regarding exercise-induced perturbation of energy substrate utilization, muscle damage, oxidative stress, and inflammation. A paired t-test was conducted to examine the participants differences in the cycling challenge performance. Two-way ANOVA with repeated measures was used to compare all blood samples. The $\alpha$ level was 0.05 to indicate a significant difference for all comparisons.

RESULTS: The study findings significantly improved cycling endurance performance following 4-day PBE supplementation. ($P < 0.05$). Notably, the observed improvement in cycling endurance performance may be attributed to a lower RER and carbohydrate oxidation rate during the first exercise challenge ($P < 0.05$). However, PBE supplementation was not signifi-

cantly attended to exercise-induced muscle damage (lactate dehydrogenase, LDH), creatine kinase (CK), uric acid (UA); oxidative stress (superoxide dismutase, SOD; thiobarbituric acid reactive substances, TBARS) and inflammation biomarkers (Interleukin 6, IL-6; tumor necrosis factor-alpha, TNF-α).

CONCLUSION: Our findings concluded that 4-day oral PBE supplementation enhances high-intensity cycling time to exhaustion. This may be partly due to the attenuated whole-body carbohydrate oxidation rate and spared glycogen depletion during the first exercise challenge. Therefore, PBE may be an effective ergogenic aid for enhancing high-intensity cycling performance among young adults.

**TART CHERRY SUPPLEMENTATION CAUSES DIFFERENTIAL REGULATION OF SKELETAL MUSCLE PROTEOME AFTER ECCENTRIC EXERCISE**

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INTRODUCTION: Polyphenol-rich tart cherry (TC) supplementation was shown to enhance recovery from exercise-induced muscle damage (EIMD) (Wangi et al. 2022). However, no studies have investigated the effects of different doses of TC supplementation on such recovery. Furthermore, the molecular mechanism(s) of action through which TC elicits these effects is unknown. This study aimed to investigate the effects of a low (L) and a high (H) polyphenol dose of TC juice on functional recovery from EIMD and to establish the molecular mechanisms of action.

METHODS: Thirty-four active males consumed 500 mL TC juice (16.1 mg and 32.2 mg anthocyanins in the LTC and HTC juice) in the morning for 7 days prior to and 48h following exercise. Knee extension maximum voluntary isometric contractions, maximal isokinetic contractions, single leg jumps, and muscle soreness measures were assessed before, immediately, 24 and 48 h after exercise. Venous blood and vastus lateralis muscle samples were collected at each time point. Plasma concentrations of IL-6 and phenolic acids were quantified. Macrophage and neutrophil numbers were quantified in muscle sections. Vastus lateralis samples from eight individuals who were randomised to receive the HTC juice or placebo for 10 days were used for tandem-mass-tagged muscle proteomics analysis.

RESULTS: HTC supplementation increased plasma ferulic acid, isoferulic, vanillic acid, hippuric acid and hydroxybenzoic acid concentrations compared to PLA ($p < 0.001$). Seven-day HTC supplementation altered the balance of structural and contractile muscle proteins (CAMERA FDR < 0.0001 , Log2FC = 0.234 vs placebo). TC supplementation also increased expression of structural and contractile proteins following EIMD; this may be protective. TC supplementation also altered macrophage cell infiltration within the exercised muscle. This study found that TC did not enhance functional recovery. However, plasma hippuric acid was associated with skeletal muscle strength in this young healthy population ($r = 0.56$, $p = 0.007$). This association has previously only been shown in frail populations (Brunelli et al. 2021).

CONCLUSION: These data provide important insights into the mediators of TC effects in skeletal muscle, and potential for therapeutic and training adaptation applications.

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**MONITORING AND FOLLOW-UP OF VITAMIN D SUPPLEMENTATION: EFFECTS ON BLOOD MARKERS AND PERFORMANCE IN RUNNERS AND NON-RUNNERS DURING AUTUMN AND WINTER SEASON**

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INTRODUCTION: Recent interest in vitamin D's role in musculoskeletal and immune health prompted this study to assess how 2 months of supplementation affects serum vitamin D status, performance, and leukocyte parameters in healthy runners and non-runners, with a subsequent 3-month follow-up.

METHODS: Fifty-two participants were randomized into four groups—runners and non-runners, with or without daily supplementation of 2000 IU vitamin D (administered as orodispersible films). Assessments were conducted at baseline (October, T0), after 2 months (T1), and 3 months post-supplementation (T2). Measurements included blood tests (25-hydroxyvitamin D in ng/mL and leukocyte counts), $VO_2$max, maximal isometric force (MIF), and vertical jump (CMJ) performance. Additionally, diet, training, local daily solar irradiation, and temperature were monitored.

RESULTS: Diet and training remained stable over the study period. Weather conditions were consistently sunny, with an average temperature of 20.0 ± 1.7 °C, daily solar irradiation of 15745.8 ± 1033.7 W/m², and approximately 9.6 ± 0.8 hours of sunshine. Notably, both solar irradiation and temperature decreased significantly from October to January; thereafter, solar irradiation increased while temperature remained low until April. Supplemented runners showed a 20.82% increase in vitamin D (from 30.45 ± 7.0 to 35.35 ± 8.9 ng/mL, $p<0.001$), whereas non-supplemented runners did not exhibit a sig-

nificant change at T1, and non-supplemented non-runners experienced a 32.23% decrease (from 25.93 ± 6.6 to 17.8 ± 7.3 ng/mL, p<0.001). At T2, vitamin D levels declined significantly in all groups (e.g., supplemented runners decreased from 35.35 ± 8.9 to 23.52 ± 5.6 ng/mL, p<0.001). Neutrophil counts varied significantly over time and by supplementation status (p=0.03): non-supplemented groups had progressive decreases (T0–T1: –12.37% and –14.50%; T0–T2: –16.23% and –23.66%), while supplemented groups remained relatively stable (a slight increase at T1 followed by a non-significant decrease at T2). No significant changes were observed in $VO_2$max or CMJ, although MIF improved modestly in supplemented groups.

CONCLUSION: Two months of daily 2000 IU vitamin D supplementation effectively increased serum vitamin D levels and maintained stable leukocyte counts in both runners and non-runners. However, cessation led to significant declines by the 3-month follow-up, indicating that continued supplementation may be necessary. Interestingly, vitamin D levels in non-supplemented subjects initially paralleled solar irradiation trends until January; subsequently, despite an increase in solar irradiation, persistently low temperatures appeared to sustain the decline in vitamin D levels. While supplementation improved vitamin D status and moderated immune responses, it did not affect $VO_2$max or CMJ, and the modest improvement in MIF warrants further investigation.

**EFFECTS OF VITAMIN D SUPPLEMENTATION ON EXERCISE PERFORMANCE, SKELETAL MUSCLE RENIN-ANGIOTENSIN SYSTEM, AND TMPRSS2 IN YOUNG MEN AND WOMEN**

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INTRODUCTION: Vitamin D (VD) is essential for muscle function, calcium balance and oxidative stress. Animal and cell models suggest that VD modulates the renin-angiotensin system (RAS), shifting the balance away from the classic axis (pro-inflammatory and oxidant), reduces RONS and may enhance antioxidant defences. ACE2 facilitates SARS-CoV-2 entry, requiring priming by TMPRSS2, whose expression is androgen-regulated. Higher ACE2 in men may affect COVID-19 severity and RAS modulation under stressors like exercise and ischaemia-reperfusion (IR). The role of VD in these processes remains unexplored in human skeletal muscle (hSM). This study examined if short-term VD supplementation modulates performance, ACE2, TMPRSS2 and antioxidant capacity at rest and after exercise with IR, considering sex differences. We hypothesised that VD would increase ACE2 expression, enhance antioxidant capacity, and improve performance, with greater effects in men due to androgen-driven ACE2 and TMPRSS2 regulation.

METHODS: Thirty (15M/15F) non-VD deficient young volunteers participated in a double-blind crossover with two conditions, Placebo (PL) or VD(D3) for 5 days (25.000IUx3times, 6wk washout). After VDsupp, they performed a control 10s sprint followed by an incremental cycling test to exhaustion. Then, 20s bilateral occlusion (300mmHg) was applied. Upon release, they performed a 10s sprint during reperfusion. Right after, one leg was re-occluded (OC), while the other remained under free perfusion (CT), and after 60s, v. lateralis biopsies were taken simultaneously from both legs for Western Blot. Stats: ANOVA, t-test and Pearson's correlation.

RESULTS: VO2max, maximal power output and rested and post-ischaemia 10s sprint performance were unaltered by VD, without sex-differences (p>.05). Basal AT2R levels dropped by 11% in VD, while globally ACE and SOD2 were differentially regulated in M and F in VD (supp*sex p=.003/ .036, respectively). After exercise+occlusion, ACE2, TMPRSS2 and catalase increased only in CT (71, 38, 62%, respectively, p<.001) while SOD1 had the opposite change (-17%, p=.05) for IR, with no effect in VD. Catalase and TMPRSS2 were differentially modulated in VD after exercise in M and F (supp*time*sex p=.019 and p=.057). ACE2 and TMPRSS2 across conditions were associated (r=.23; p=.03), and each of them with Catalase (r=.70/ .50; p<.001).

CONCLUSION: Vitamin D supp had no ergogenic effect and did not modify the response of RAS markers or antioxidant enzymes to intense exercise and IR in hSM, though it selectively modulated some RAS markers at rest. Exercise and IR strongly influenced ACE2, TMPRSS2, and catalase, suggesting oxidative stress-dependent regulation. The correlation between these markers supports a link between ACE2 dynamics and antioxidant capacity. Its broader impact on RAS regulation, redox homeostasis, and muscle adaptation remains to be determined.

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**EXERCISE IMPROVES GUT MICROBIAL METABOLITES IN AN INTENSITY-DEPENDENT MANNER**

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INTRODUCTION: Obesity and the metabolic syndrome (MetS) are major global health concerns, increasing the risk for morbidity and mortality. Recent research highlights the gut microbiome as a key regulator of metabolic health, with short-chain fatty acids (SCFAs) produced in the intestinal tract playing a crucial role in cardiometabolic health [1]. There is evidence that exercise may alter gut metabolites [2], but findings of previous studies remain inconsistent. We hypothesized that these discrepancies stem from differences in exercise intensity, with higher-intensity exercise leading to more pronounced microbial adaptations. This study examined the effects of a low-volume interval training plus single-set resistance training (RT) program, performed at either high intensity (HIGH-EX) or moderate intensity (MOD-EX), on gut SCFAs and cardiometabolic health indices in obese individuals with MetS.

METHODS: A total of 113 subjects (53±12 yrs, BMI: 39±5) were randomized into three groups: HIGH-EX (5×1 min cycling at 80–95% HRmax, followed by progressive RT, 5 exercises, 50–80% 1-RM), MOD-EX (5×1 min cycling at <80% HRmax, followed by moderate RT, 50–60% 1-RM), and a non-exercising control group (CON). Training was performed twice weekly for 12 weeks. Stool samples were collected pre- and post-intervention to analyze SCFA concentrations. Additionally, VO2max, muscle strength, cardiometabolic risk markers, and MetS severity (MetS Z-score) were assessed.

RESULTS: HIGH-EX and MOD-EX improved MetS-Z-Score (–1.1 units, $p<0.01$; and –0.5 units, $p<0.05$, respectively), VO2max (+4.2 mL/kg/min, $p<0.01$; and +2.7 mL/kg/min, $p<0.05$, respectively) and 1-RM strength values in major muscle groups (19–26%, all $p<0.001$; and 22–29%, all $p<0.001$, respectively). Both exercise groups also significantly reduced inflammation (hs-CRP, HIGH-EX: –2.2 mg/L, $p=0.013$; MOD-EX: –1.3 mg/L, $p=0.01$). Only HIGH-EX significantly increased total fecal SCFA concentration (+29%, $p<0.001$), including acetate (+27%, $p<0.001$), propionate (+24 %, $p<0.001$), and butyrate (+39%, $p<0.001$). None of the parameters changed in CON.

CONCLUSION: This study indicates that low-volume interval training combined with single-set RT (70 min/week) improves physical fitness and cardiometabolic health in obese MetS patients at both high and moderate intensities. However, improvements in SCFA production were only observed in HIGH-EX. This suggests that exercise intensity plays a critical role in gut microbial adaptations, potentially mediated by higher lactate production, which has been linked to increased SCFA

production [3]. Future research should further explore the mechanistic links between exercise intensity and gut microbiota metabolism to optimize exercise prescriptions for metabolic health improvements.

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**THE METABOLIC CHARACTERISTICS OF THE EFFECTS OF COMBINED EXERCISE ON THE TRANSITION OF METABOLICALLY UNHEALTHY OBESITY IN YOUTH**

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INTRODUCTION: This study focused on the phenotypic characteristics of youth with metabolically unhealthy obesity (MUO)and metabolically healthy obesity (MHO). It aimed to evaluate the metabolic characteristics of combined training modalities, resistance training followed by moderate-intensity continuous training (RT+MICT), on the transition from MUO to MHO in young adults.

METHODS: This randomized clinical trial, conducted from September 2024 to November 2024, involved 50 obese college students (ages 18-25) from China Agricultural University in Beijing. Of these, 30 participants were classified as MUO, while 20 were classified as MHO based on their phenotypic characteristics. Participants underwent a combined intervention of resistance training and MICT (50-75% HRmax), which was performed twice a week for a duration of 8 weeks.

RESULTS: There were 33 differential metabolites identified between MUO and MHO individuals prior to exercise intervention. After an 8-week combined exercise program, 52% of the MUO participants transitioned to the MHO state, while 20 MHO participants remained in the MHO state. RT+MICT intervention significantly improved body composition, with reductions in body weight, body mass index (BMI), and percent body fat (PBF). Regarding metabolic health indicators, blood pressure remained unchanged, whereas blood glucose levels decreased in both groups. Following the 8-week combined exercise, there were 374 differential metabolites observed in the MUO group transitioning to the MHO state, and 342 differential metabolites identified in the MHO group that remained in the MHO state. Key metabolic indicators related to the combined training modalities that facilitated the transition of MUO in youth included tetradecanedioic acid, 4-Ethylphenylsulfate, p-Cresol, p-Cresol sulfate, Cholic acid, 1,4-dihydroxyheptadec-16-en-2-yl acetate, 7a-Hydroxy-cholestene-3-one, and Hypocrellin A.

CONCLUSION: Combined exercise intervention effectively improves the metabolic abnormalities associated with MUO and promote its transition to the MHO state.

**EFFECTS OF REDUCED SEDENTARY TIME ON FAT OXIDATION DURING EXERCISE IN ADULTS WITH METABOLIC SYNDROME**

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INTRODUCTION: Sedentary behavior (SB) and physical inactivity are associated with impairments in energy metabolism, while exercise training is known to enhance substrate metabolism, including fat oxidation during exercise. It is not known, however, whether similar enhancements can be achieved with reduced SB and increased habitual, non-exercise physical activity (PA). This study therefore investigated the effects of reducing SB on fat oxidation during exercise in adults at risk of type 2 diabetes in a 6-month randomized controlled trial.

METHODS: Sixty-four sedentary middle-aged adults with metabolic syndrome were randomized into intervention (INT, n=33) and control (CON, n=31) groups. INT aimed to limit SB by 1 h/day by increasing standing and light-to-moderate-intensity PA, and CON was instructed to maintain usual habits. SB and PA were assessed with hip-worn accelerometers for 6 months. At the beginning and end of the intervention, cardiorespiratory fitness (CRF; VO2max), absolute maximal fat oxidation (MFO; g/min), MFO relative to fat-free mass (mg/kgFFM/min), and FatMax (exercise intensity that elicits MFO; % of VO2max) were determined from respiratory gases during a graded cycle ergometer test with 3-min stages and 25-W increments. Dietary intake was assessed with 4-day food diaries and body composition with air displacement plethysmography (Bod Pod).

RESULTS: INT reduced SB by 41 min/day and increased moderate-to-vigorous PA by 20 min/day during the intervention, with no statistically significant changes in CON (group x time p=0.004 and p=0.003, respectively). Both groups increased light-intensity PA (9 min/day) and daily steps (INT +3300, CON +1600 steps/day), and lost an average of ~1 kg weight mainly through a decrease in fat mass (time $p<0.05$ for all). During the intervention, absolute MFO increased from 0.31 (95% CI: 0.29, 0.33) g/min at baseline to 0.34 (0.32, 0.36) g/min at 6 months, and relative MFO from 5.85 (5.48, 6.22) mg/kgFFM/min to 6.43 (6.04, 6.82) mg/kgFFM/min, with no statistically significant difference between groups (time p=0.01, group x time $p>0.05$ for both). Increased MFO (absolute and relative) correlated with improved CRF (r=0.45, p=0.001 for both), and increases in absolute MFO also correlated with increased FFM (r=0.29, p=0.03). FatMax did not change in either group from 46.0 (43.6, 48.5) % VO2max at baseline, but changes during the intervention in FatMax correlated with changes in the intake of total energy (kcal/day), protein, and fat (g/day) (r=0.33, r=0.39, and r=0.35, respectively; $p<0.05$ for all).

CONCLUSION: Reduced SB and increased PA did not have an intervention effect on fat oxidation during exercise. Changes in fitness level, body composition and dietary intake might be more important contributors to fat oxidation during exercise than habitual sedentary and physical activities. More intense exercise training is likely needed for enhanced exercise-stimulated fat oxidation.

**THE EFFECTS OF HOME-BASED PILATES ON MUSCLE QUALITY INDEX IN INDIVIDUALS AFFECTED BY OBESITY**

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INTRODUCTION: Combining Pilates with dietary interventions may represent an effective strategy to improve body composition in individuals affected by obesity [1]. However, there is a lack of evidence on how Pilates may improve muscular fitness, an important health-related indicator in this population [3]. Specifically, muscle quality (i.e., the amount of strength and/or power per unit of muscle mass) has been proposed as a relevant health indicator [4]. Therefore, this study aimed to evaluate the effects of 12-week home-based Pilates on muscle quality in individuals affected by obesity.

METHODS: Participants (age: 52.6 ± 7.1 years; BMI: 33.8 ± 5.8 kg/m2) were recruited and randomly assigned to Control Group (CG, n=10) or Pilates Group (PG, n=12). All participants adhered to a Mediterranean diet, while only the PG followed a supervised home-based Pilates program three times a week for 12 weeks. Muscular strength was assessed with the handgrip strength test (HG). 10-repetition chair-stand test (CST) was used to evaluate Muscular Power (MP). Skeletal Muscle Mass (SMM) was obtained through body composition analysis and used to calculate Specific Strength (SS, HG/SMM) and Specific Power (SP, MP/SMM). These two latter variables were used to assess the overall muscle quality index (MQI). Results were classified as poor, low or normal according to sex. All participants were evaluated at baseline (T0) and after 12-week of intervention (T1).

RESULTS: HG increased by 1.2% in CG and 6.5% in PG. The time to perform CST was reduced in both groups (CG: -16.2%; PG: -12.1%). SMM increased by 2.0% and 1.5% in CG and PG, respectively. In the CG, SS values were classified as poor (80%) and low (20%) at T0, with none of the participants reaching normal values at T1. In the PG, SS values were categorized as poor (90%) and low (10%) at T0, with none of the participants achieving normal values at T1. In the CG, SP values were classified as poor (10%), low (50%) and normal (40%) at T0, with 60% of participants reaching normal values at T1. Similarly, in the PG, SP values were categorized as poor (8.3%), low (50%) and normal (41.7%) at T0, with 58.3% of participants achieving normal values at T1. Overall, MQI reached normal values at T1 in 20% and 33.3% of participants in CG and PG, respectively.

CONCLUSION: Our preliminary data suggest that not all participants in both groups achieved normal MQI values after 12 weeks of intervention. However, the trend of improvement in HG and MQI was greater in PG. Future studies with larger sample sizes are needed to confirm these findings.

References:

1. Greco et al. Nutrients 2024

2. Rayes et al. PeerJ 2019

3. Valenzuela et al. BMC Musculoskelet Disord 2020

## Oral Presentations

### OP-AP17 Swimming I - Strength Training

**COMPARISON OF DIFFERENT RESISTANCE LOADS IN WATER ON THE TRAINING PERFORMANCE AND OPTIMAL LOAD SELECTION OF FRONT CRAWL SWIMMING**

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INTRODUCTION: Front crawl is the fastest and most streamlined swimming stroke, with the swimming phase accounting for the majority of race time, excluding the start and turns [1]. Effectively utilizing aquatic resistance training to simulate race conditions and enhance swimming performance is crucial. Therefore, the purpose of this study is to compare the effects of different aquatic resistance loads on swimming performance and determine the optimal resistance load. The findings aim to provide practical guidance for implementing aquatic resistance training.

METHODS: This study recruited 19 male elite swimmers. Resistance cord was attached to the waist using a semi-systematic electromechanical device (1080 Sprint 2). Resistance loads were set at 1%, 3%, and 5% of body weight for a 25 m front crawl sprint test. Analyze parameters such as maximum velocity, peak force, peak power, and velocity decrement rate (VDR) from 5 to 20 m. One-way repeated measures ANOVA was conducted to examine the effects of different resistance loads on short-distance sprint performance.

RESULTS: The results of this study showed that under different resistance loads. The 1% load achieved the highest maximum velocity, while maximum velocity decreased as resistance load increased ($p = .000$). In addition, The peak force and

peak power were highest at the 5% load (p = .00). Further analysis of the VDR1-5% revealed an 18% reduction (p = .000), 10% reduction from VDR1-3% (p = .00), and 8% reduction from VDR3-5% (p = .000).

CONCLUSION: The results of this study indicate that an increase in resistance load further enhances peak force and peak power, demonstrating that a moderate increase in resistance can effectively improve an athlete's strength and power output. However, excessive resistance may lead to a significant decline in maximum velocity, which is detrimental to explosive power development. Given that the VDR1-5% was significantly higher than at VDR1-3%, 5% body weight resistance load is not conducive to maximum velocity. Therefore, 3% resistance load is recommended as an optimal training intensity to help athletes achieve better strength and speed performance for developing more tailored resistance training strategies for athletes at different competitive levels.

1. Arellano et al. (2018)

**THE EFFECTS OF TRUNK STRENGTH TRAINING ON TURN TIME PERFORMANCE IN 400 M FREESTYLE FOR NATIONAL-LEVEL SWIMMERS**

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INTRODUCTION: Trunk muscles are critical for effective freestyle turn performance because they facilitate dual rotational movements—rolling and twisting. Enhanced trunk strength not only stabilizes the spine and overall body but also improves underwater performance (e.g., gliding and undulatory underwater swimming) by reducing disturbances and drag while increasing body amplitude [1-2]. Previous studies have shown that incorporating trunk strength training (TST) into day-land programs can improve 50 m freestyle performance and turn efficiency (measured as the 5 m segment following wall contact) [3-4]. However, due to differences in performance parameters between sprint- and middle-distance events, the effects of TST on 400 m freestyle remain unclear. Thus, thus study aimed to examine the impact of TST on turn time performance during 400 m freestyle among national-level swimmers.

METHODS: Fourteen national-level swimmers (8 males, 6 females) specializing in middle-distance freestyle were divided into an experimental group (EG: 18.3 ± 3.3 y, 177.3 ± 9.5 cm, 65.7 ± 9.5 kg) and a control group (CG: 20.3 ± 4.2 y, 179.5 ± 7.3 cm, 69.4 ± 11.7 kg). In addition to their regular day-land training (focusing on upper and lower limb strength), the EG completed an 8 weeks TST program (three sessions per week) divided into two phases: a basic stage (4 weeks) focusing on trunk bilateral rotation stability and dynamic strength, followed by advanced stage (4 weeks) emphasizing explosive power and specific turn exercise. Pre- and post-intervention assessments included trunk isokinetic peak force (PT) using an IsoMed 2000 dynamometer for flexion-extension (60°/s) bilateral rotation (150°/s), and turn time parameters during 400 m freestyle test. Turn performance was evaluated by overall turn time (OTT: the cumulative time for 7 turns, measured from the last 5 m before the rolling rotation to the 10 m mark after wall contact) and the average 5 m round turn time (5 m-RTT). A two-way repeated measures ANOVA was used to analyze intervention effects.

RESULTS: Significant interactions between time (pre vs. post) and group (EG vs. CG) were found for trunk flexion PT ($F = 5.600$, $p = 0.036$, $\eta 2p = 0.318$), extension PT ($F = 5.534$, $p = 0.037$, $\eta 2p = 0.316$), left rotation PT ($F = 19.496$, $p = 0.001$, $\eta 2p = 0.619$) and right rotation PT ($F = 10.626$, $p = 0.007$, $\eta 2p = 0.470$), OTT ($F = 15.061$, $p = 0.002$, $\eta 2p = 0.557$), 5 m-RTT ($F = 21.396$, $p = 0.001$, $\eta 2p = 0.641$), and overall 400 m freestyle performance ($F = 9.526$, $p = 0.009$, $\eta 2p = 0.443$). Compared to the CG, the EG showed significantly greater improvements in trunk strength and turn performance.

CONCLUSION: Combined TST can enhance trunk flexion, extension, and bilateral rotation strength, leading to improved turn efficiency and overall performance in 400 m freestyle among national-level swimmers.

Reference:

[1] Kwok et al., 2021; [2] Ikeda et al., 2021; [3] Weston et al., 2015; [4] Karpiński et al., 2020

**RESEARCH ON THE ARM STROKE FORCE CHARACTERISTICS OF CHINA ELITE SWIMMERS**

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INTRODUCTION: This study focuses on Chinese elite swimmers and deeply analyzes their arm stroke force characteristics, aiming to provide crucial scientific bases for enhancing athletes athletic performance and optimizing training programs. By measuring the arm strokes of 48 high-level swimmers during a 50-meter all-out swim, comprehensively collecting and analyzing the force data of arm strokes, this research reveals the internal connections and laws among various force indicators, explores the key factors influencing swimming performance, breaks through the limitations of traditional training ideas, and lays the foundation for formulating innovative training strategies.

METHODS: The eoswimbetter force plate was used to test 48 freestyle swimmers (FINA score 852 ± 8, with a training experience of 7.3 ± 3.5 years and the dominant side being the right hand). The athletes first completed a standardized routine warm-up and then swam a 50-meter freestyle with full effort while breathing normally, ensuring that the test conditions were close to the actual competition situation. Various statistical methods were applied to process the data obtained from the force plate. Descriptive statistics such as means and standard deviations were calculated, box plots and heat maps were drawn, and the correlations among various indicators were thoroughly analyzed to explore the characteristics and laws of arm stroke mechanics.

RESULTS: Regarding the individual characteristics of the athletes, the average force has a mean value of 2.35, with differences among different athletes, and shows a strong positive correlation (with a correlation coefficient of 0.82) with the average forces of the left and right hands. The average stroke frequency has a mean value of 38.71 and a high degree of dispersion (standard deviation of 8.21), and has a certain positive correlation with the number of movements, being affected by factors such as personal habits. The force distribution has different values in various directions among different athletes, reflecting the differences in the emphasis of force application. The forward propulsion efficiency percentage has a mean value of 0.48, with concentrated data, and has a certain positive correlation with the number of movements, but a weak correlation with the average force and average stroke frequency.

CONCLUSION: From the perspective of the group performance of the athletes, the data were classified according to quartiles, clarifying the performance level distribution of different athletes in terms of average force, stroke frequency and other indicators. Based on individual differences, personalized training strategies can be formulated. In terms of the symmetry characteristics of arm strokes, the average symmetry index is 0.18, with a standard deviation of 0.15, showing obvious individual differences. Athletes with a symmetry index close to 0 have excellent symmetry in arm stroke mechanics; those in the range of 0.1 - 0.3 have relatively good symmetry; those in the range of 0.3 -

**SHOULDER ISOKINETIC STRENGTH SYMMETRY IN ADOLESCENT SWIMMERS AND ITS CORRELATION WITH SWIMMING PERFORMANCE**

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*BEIJING SPORT UNIVERSITY*

INTRODUCTION: This study aimed to compare shoulder joint isokinetic strength symmetry among adolescent swimmers specializing in different strokes and examine the relationship between shoulder strength imbalances and swimming performance.

METHODS: Forty-two swimmers (23 males, 15.8 ± 1.4 years, 182.8 ± 6.6 cm, 74.7 ± 6.4 kg; 19 females, 14.7 ± 1.6 years, 170.0 ± 4.4 cm, 60.3 ± 5.7 kg) participated. Maximum strength (60°/s, 4 reps) and explosive power (180°/s, 26 reps) of shoulder flexors and extensors were measured unilaterally, and flexor-extensor ratios were calculated. Swimming performance was assessed via 100-meter sprint times in each swimmer's primary stroke. Strength imbalance rates were calculated as: (%) = (dominant - non-dominant) / dominant × 100.

RESULTS: Wilcoxon tests showed that the flexor-extensor ratio was significantly lower for maximum strength than for explosive power ($P < 0.01$), but imbalance rates between sides were not significantly different ($P > 0.05$). Mann-Whitney U tests found no significant gender differences in strength imbalance rates ($P > 0.05$). Kruskal-Wallis tests showed no significant differences among strokes ($P > 0.05$). Spearman's analysis revealed a positive correlation between the flexor-extensor ratio and 100-meter performance in butterfly swimmers ($P < 0.05$) but a negative correlation in backstroke swimmers ($P < 0.05$). Other correlations were not significant ($P > 0.05$).

CONCLUSION: These findings suggest no significant gender differences in shoulder strength imbalance, though males exhibited a slightly lower explosive power flexor-extensor ratio than females ($P = 0.05$), indicating greater flexor-extensor disparity. Prior research links excessive imbalances to injury; in this study, 71% of swimmers with shoulder discomfort or injuries were male. The absence of significant differences across strokes suggests that bilateral imbalances are common. The correlation in butterfly swimmers may stem from the greater involvement of extensors in the stroke's entry phase, while backstroke results suggest that a controlled arm entry is more beneficial for performance.

Maintaining an appropriate flexor-extensor ratio may help prevent injuries. Butterfly swimmers should balance flexor and extensor strength, while backstroke swimmers need not prioritize symmetry but should maintain a reasonable ratio to avoid injury. Further research is needed to determine optimal strength balance ranges. Additionally, the lack of correlation between land-based strength imbalance and swimming performance suggests that symmetry assessments should incorporate water-based metrics.

## Oral Presentations

### OP-AP18 Coaching I - Psychology

**PSYCHOMETRIC CHARACTERISTICS OF LATVIAN TEAM SPORTS ATHLETES**

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INTRODUCTION: The psychological skills of athletes are widely studied, especially in high performance sports. It highlights significant psychometric issues in the athletes preparation and allows corrections to be made in the training process. Psychological skills are crucial to the success and achievement of athletes. The aim of this study was: to assess the applicability of PSIS-R5 in the Latvian team sports environment, examining the relationship between athletes achievement levels and psychological skills, and to provide recommendations to coaches for improving the training process.

METHODS: A total of 254 Latvian team sports athletes aged between 18 to 35 completed the PSIS-R5 inventory to assess their psychological skills. Participation in the study was voluntary and anonymous. Prior to completing the questionnaire,

participants provided written informed consent, ensuring they were aware of the study's purpose and the intended use of their data. The PSIS-R5 includes 45 items distributed across six scales: Anxiety control, Concentration, Confidence, Mental preparation, Motivation, and Team emphasis The PSIS-R5 was re-translated into Latvian language (PSIS-R5-L) using forward-backward translation. The levels of athletes achievements were evaluated according to the national and international performance statistics of the specific team sport (hockey (n=73), basketball (n=52), floorball (n=36), volleyball (n=35), football (n=33), handball (n=25)). The data collected was analyzed using the Statistical Package for the Social Sciences (IBM SPSS v.28.0.0) and JASP 0.18.3.0.

RESULTS: The obtained data reveal that there are significant differences in self-confidence between elite and pre-elite athletes, suggesting that elite athletes demonstrate a higher level of self-confidence. Additionally, statistically significant differences in self-confidence were found between pre-elite and amateur athletes, indicating that pre-elite athletes exhibit lower self-confidence than amateur athletes. The motivation scale, based on average scores, shows a descending order from the elite to the pre-elite , with amateurs group scoring the lowest. These results suggest that athletes with higher levels of achievement exhibit higher motivation in sports. On the team emphasis scale, no statistically significant differences were detected among athletes' achievement groups, indicating comparable team orientation across all groups. For the visualization scale, statistically significant differences were found only between the elite and amateur groups, suggesting that elite athletes possess stronger visualization skills than amateurs.

CONCLUSION: These findings align with previous studies, supporting the fact that the higher achievement levels are associated with stronger psychological skills. The results indicate that scores on various scales are not particularly high or close to maximum levels, highlighting the necessity of integrating targeted psychological skills training into athletes' development programs.

**EXAMINING PSYCHOLOGICAL ASSOCIATION BETWEEN COACH TRANSFORMATIONAL LEADERSHIP BEHAVIOURS WITH ATHLETE BASIC NEEDS SATISFACTION AND MINDFULNESS TO SUPPORT COACH PRACTICES**

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INTRODUCTION: Integral to the role of a sport coach are facets of leadership that are instilled through developed behaviours that enhance approaches across practice alongside the athletes they support [1]. Transformational leadership (TFL) has been extensively studied in sport psychology as a leadership style that enhances athlete motivation, performance, and well-being [2]. TFL is characterised by behaviours that inspire, intellectually stimulate, and consider needs of followers [3]. However limited work has explored its relationship with athlete focus through mindfulness and basic psychological need satisfaction in sport coaching settings. Given the central role of sport coaches as leaders, the study focuses on addressing this gap through analysis of the interplay across these aspects.

METHODS: Tennis athletes (n=422) completed validated scales to measure coach TFL behaviours (DTLI), athlete satisfaction (BNSSS), and mindfulness (MAAS). Descriptive and inferential statistical analysis, including Welch t-tests, ANOVA, Cronbach alpha coefficients, Pearson correlations, and mediation analysis using PROCESS macro, were conducted to explore the hypothesised relationships across: (1) positive correlations between athlete perception of coach TFL behaviours with satisfaction and mindfulness, (2) differential associations of TFL subscales with athlete satisfaction, (3) differential associations of TFL subscales with mindfulness, and (4) the mediating role of mindfulness in the relationship between TFL and athlete satisfaction.

RESULTS: Findings revealed significant positive correlations between athlete perception of coach TFL behaviours and both athlete satisfaction (medium correlation) and mindfulness (small correlation). Among TFL subscales, inspirational motivation had the strongest association with athlete satisfaction, while appropriate role modelling was most strongly linked to athlete mindfulness. Gender-based differences were observed, with male coaches receiving higher TFL ratings than female coaches. Contrary to expectations, mediation analysis indicated mindfulness did not significantly mediate the relationship between coach TFL behaviours and athlete satisfaction. However, significant direct effects were found between TFL and mindfulness, as well as between mindfulness and satisfaction.

CONCLUSION: This study reinforces the relevance of TFL in sport coaching, highlighting its positive association with athlete satisfaction and focus through mindfulness. Findings indicate inspirational motivation and role modelling are particularly influential behaviours in shaping athlete experiences. These insights contribute to the field of sport psychology through identifying key TFL behaviours of coaches that enhance athlete outcomes. Further studies should explore contextual factors influencing these relationships and the impact of performance level and gender disparities across coach-athlete dynamics.

1. Bass (1985), 2. Carvalho et al. (2020), 3. Arthur et al. (2020)

**EXPLORING TEAM PERFORMANCE IN ENDURANCE SPORT: HOW DO INDIVIDUALS USE THEIR SELF-REGULATION SKILLS TO PERFORM AS A TEAM?**

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INTRODUCTION: Self-regulation is one of the key elements for excelling in individual sports [1]. However, when performing in teams, self-regulatory processes might include additional elements relating to collaboration with teammates (group-based self-regulation). Insight into an athlete's success orientation, focusing predominantly on personal versus team

success, might help understanding the self-regulatory processes contributing to team performance. The aims of this study are to 1) investigate group-based self-regulation in endurance athletes, as well as the impact of their success orientation, and 2) explore behavior, satisfaction, and performance of individual athletes in teams.

METHODS: Twenty-nine competitive junior long-track speed skaters (14 males, 15 females), aged 16 (±1) years, skated an individual performance (1500m) and a team performance, consisting of skating three laps in a team of three skaters (team pursuit). Participants completed questionnaires on individual and group-based self-regulation, including the facets reflection, planning, evaluation, effort, self-efficacy, speaking up, and coaching, with additional questions about success orientation (categories: personal, combined, team), general team behavior and satisfaction. Differences between individual and group-based self-regulation were tested by Related Samples Wilcoxon Signed-Rank tests. Behavior, satisfaction, and performance were explored by Spearman's rho correlations. Statistical significance was set at $\alpha$=0.05 and effect sizes (r) were calculated.

RESULTS: The score on group-based coaching (median=3) was significantly higher than the score on individual coaching (median=2) (W=197, Z=3.54, p<0.001, r=0.66). Distribution of success orientation was as follows: personal (n=18), combined (n=11), team (n=0). Only in participants with a combined success orientation, the group-based planning score (median=4) was higher than the individual planning score (median=3) (W=61, Z=2.53, p<0.05, r=0.76). Variation in behavior, satisfaction, and performance within and between teams was considerable, evidencing the complexities of team performance.

CONCLUSION: When performing in teams, individual athletes increased their amount of coaching. Athletes more focused on team success also increased their amount of planning. When individual athletes are assembled into a team, factors such as success orientation and the behavior and performance of teammates become important. Self-regulation (planning, coaching) may be used to navigate these complexities and improve team performance.

1. Jonker et al. (2010)

**IMPACT OF COACH'S DRAWING ON VISUAL ATTENTION AND MEMORIZATION OF TACTICAL SOCCER SCENE: THE MODERATING EFFECT OF EXPERTISE AND VISUOSPATIAL ABILITIES**

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Aiming to facilitate learning from narrated tactical diagrams, this study investigates the impact of drawing on visual attention and memorization of soccer tactical scenes, considering participants visuospatial abilities (VSA) and expertise level. One hundred twenty participants (60 expert soccer players and 60 novices, both with high and low VSA) were randomly assigned to one of two conditions: a control condition (pre-drawn diagrams with oral explanation) or an experimental condition (diagrams actively drawn by the coach while providing explanations). Eye-tracking and a reconstruction task were conducted to evaluate recall accuracy, allocated mental effort, recall time, and total fixation duration on the diagrams. Key findings reveal a moderating effect of VSA and expertise, emphasizing the need to tailor the drawing format of tactical diagrams to individual characteristics in order to optimize memorization and visual processing of tactical soccer diagrams.

## Oral Presentations

### OP-MH44 Cardiovascular Disease and Disfunction

**THE ROLE OF OXYGEN SUPPLEMENTATION IN CARDIAC REHABILITATION: ENHANCING AEROBIC PERFORMANCE AND QUALITY OF LIFE IN HEART FAILURE PATIENTS**

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INTRODUCTION: Physical activity training programs during cardiac rehabilitation reportedly reduce morbidity and hospitalization in heart failure (HF) patients. While acute oxygen supplementation has been shown to improve muscle oxygenation and enhance exercise duration and intensity, its effects during a prolonged training program remain unclear. This study aims to investigate (1) the effects of oxygen-supplemented during training on maximal and submaximal performance, 6-minute walk test (6MWT), and quality of life in HF patients; (2) the impact of oxygen supplementation during acute exercise on lactate concentration and performance.

METHODS: Twenty-four HF patients (ejection fraction <50%, with no resting desaturation) were randomly assigned to an oxygen supplementation ($O_2$) group or a placebo control group. The $O_2$ group received supplemental oxygen during all exercise sessions throughout the two-month training program. The control group trained under room air conditions. All participants completed baseline and post-program assessments, including measurements of maximal and submaximal aerobic capacity, 6-minute walk test (6MWT) distance, disease severity (New York Heart Association- NYHA classification), and quality of life (Kansas City Cardiomyopathy Questionnaire, KCCQ). Participants also performed an acute submaximal effort test at 80% of their maximum heart rate, with and without supplemental oxygen. Lactate concentration, heart rate, and rate of perceived exertion were recorded every three minutes throughout the test.

RESULTS: The $O_2$ group showed significant improvements in maximal (p=0.007) and submaximal (p=0.003) aerobic tests, 6MWT (p<0.001), and KCCQ score (p=0.011) compared to controls. NYHA classification improved in 90% of the $O_2$ group versus 16% in controls. Oxygen supplementation during the acute submaximal test extended exercise duration (p<0.001) and led to a slower rise in lactate and heart rate (p<0.001) compared to exercise without oxygen supplementation.

CONCLUSION: Supplemental oxygen during training in HF patients undergoing cardiac rehabilitation improved aerobic performance and quality of life. It also prolonged exercise duration and moderated physiological responses during single submaximal exercise. Oxygen supplementation should be considered in rehabilitation programs, even for patients without resting desaturation.

**OXYGEN SATURATION IN THE LEG MUSCULATURE AFFECTED BY PERIPHERAL ARTERY DISEASE DURING EXERCISE ON AN ARM ERGOMETER**

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*UNIVERSIDADE NOVE DE JULHO*

INTRODUCTION: Arm ergometer (AE) exercise training have shown to improve functional capacity of patients with peripheral artery disease (PAD) [1], bypassing the main barrier to exercise in these patients: the pain during walking exercise. The only study that investigated the mechanism underlying this adaptation observed that chronically training with AE improved muscle oxygen saturation ($StO_2$) in the leg muscles during walking [2]. However, the how AE exercise acutely affects $StO_2$ in the leg muscles remain unknown. Thus, the aim of this study was to analyze the acute responses of AE exercise on $StO_2$ in the leg affected by PAD. The secondary objectives were to analyze oxy-, deoxy-, and total hemoglobin responses, describe the intensity of leg pain symptoms during exercise in AE, and examine the relationship between $StO_2$ during AE and PAD severity.

METHODS: Fourteen patients (57% men, 66 ± 6 years, 27.4 ± 4.6 kg/m2) with PAD and symptoms of intermittent claudication were recruited. PAD severity was assessed using the ankle-brachial index. The exercise session consisted of 15 sets of 2 minutes of AE exercise with an intensity between 13-15 on the Borgs perceived exertion scale. The Near-Infrared Spectroscopy sensor was placed on the calf muscle of the leg most affected by the disease. Prior to exercise, a physiological calibration was performed using arterial occlusion to establish a functional zero for tissue oxygenation. $StO_2$, oxy-, deoxy-, and total hemoglobin. These variables were continuously recorded throughout the entire session. At the end of each set, leg pain and perception exertion were recorded.

RESULTS: During AE there was an increase in leg $StO_2$ throughout the sets (Rest: 57.9 ± 3.6 vs. Peak: 66.8 ± 6.1 %, p<0.001) with a mean rise of 9.0 ± 4.1 %. On average, the participants reached peak $StO_2$ in the 9.9 ± 4.1 set. Additionally, there was an increase in oxyhemoglobin (Rest: 10.7 ± 10.2 vs. Peak: 26.6 ± 13.7 µM, p<0.001) with average increases of 15.9 ± 7.9 µM, and total hemoglobin (Rest: 0.2 ± 5.1 vs. Peak: 14.9 ± 12.4 µM, p<0.001) with average increases of 14.6 ± 11.2 µM; and a decrease in deoxyhemoglobin (Rest: 0.1 ± 2.2 vs. Trough: -4.8 ± 6.7 µM, p=0.017) with average decreases of -4.9 ± 6.7 µM. Perceived exertion remained at an average of 13.5 ± 0.9, and two patients reported pain in the leg during AE. There were no associations between $StO_2$ responses and PAD severity (p>0.160).

CONCLUSION: A single session of AE increased $StO_2$, oxy-, and total hemoglobin while decreasing deoxyhemoglobin, and these responses occurs independently of PAD severity. Finally, two out of 14 patients reported leg pain during the AE. This study was supported by the São Paulo Research Foundation (FAPESP) under grant number 2022/14412-8.

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**CARDIORESPIRATORY FITNESS, GENETIC RISK, AND INCIDENT ATHEROSCLEROTIC CARDIOVASCULAR EVENTS: A PROSPECTIVE COHORT STUDY**

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INTRODUCTION: Cardiorespiratory fitness (CRF) is an important modifiable risk factor for atherosclerotic cardiovascular disease (ASCVD). It remains unknown, however, if the associations of CRF with ASCVD risk differ by genetic risk. We examined prospective relationships of CRF with incident ASCVD across genetic susceptibility strata.

METHODS: This prospective study included 69,447 UK Biobank participants (mean age 58 years; 54% female) without prevalent ASCVD and who completed a sub-maximal cycle test. Maximal oxygen consumption (mlO2/min/kg) was estimated using a validated bike ergometry procedure, standardised within sex and age strata, and categorised to create low (20th percentile), intermediate (20-80th percentiles) and high (80th percentile) fitness groups. Genetic susceptibility to ischaemic heart disease was quantified with weighted polygenic risk scores, and was used to assign participants to low, intermediate, and high genetic risk groups. Cox regression models were used to estimate the hazard of developing ASCVD and its major sub-components. In line with international definitions, ASCVD included all documented cases of ischaemic heart disease (IHD: comprising myocardial infarction, angina, coronary revascularisation procedures), ischaemic stroke, and peripheral arterial disease. We investigated IHD and major ischaemic events (myocardial infarction and ischaemic stroke) as nested secondary outcomes.

RESULTS: During a median follow-up of 12 years, there were 5,448 incident ASCVD, 4,177 IHD, and 2,299 major ischaemic events. Each 1-standard deviation difference in sex- and age-standardised CRF (equivalent to 5.6 mLO2/kg/min) was associated with an 8% (hazard ratio [95% confidence interval]: 0.92 [0.89-0.95]) lower hazard of ASCVD, independently of demographic, lifestyle and health-related factors, and genetic risk. There was weak evidence of multiplicative interaction (p=0.06) between CRF and genetic risk, suggesting that the associations might be slightly stronger in the low genetic risk group (0.87 [0.80-0.94]) compared with intermediate (0.94 [0.90-0.98] and high genetic risk groups (0.91 [0.86-0.97]). There was no evidence of additive interaction (p=0.78). The 10-year absolute risk differences between low and high CRF groups were 1.2% and 1.6% within high and low genetic risk categories, respectively. Similar patterns of associations were found for incident IHD and major ischaemic events.

CONCLUSION: Across all strata of genetic risk for cardiovascular disease, higher CRF is strongly associated with lower risk of ASCVD and its major sub-components. Adults should be encouraged to increase or maintain CRF levels, irrespective of genetic susceptibility.

**SEX AND GENOTYPE SPECIFICITIES OF MICROVASCULATURE AND MUSCLE REMODELING IN SUB-SAHARAN SICKLE CELL TRAIT AND DISEASE**

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*UNIVERSITÉ SAVOIE MONT BLANC*

INTRODUCTION: Sickle cell disease (SCD), the most common genetic disease in the world, is due to the synthesis of abnormal hemoglobin S (HbS) which may polymerize once deoxygenated, rigidifying and distorting the red blood cells in sickle shape. SCD is associated with reduced exercise tolerance connected with a microvasculature and muscle remodeling. However, SCD-repercussions on microvasculature and muscle remain unknown in women. The present study aimed to compare muscle microvascular and energetic characteristics of female and male healthy subjects (CON), carriers of sickle cell trait (SCT) and patients with SCD.

METHODS: 56 Cameroonians [16 SCD patients (9 women and 7 men), 20 SCT carriers (10 women and 10 men) and 20 healthy controls (CON, 10 women and 10 men)] were involved. Blood samples were assayed for complete blood count, HbS and HbF proportions, derived parameters and circulating molecules (AOPP, L-, P- and S-selectins, ICAM, VEGF, MMP2 and MMP9). Biopsies of the right vastus lateralis muscle were performed percutaneously at rest to determine microvascular network, fibre type (distribution and morphology), proteins content (CAII, CAIII, CAIV, MCT1, MCT2, MCT4, NHE1, NBC) and mRNA content (HIF-1α, REDD1, NF-κB1, NF-κB3, SOD1, CAT, GPX3, GPX4). CS, CK, LDH, PFK and β-HAD enzyme activity was also analyzed on muscle lysate. Total and peri-capillary COx activity were analyzed by histoenzymology.

RESULTS: In SCD, correlations between capillary density and plasma L-selectin ($p<0.001$) and ICAM ($p<0.01$) and between capillary diameter and mean corpuscular hemoglobin S concentration ($p<0.01$) were noticed. The capillary network rarefaction observed in SCD was more pronounced in women than in men (interaction: $p<0.01$). Compared to CON, the surface for 100 myocytes was lower in men with SCD (both $p<0.001$) but not in women. Advanced oxidation protein products (AOPP) were increased in SCD patients and to a greater extent in men (interaction: $p<0.02$). Components of muscle pH regulation (CAII and MCT4) were specifically higher in SCT.

CONCLUSION: Our results suggest that SCD-associated capillary rarefaction and enlargement could be related to disturbed hemodynamics and reduced erythrocytes deformability, respectively. The specific remodeling in female SCD patients included aggravated microvascular remodeling but preserved myocytes. Muscle pH regulation mechanisms appeared specifically up-regulated in SCT carriers.

**CHRONIC E-CIGARETTE USE IMPAIRS CENTRAL AND PERIPHERAL VASCULAR FUNCTION AND AEROBIC FITNESS IN YOUNG ADULTS**

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INTRODUCTION: Chronic e-cigarette use (vaping) has been shown to increase inflammation and reduce nitric oxide (NO) bioavailability, similar to the effects of combustible cigarette use (smoking). These changes may contribute to both central and peripheral vascular dysfunction. However, the impact of vaping on vascular health in age- and sex-matched individuals remains unclear. Additionally, vaping has been linked to lung function impairments comparable to those seen in smokers, which may negatively affect aerobic fitness. This study aims to examine the effects of chronic e-cigarette use on vascular function and cardiorespiratory responses to exercise in young individuals.

METHODS: Sixty participants were recruited and completed two separate visits. The first visit included peripheral and central vascular function assessments: flow-mediated dilation (FMD) and the carotid artery reactivity (CAR) test. The second visit involved a maximal cardiopulmonary exercise test (CPET) to determine peak oxygen uptake (peak VO2). Participants also wore an accelerometer for seven days between visits. Unpaired t-tests were used to compare groups between each other.

RESULTS: Preliminary data were analysed for 44 participants (18 controls: mean age 28 years, 45% female; 11 smokers, 45% female; and 15 vapers, 45% female). FMD was similar between vapers and smokers (3.34±1.82% vs. 3.74±1.95%, p=0.73) but lower in both groups compared to controls (7.77±3.76%; p=0.01 vs. vapers, p=0.003 vs. smokers). These findings remained consistent after adjusting for baseline diameter, shear stress, peak VO2, and physical activity volume.

Similarly, CAR was comparable between vapers and smokers (-0.20±4.72% vs. -1.08±3.45%, p=0.77) but lower in both groups compared to controls (4.99±3.99%; p=0.03 vs. vapers, p=0.02 vs. smokers). Peak VO2 was also lower in vapers and smokers compared to controls (p=0.03 for both), with no difference between the two groups (p=0.73).

CONCLUSION: Vascular dysfunction is an early and robust marker of cardiovascular disease, preceding the onset of atherosclerosis. Using validated, non-invasive and clinically relevant measures of vascular health, which are known to predict the risk of major adverse events, our study provides critical insights into the impact of e-cigarette use on cardiovascular function and aerobic fitness, both of which may contribute to long-term health complications.

## Oral Presentations

### OP-MH07 Orthopedics

**A GENOMIC INTERVAL WITHIN THE PROTEOGLYCAN GENE HSPG2 IS IMPLICATED WITH A DECREASED RISK OF ANTERIOR CRUCIATE LIGAMENT INJURY.**

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INTRODUCTION: Anterior cruciate ligament (ACL) ruptures is a common lower limb injury. The potential risk factors include a genetic component. Variants within the proteoglycan gene heparan sulphate proteoglycan 2 (HSPG2) was previously implicated in a South African population. This study aimed to investigate the genetic association of HSPG2, with ACL rupture risk in a large cohort recruited from participants from Poland (POL), Sweden (SWD), Australia (AUS) and South Africa (SA).

METHODS: The combined (COMB) cohort comprised of 579 asymptomatic controls (COMB-CON: POL-CON= 150; SWD-CON= 116; AUS-CON= 80 and SA-CON= 234), and 822 ACL ruptures by non-contact and other mechanisms (COMB-ACLR: POL-ACLR= 141; SWD-ACL= 95; AUS-ACLR= 332; and SA-ACL= 253); subgroup (COMB-NON), n=434 ACL rupture by non-contact mechanism of injury (NON), (POL-NON= 54; SWD-NON= 79; AUS-NON= 154, and SA-NON= 149). Participants were genotyped for HSPG2 (rs2291826 A/G, rs2291827 G/A). Genotypes and inferred haplotypes were compared. Statistical significance was assumed if P< 0.05 and false discovery rate (FDR) was used for multiple comparisons.

RESULTS: The HSPG2 rs2291826 AG genotype was associated with a reduced risk of ACL rupture (COMB-CON vs. COMB-ACLR: P= 0.002; FDR= 0.009; OR: 0.69; 95% CI: 0.55 – 0.87 and COMB-CON vs. COMB-NON: P= 0.003, FDR= 0.009, OR: 0.66; 95% CI: 0.50 – 0.87). The HSPG2 (rs2291826 A/G, rs2291827 G/A) G-A haplotype was also associated with reduced ACL rupture risk (COMB-CON vs. COMB-ACLR: P= 0.019; OR: 0.64; 95% CI: 0.79 - 0.99 and COMB-CON vs. COMB-NON: P= 0.040; OR: 0.60; 95% CI: 0.78 - 1.01). The recessive model was most significant when the COMB-CON vs. COMB-ACLR groups were compared (P= 0.007; FDR= 0.009; OR: 2.29; 95% CI: 1.22 – 4.31). No independent significant differences in the genotype or allele frequencies distribution for the HSPG2 rs2291827 G/A variant were detected in the combined cohort.

CONCLUSION: Novel findings of this study include (i) an independent association of variants within the HSPG2 (rs2291826 A/G; with a protective effect) and confirming this was the (ii) association of the HSPG2-GA haplotype were a reduced risk. This study has identified the association of HSPG2 with a reduced risk and has specifically implicated a genomic interval within this gene with a protective effect. These findings provide the basis for further research to understand the exact biological mechanisms underpinning ACL rupture risk.

**ACHILLES TENDON PROPERTIES IN HEALTHY YOUNG MALE AND FEMALES: A PILOT STUDY**

AKMAN, M., KOVÁCS, B., EMAM, M., ZHANG, L., YE, J., CSIZMADIA, B., NÉGYESI, J., HORTOBÁGYI, T.
*HUNGARIAN UNIVERSITY OF SPORTS SCIENCE*

INTRODUCTION: Systematic reviews suggest that up to 80% of Achilles tendon injuries occur in men. However, sex-differences in Achilles tendon mechanical and morphological properties have been inconsistent. Therefore, this study aimed to compare selected Achilles tendon properties between healthy young males and females.

METHODS: Healthy young adults (4 males, 5 females; age: 31.3 ± 9.19 years, mass: 67.8 ± 17.48 kg height: 174.7 ± 9.59 cm) participated in this study. Study volunteers were sports science university students and pursued various sports disciplines without a recent or past Achilles tendon injury. Maximal plantarflexor isometric torque was measured by dynamometer in a prone position with the knee extended and ankle at 90˚. Achilles tendon moment arm and stiffness were measured using the tendon excursion method. Morphological parameters of the Achilles tendon at rest, such as cross-sectional area and thickness were assessed by ultrasound at the level of the medial malleoli. A series of independent t-tests were performed to analyze sex-differences using the JASP (version 0.19.3) statistical program.

RESULTS: We observed no sex-differences in the measured morphological and mechanical variables of the Achilles tendon. Specifically: moment arm; male = 3.0±0.8 (cm) female= 2.92±0.36 (cm) stiffness; male = 293.97±347.80 (N/mm), female = 229.16±102.93 (N/mm) , and tendon thickness; male = 6.65±1.0 (mm) female = 6.36±0.57 (mm). Maximal plantarflexor isometric torque; male =72.5±23.05 (Nm), female =70.73±20.20 (Nm). Sex-differences in tendon cross-

sectional area revealed a large effect size (d = 1.25) without statistical significance (male = 85.5±21.20 mm², female = 65±11.57 mm²)

CONCLUSION: The current preliminary data are limited by the small sample size. The lack of sex-differences in Achilles tendon properties might be related to differences between the two sexes in training history, sports disciplines, and training status at the time of testing. Additional data we are currently collecting might help resolve the inconsistencies in sex-differences in Achilles tendon properties reported by previous studies.

**PREVALENCE OF BONE HEALTH DETERMINANTS IN ELITE TRIATHLETES: A 5-YEAR PROSPECTIVE STUDY**

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*UNIVERSITY OF CANBERRA*

INTRODUCTION: Bone stress injuries (BSIs) have a high injury burden in elite triathletes, with the rate of BSIs in females reported to be three times greater compared with males [1]. Being female, competitive sport participation, problematic low energy availability (LEA), vitamin D or iron deficiency, irregular menstrual cycles and large variations in training load are the most commonly reported risk factors for sustaining a BSI. Despite the high incidence and burden of BSIs in triathletes, and concomitant impact on performance, there is limited literature outlining the aetiology and risk factors for injury and illness in this population. This study aimed to establish the prevalence of low bone mineral density (BMD), iron deficiency and problematic LEA in elite short-course triathletes, and to compare the prevalence of these health determinants between males and females.

METHODS: Forty-seven triathletes (21 males, age: 24.0 ± 3.4 y, height: 182.8 ± 5.8 cm, weight: 71.0 ± 5.4 kg; and 26 females, age: 26.0 ± 5.4 y, height: 168.2 ± 6.2 cm, weight: 57.7 ± 9.3 kg) were prospectively recruited and monitored over five consecutive seasons, with data collection occurring annually. Dual-energy X-ray absorptiometry (DEXA) was conducted on a GE Lunar iDXA (GE Medical Systems, using GE enCORE analysis software version 16 and 18 Madison, WI, USA) to assess BMD of the anteroposterior lumbar spine and femoral neck. A cut-off Z-score of <-1 was used as the threshold for low BMD. Fasted blood samples were collected via venepuncture. A cut-off of ≤30µg/L was used as the threshold for low ferritin. The Low Energy Availability in Females Questionnaire (LEAF-Q) was administered electronically to assess energy intake in the female athletes. A cut-off score of ≥8 was used to identify individuals at risk of LEA.

RESULTS: A higher proportion of female athletes were found to have low BMD (28.57%; 95%CI=12.83-44.32) as compared to males (11.11%; 95%CI=-1.56-23.78). Females had an average lumbar spine and femoral neck Z-Score of -0.0 (SD=0.8) and -0.7 (SD=1.0) respectively, compared to -0.6 (SD=0.5) and 0.2 (SD=0.6) in males. The prevalence of low ferritin in females (12.00%; 95%CI=2.67-21.33) was higher than males (4.25%; 95%CI=-1.73-10.24). Of the 46 LEAF-Q responses from the female athletes across five years, 63.04% (95%CI=48.55-77.53) were above the low-risk threshold for LEA.

CONCLUSION: This study outlines the differences in bone health related markers in male and female triathletes, with females demonstrating a higher prevalence of low BMD and low ferritin. This highlights the need to further investigate these health domains and explore relationships to bone health and BSIs, specifically in female triathletes given the high burden of these injuries in this population.

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**SURFACE ELECTROMYOGRAPHY ANALYSIS OF CLIMBERS WITH UNILATERAL SHOULDER PAIN BEFORE AND AFTER A PHYSIOTHERAPY PROTOCOL**

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*UNIVERSITY OF TRIESTE*

INTRODUCTION: Climbing involves overloading of the shoulder girdle that can result in the development of shoulder pain (Jones et al., 2018). Therefore, understanding the possible altered neuromuscular patterns could support the development of strategies for the management of this specific musculoskeletal condition. The aim of this study was to investigate the neuromuscular activity of the shoulder during climbing in climbers with unilateral shoulder pain and healthy controls to define possible altered neuromuscular patterns and investigate the effects of a physiotherapy protocol on the neuromuscular activity.

METHODS: Ten healthy climbers (4 females, 31±5 years) and ten climbers with history of unilateral shoulder pain (4 females, 30±6 years) voluntary participated to the study. Surface electromyography (sEMG) was recorded bilaterally during the execution of the frontal and opposite shoulder movements on the following muscles: medial deltoid (m. MD), pectoralis major (m. PM), latissimus dorsi (m. LD), upper trapezius (m. UT), lower trapezius (m. LT) and serratus anterior (m. SA). The sEMG signals were reported as percentage of the maximal voluntary isometric contraction (%MVIC). Climbers with unilateral shoulder pain were evaluated before and after a physiotherapy protocol.

RESULTS: Considering the differences between healthy climbers and those with unilateral shoulder pain the main findings of this study suggested that m. LD showed a lower activation in the pain group compared to the healthy controls during both the opposite shoulder movement (-27.0%; p=0.001) and frontal movement (-3.9%; p=0.042). Furthermore, m. PM showed a higher activation in pain group compared to controls in the opposite shoulder movement (6.6%; p=0.049). After the physiotherapy protocol, no significant differences were found between the two groups in m. LD and m. PM activation.

CONCLUSION: The presence of unilateral shoulder pain in climbers could lead to altered neuromuscular patterns (Raffini et al., 2024) and, in particular, the present study suggests a lower activation of the latissimus dorsi that might reflect a dynamic muscle imbalance and altered scapular kinematics typically present in overhead athletes (Wong et al., 2009).

Based on these findings, the proposed physiotherapy protocol was effective in restoring a pattern of muscle activation similar to that found in healthy climbers.

**INVESTIGATION OF ASSOCIATED FACTORS FOR PREGNANCY-RELATED LOW BACK PAIN AND ITS ASSOCIATION WITH MOTOR CONTROL ABILITIES**

LIN, T., CHEN, Y., HUANG, J.P., WANG, T.J.

*NATIONAL YANGMING CHIAOTUNG UNIVERSITY*

INTRODUCTION: Pregnancy-induced low back pain (LBP) significantly affects health and quality of life during and after pregnancy, often complicating recovery. While various risk factors have been identified in Western populations, differences in culture, physiology, and daily life in Eastern populations highlight the need for research focused on Asian women. Motor control is crucial during pregnancy as changes in the lumbar spine and pelvis require increased stability. Impaired motor control may contribute to LBP, but its role in pregnancy-related LBP is less studied. Investigating motor control and movement dissociation could improve preventative and rehabilitative strategies, particularly for Asian populations where research is limited. This study aims to examine the factors associated with pregnancy-related LBP in Taiwanese women by comparing those who experience LBP with those who do not. Crucial factors include sociodemographic variables, health status, physical activity and psychosocial factors. Additionally, the study explores the relationship between motor control and the occurrence or severity of pregnancy-related LBP, as motor control plays a key role in movement and postural stability during pregnancy.

METHODS: This cross-sectional study investigates differences between women with and without pregnancy-related LBP. 60 participants in their second trimester provided demographic, work, and exercise information. They completed six motor control assessments (three extension and three rotation tests), following therapist demonstrations, and were evaluated using the Kinetic Control Test scoring system. Each test included 10 components, with points awarded for successful completion. An independent t-test assessed differences between groups, while correlation analysis explored the link between motor control and LBP occurrence or severity.

RESULTS: The independent t-test for non-parametric analysis revealed significant results for regular exercise ($Z = -2.054$, $p = 0.04$) and a history of pain prior to pregnancy ($Z = -4.144$, $p < 0.001$) in relation to pain intensity on the Numerical Rating Scale (NRS) in 60 pregnant women. Spearman's correlation showed no significant relationship between BMI or age and pain intensity ($r = 0.091$, $p > 0.05$; $r = -0.128$, $p > 0.05$), nor between pain intensity and motor control ability ($r = -0.246$, $p = 0.06$).

CONCLUSION: The study found that regular exercise is associated with lower pregnancy-related LBP, while a history of pain correlates with greater severity. Other factors, including lower education level, high BMI, nausea, long work hours, and monoparity, did not show significant effects, likely due to the limited sample size, although pain was higher in these groups. Motor control scores below 4 on specific tests were linked to higher pain levels, with extensional control being more strongly associated with pain. These findings underscore the importance of incorporating exercises focused on extensional motor control in pregnancy-related pain prevention.

## 10:00 - 11:15

## Oral Presentations

### OP-PN31 Physiology of Fatigue III

**THE EFFECT OF COMPETITIVE FEMALE GAELIC GAMES MATCH PLAY ON NEUROMUSCULAR FUNCTION**

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INTRODUCTION: Gaelic games match play consists of intervals of lower intensity activities including walking, jogging or standing interspersed with repeated high-intensity bouts which often leads to fatigue [1,2]. Despite this, no study has comprehensively investigated the effect of competitive match play on fatigue in female Gaelic games athletes. The purpose of this study was to examine the post-match changes in neuromuscular function following competitive female Gaelic games.

METHODS: Twelve collegiate female Gaelic games players (age: 21±1 yrs, height: 170.5±4.5 cm; body mass: 66.2±8.1 kg) were recruited for this study. The following were collected pre- and post- competitive match, and again at 12h, 36h, and 60h post-match: reactive strength index (RSI), countermovement jumps (CMJ) and maximal isometric relative torque during knee extension (KE) and flexion (KF) paired with surface electromyography (eEMG), plasma interleukin-6 (IL-6) as well

as Global positioning systems (GPS) recording match play. Data were analysed using one-way repeated measures ANOVA and paired T-tests to examine changes.

RESULTS: The mean distance covered was 4812.5±1315.8 m. CMJ height decreased from immediately post- to 12h post-match (226.9±5.0 to 24.7±4.2 cm, P=0.006, ηp2= 0.356). Neither Vastus Lateralis (VL) or Biceps Femoris (BF) peak amplitude, RSI or KF changed over time (P>0.05). There was a main effect of time on KE (P=0.006), which decreased from 2.56±0.63 Nm.kg-1 post- to 2.25±0.62 Nm.kg-1 60h post-match (P=0.026), with a large effect (ηp2 = 0.274) and did not return to baseline (2.48±0.12 Nm.kg-1) at 60h post-match. There was a main effect of time on blood plasma IL-6 pg.mL-1 (P=0.019). IL-6 increased from 1.36±2.59 pre- to 3.91±3.26 pg.mL-1 post-match (P=0.030). IL-6 decreased from 3.91±3.26 post- to 0.95±1.60 pg.mL-1 12h post-match, with a large effect (ηp2 = 0.410), and remained at baseline until 60h post-match (P=0.448).

CONCLUSION: This is the first study to identify the post-match changes in neuromuscular function following competitive collegiate female Gaelic games. The reductions in neuromuscular function up to 60h post-match, indicates the fatigue induced by female Gaelic games players. This is similar to male Gaelic games players who experience fatigue up to 48h post-match [3]. Although the systematic inflammation dissipates quickly (<12 h), the neuromuscular system remains suppressed until 36h and in some respects 60h, which has implications for training and match schedules where optimising performance is crucial.

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**SUPERIMPOSED LOCAL VIBRATION AND THE TIME BEFORE EXHAUSTION: IS IT SEX AND INTENSITY-DEPENDENT?**

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INTRODUCTION: Muscle spindle stimulation with superimposed local vibration (SLV) revealed temporarily motor unit recruitment facilitation and increased strength during submaximal contraction (1). Conversely, repeated spindle activation during voluntary contractions reduces support to α-motoneurons, leading to fatigue and strength loss (2). Thus, applying SLV during fatiguing submaximal contractions may slow the decline in force (known as "performance fatigability"). This study examined SLV effects during an intermittent, fatiguing knee extension task and explored its interaction with contraction intensity (low vs. moderate) and sex.

METHODS: A total of 45 participants performed maximal voluntary contraction (MVIC) of the knee extensors and flexors before (PRE) and after (POST), a fatiguing task. The fatiguing protocol consisted of intermittent knee extensions (15s effort, 5s rest) at 50% (15 males and 9 females) or 30% MVIC (13 males and 8 females) until a 10% strength target loss. Participants realized the control task (CON) or the vibration condition (SLV) in random order. The vibration was applied to the quadricipital tendon (100 Hz, 2-3 mm).

An ANOVA between Condition was used for the time to exhaustion (TTE) including statistical parameters Sex and Intensity (30% vs. 50%) as between-subject factors and Condition (CON vs. SLV) as a within-subject factor. Similar parameters were used for the MVIC using a two repeated factors ANOVA (Time [PRE vs POST] × Condition [CON vs SLV]).

RESULTS: The MVIC decreased from PRE (240 ± 71 N·m) to POST (164 ± 54 N·m) similarly in both Condition ($p = 0.834$), Intensity ($p = 0.948$) or Sex ($p = 0.147$).

The ANOVA revealed a longer TTE at 30% (274 ± 119s) than at 50% (112 ± 28s, $p < 0.001$) and Sex did not influence the TTE ($p = 0.245$). The analysis showed that SLV increased by 11 ± 21% the TTE (CON: 179 ± 110s, SLV: 196 ± 121s, $p = 0.007$) without differences between Intensity ($p = 0.064$) or Sex ($p = 0.120$). Finally, no correlation was found between the MVIC and the Condition ($p = 0.815$).

CONCLUSION: We found that superimposed local vibration is an efficient method to increase the time before exhaustion at low or moderate intensity for males and females without altering the force loss after the fatiguing task. Moreover, its positive effect remains consistent regardless of maximal force, suggesting that SLVs influence is independent of individual strength levels. This leads us to ask how the chronic use of SLV during resistance strength training can influence performance?

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**COGNITIVE FATIGUE INDUCED BY MILITARY OPERATIONS IN HYPOXIC AND COLD ENVIRONMENT**

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INTRODUCTION: The Arctic environment features various environmental challenges, such as extreme cold and hypoxia, could increase soldiers' mental demand and impair soldiers' cognitive performance in terms of accuracy and attention. The purpose of this study was to explore the effects of operating in a hypoxic and cold environment (HCE) on the cognitive functions of three different groups of alpine soldiers.

METHODS: 34 soldiers specialized in mountain warfare (Alpine Corp) were tested before, during and after 3 days of military training (1-2-3/12 2024), on the Mont Blanc (3375m). Additional tests were conducted at 551m, four days before and 14 days after training. Soldiers were divided in 3 different groups, based on their experience and operational role: A (alpine lieutenant), B (alpine special forces), C (alpine specialized guides). Each day, soldiers were tested before and after the military operation session consisting of trekking and survival skills. Pre-operation measures included the Groningen Sleep Quality and the Fatigue scales, a 5-min psychomotor vigilance task (PVT), and a 5-min step test. After operating, soldiers repeated PVT and the step test. In addition, they rated the effort (session RPE), the workload (NASA-TLX) experienced during the operating session and the subjective fatigue changes compared to pre-military operation (Fatigability scale).

Mixed ANOVAs were used to test the effects of Group, Day and, when relevant, Time. Significance was set at $p<0.05$.

RESULTS: PVT performance deteriorated significantly after training only on the first day in HCE ($p<0.05$), indicating acute cognitive fatigability. Military training was perceived as more mentally demanding in HCE ($p <0.05$). Both fatigue and fatigability increased significantly in HCE ($p <0.001$). In addition, fatigability rating was the highest on the 1st day and then decreased, being significantly higher compared to 3rd day in HCE ($p=0.002$).

Rating of sleep quality worsen at in HCE ($p <0.001$). No significant difference between groups.

CONCLUSION: These results show that even soldiers specifically trained for mountain warfare suffer from the negative effects of HCE on cognitive performance, sleep perceived quality and general fatigue. There was no significant effects of HCE on cognitive performance before military operation, while after the operation cognitive performance decreased significantly especially on the first day in HCE, indicating a significant degree of cognitive fatigue induced by operating in hypoxia, cold and a challenging environment. Moreover, this military operation was perceived to be more mentally demanding and fatiguing in HCE compared to low altitude. Countermeasures for cognitive fatigue should be developed to improve soldiers' performance, especially during the first day in HCE.

**A NEW INCREMENTAL CYCLING COGNITIVE-MOTOR DUAL-TASK TEST TO ASSESS SIMULTANEOUS SUSTAINED ATTENTION AND NEUROMUSCULAR FATIGUE IN TRAINED ATHLETES.**

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*UNIVERSITÉ SAVOIE MONT BLANC*

INTRODUCTION: Cognitive efficiency during isolated cognitive-motor dual-task (CMDT) is influenced by exercise intensity, with moderate intensities enhancing performance compared to low or high intensities, consistent with the inverted-U theory. However, this relationship remains unexamined in whole-body exercises among trained athletes. Conversely, neuromuscular fatigue etiology resulting from high-effort cycling has been shown to be modulated by concurrent sustained attention tasks, yet the development of neuromuscular fatigue during progressively demanding CMDT remains unclear due to methodological constraints (time needed to move the participants to an isometric knee-extensor ergometer). This study aimed to investigate sustained attention performance during incremental cycling in trained individuals, with periodic assessments of neuromuscular fatigue using an innovative ergometer that allowed for real-time measurements without delay.

METHODS: Forty well-trained adults completed a novel incremental cycling and cognitive test, to assess cognitive-motor interactions under progressive physical exercise. This test consisted of 3-min ramp stages, beginning at 1 $W \cdot kg^{-1}$ with 0.4 $W \cdot kg^{-1}$ increments, combined with a sustained attention Mackworth task. Participants continued until reaching an "extremely strong" perceived effort (CR100 Borg scale, task-failure TF). At each stage, concurrent psycho-physiological assessments included Mackworth score, quadriceps isometric maximum voluntary contraction (IMVC), associated neuromuscular fatigue indices through femoral nerve electrostimulation (peripheral fatigue: twitch force, Pt; central fatigue: voluntary activation, VA), prefrontal cortex (PFC) oxygenation assessed via near-infrared spectroscopy, and perception of effort. Individual data were extrapolated at 20, 40, 60, and 80% of TF to analyse progressive changes in cognitive and neuromuscular function.

RESULTS: Pt was linearly decreased throughout the test (Pre-TF= –40.7±15.1%, $P<0.001$). VA started to be depressed at 40%TF (–1.5±0.9%, $P=0.003$), with an exacerbated decline at 80%TF and TF (Pre-TF= –6.9±2.4%, $P<0.001$), concomitant to IMVC exacerbated declines at these time-points (Pre-TF= –20.9±8.9%, $P<0.001$). PFC oxygenation started to decline at 60%TF up to TF (–7.9±2.2%, $P<0.001$). The Mackworth score was not significantly affected during the test until 80%TF, at which point CMDT engaged 84±7% of HRmax (–8.3±5.7% and –11.0±6.7% from Pre to TF, both $P<0.026$).

CONCLUSION: This study found that sustained attention performance did not follow the inverted-U theory during an incremental cognitive-motor test involving large muscle mass in well-trained adults. Sustain attention efficiency declined only at cycling intensities corresponding to "very strong" perceived effort, coinciding with PFC deoxygenation and exacer-

bated central fatigue. Notably, central fatigue emerged early, underscoring the importance of carefully managing cognitive-motor dual-task scenarios in both training and occupational settings.

**EFFECTS OF TRANSCRANIAL DIRECT CURRENT STIMULATION OVER THE SUPPLEMENTARY MOTOR AREA ON EXERCISE TOLERANCE AND PSYCHOPHYSIOLOGICAL RESPONSES TO HEAVY-INTENSITY EXERCISE**

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INTRODUCTION: Transcranial direct current stimulation (tDCS) has emerged as a minimally invasive form of cortical stimulation that may modulate psychophysiological responses to exercise and enhance exercise performance. While some studies have reported increased exercise tolerance during large-muscle mass dynamic exercise, overall findings remain inconsistent. The reasons for these discrepancies among tDCS studies are unclear but may, in part, be attributed to variations in electrode montage and placement. We therefore hypothesised that an electrode montage targeting the supplementary motor area (SMA) — a key region implicated in the effort perception, which is a potential factor influencing the ergogenic effects of tDCS — could, in contrast to conventional placements over the primary motor cortex, lead to a reduced perception of effort and, arguably, influence exercise tolerance during heavy-intensity cycling exercise.

METHODS: Twelve healthy, recreationally active men (mean age: 25 ± 2 years, $\dot{V}O_2$peak: 42.9 ± 3.6 mL·kg$^{-1}$·min$^{-1}$) participated in the study. All volunteers were required to visit the laboratory on four separate occasions. On Day 1, they performed a ramp-incremental exercise test on an electronically braked cycle ergometer to determine the gas exchange threshold (GET), $\dot{V}O_2$peak, and peak power output (POpeak). On Days 2–4, participants completed a heavy-intensity exercise bout to exhaustion at a workload corresponding to 25% of the difference between the GET and POpeak attained during the ramp exercise test. Each test was conducted following the administration, in a randomised crossover design, of 10 minutes of brain stimulation using either sham tDCS, anodal tDCS, or cathodal tDCS (current intensity: 1 mA). Perceived exertion was recorded every 2 minutes during the exercise tests. Pulmonary gas exchange and ventilation, central haemodynamics, and electromyographic activity responses were continuously monitored.

RESULTS: There were no significant differences in pulmonary gas exchange and ventilation, central haemodynamics, electromyographic activity, or perceived exertion between sham, anodal, and cathodal tDCS during heavy-intensity exercise bouts ($P > 0.05$). The tolerable duration of heavy-intensity exercise was also unaffected by the tDCS conditions, with values of 30.8 ± 7.8 minutes, 31.2 ± 11.4 minutes, and 30.8 ± 12.0 minutes for sham, anodal, and cathodal tDCS, respectively ($P > 0.05$).

CONCLUSION: The present findings suggest that a single session of brain stimulation applied over the SMA region does not significantly alter psychophysiological responses to heavy-intensity exercise or enhance exercise tolerance in healthy, recreationally active men. These results indicate that this simple, non-invasive neuromodulatory technique is ineffective during fatiguing, high-intensity activities involving large muscle mass. However, further research is required to explore alternative brain stimulation protocols and exercise modalities.

## Oral Presentations

### OP-AP22 Power and Strength I - Post-activation Performance Enhancement

**EXAMINING SEX DIFFERENCES IN POST-ACTIVATION PERFORMANCE ENHANCEMENT (PAPE) FOLLOWING SQUAT AND POWER CLEAN PROTOCOLS**

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INTRODUCTION: Post-Activation Performance Enhancement (PAPE) is a temporary improvement in neuromuscular performance following a high-intensity conditioning activity (CA). Previous meta-analyses suggest individuals with higher training experience and strength levels may show a greater PAPE response due to enhanced fatigue resistance and improved balance between potentiation and fatigue. While PAPE has been studied extensively in men, studies on female athletes remain limited. Therefore, this study investigated how trained men and women respond to two PAPE protocols. Understanding these variations is crucial for optimizing training interventions for both men and women.

METHODS: 15 men (M, mean±SD: age=29±4 yrs; BMI= 30.3± 6.5 kg/m²), and 17 women (W, age=27±4 yrs; BMI= 25.9± 2.4 kg/m²) volunteered in this study. All participants were athletes with similar years of resistance training experience and relative strength in back squat (1RM: M=2.1±0.3 X body weight (BW); W=1.7±0.3 X BW) and power clean (1RM: M=1.4±0.3 X BW; W=1.2±0.2 X BW). Two CAs were tested: back squat (3 reps @90%1RM) and power clean (3 reps @75%1RM) each performed after warm-up. Countermovement jump (CMJ) performance was assessed Pre-CA and at 1, 3, 5, 7, 9, 11, 13, and 15 min post-CA using force plates sampling at 1000 Hz. A mixed-model ANOVA ($p<0.05$), with time and CA as within factors, and sex as a between factor, was applied for statistical analysis. PRE was calculated as the mean of three CMJs performed before the CA. Post-CA (POST) performance was recorded at each time point. Bonferroni correction was used for pairwise comparisons.

RESULTS: Significant sex differences were observed ($p<0.001$; $np^2=0,543$; large). M showed enhanced CMJ height at POST 3, 5, and 7 min for back squat ($p<0.05$) and POST 1, 3, 5, 7, 9, and 11 min for power clean ($p<0.05$). W exhibited no significant improvements at any time point for either CA. The interaction between sex and time was significant ($p<0.001$; $np^2=0,178$; large). No significant differences were found between CA types ($p>0.05$).

CONCLUSION: Men seems to benefit from standard PAPE protocols, displaying significant short-term CMJ performance enhancements. Conversely, trained women do not seem to exhibit a measurable response under the same conditions. These findings might suggest that sex-specific physiological mechanisms, such as differences in proportion of fast-twitch fibers, acute hormonal responses (e.g., testosterone), and neuromuscular activation strategies, may influence PAPE outcomes. However, these hypotheses remain speculative, emphasizing the need for further research to understand PAPE mechanisms in women. This study highlights the importance of individualized training prescriptions to maximize power output and athletic performance across sexes.

A.J. Blazevich & N.Babault, Front Physiol, 2019.

K. Xu et al., Sports Med, 2025.

**A COMPARISON OF SIX POST-ACTIVATION PERFORMANCE ENHANCEMENT PROTOCOLS WITH A WARM-UP ON THEIR EFFECTS ON COUNTERMOVEMENT JUMP HEIGHT**

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INTRODUCTION: Post-activation performance enhancement (PAPE) refers to the acute improvement in neuromuscular voluntary performance following conditioning activities (CAs). Traditionally, CAs include high-intensity resistance exercises such as back squats (BS), and plyometric exercises like drop jumps (DJ) and weighted DJ (Seitz & Haff, 2016). However, a CA preceded by a general warm-up exercise appears to provide trivial-small effects on PAPE (Xu et al., 2025). Nonetheless, to the best of our knowledge, no previous studies have investigated the effect of warm-up exercise with different CAs on PAPE assessed by counter movement jump (CMJ) height, especially for individuals who do not show PAPE by warm-up exercise. Thus, we compared six CA protocols with a proper warm-up exercise for their effects on CMJ height, and between warm-up responders and non-responders, to test the hypothesis that no additional CMJ height increase would be observed after any CA following the warm-up.

METHODS: Thirty-five (18 male, 17 female) participants (24.6±3.7 y, 1.71±0.10 m, and 75.7±16.1 kg) were familiarized with DJ exercises, CMJ tests, and had their BS one-repetition maximum (1-RM) assessed on the first visit (134.1±32.1 kg). The remaining seven visits were randomized for the following CAs: warm-up (WUP), BS (3 sets of 5 reps at 87% of 1-RM), concentric BS (3 sets of 10 reps at 87 % of 1-RM), eccentric BS (3 sets of 10 reps at 87 % of 1-RM), 40-cm DJ (3 sets of 5 reps), loaded 40-cm DJ (10% of body mass added by a weight vest, 3 sets of 5 reps), and eccentric-only loaded 40-cm DJ with 10% body mass load (3 sets of 10 reps). At each visit, participants performed a standardized warm-up consisting of aerobic exercise, dynamic stretching, and bodyweight exercises for approximately 10 minutes, followed by three CMJs, the CA of the day, and three CMJs after the CA. Individuals who presented an increase in CMJ height greater than the CMJ height measurement error (3.2% based on the baseline CMJ measures after the standardized warm-up) were considered as warm-up responders. A two-way repeated measures ANOVA was used to compare conditions for changes in CMJ height from pre- to post-CA.

RESULTS: The baseline CMJ height was 36.7±9.3 (male: 26.7-70.1, female: 19.5-49.6) cm among the participants. Considering the entire sample, WUP increased ($p<0.05$) CMJ height by 3.3±4.0% (-3.6-14.1%), but no other CA induced a significant increase. Warm-up responders showed an increase ($p<0.05$) in CMJ height by 6.7±3.2% (3.3-14.1%) after WUP only, whereas non-responders did not demonstrate any significant change in CMJ in any conditions.

CONCLUSION: These results showed no additional effects of any of the CA than WUP on acute CMJ performance enhancement. It appears that the PAPE effect is within the warm-up effect.

Seitz & Haff (2016). Sports Med. https://doi.org/10.1007/s40279-015-0415-7

Xu et al. (2025). Sports Med. https://doi.org/10.1007/s40279-024-02170-6

**THE POWER-STRENGTH-RATIO INFLUENCES POST-ACTIVATION POTENTIATION**

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INTRODUCTION: Acute increases in athletic performance are goals of practitioners in sports. Previous studies reported that vertical jumping (1) and sprint running (2) and cycling (3) performance was increased following submaximal or maximal voluntary muscle activations. This phenomenon is known as post-activation potential enhancement (PAPE) and is of great interest to practitioners (4). Mechanisms contributing to PAPE is unclear, whearas evidence proved that the potential is related with increased neural drive/muscle activation, improved muscle-tendon stiffness, decreased muscle pH, greater muscle temperature, and so on (4). Moreover, the magnitude of acute improvement is modulated by several factors, such as age, sex, training status. For example, stronger individuals have been reported to attain greater potentiation of performance in comparison to weaker individuals . However, from a practical perspective, it is important to determine whether other individual characteristics, such as muscle power, also influence the ergogenic benefits of contrast training protocols. Therefore, this study aimed to investigate the effect of power-strength-ratio (PSR) on acute athletic performance.

METHODS: Thirty-six male college players with well-trained background were recruited in this study. Before and 4 min after intervention, all participants performaned three maximal isometric squats (IS), CMJ and 30 m sprints in randon order, with 2-3 min rest interval between trials and 5 min interval between tests. The intervention consisted of 3 sets of 4 repetitions of 90% 1RM back squat.The power-strength-ratio was defined as the ratio of maximal power-output derived from CMJ and maximal concentric strength of IS. The participants were classied as high PSR group and low PSR group using media spliting. The one-way ANOVA was used to analyze the differences in improvements of athletic performance between groups and LSD was used for post-hoc analysis.

RESULTS: Following intervention, significant increases ($p < 0.05$) were observed in CMJ height (46.5 ± 3.7 cm vs 49.2 ± 4.2 cm), 30 m sprint time (4.34 ± 0.32 s vs 4.15 ± 0.12 s), jump peak power (3832.32 ± 562.34 w vs 4267.23 ± 531.23 w), maximal isometric strength (3723.32 ± 287.13 N vs 4102.18 ± 327.16 N). Compared to participants with low PSR, participants with high PSR exhibited significantly greater improvements ($p < 0.05$) in CMJ height and jump peak power. However, no significant differences in changes in sprint time and maximal isometric strength between both groups ($p > 0.05$).

CONCLUSION: Power-strength ratios also affect PAPE, so differences in individual strength-strength ratios should be considered when designing acute intervention programs.

**PRECISION IN POST ACTIVATION POTENTIATION DYNAMICS: A BASELINE-DEPENDENCY PHENOMENON FOR INDIVIDUALIZED RESPONSES**

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INTRODUCTION: Post-activation potentiation (PAP) is a transient increase in twitch torque following a conditioning contraction. Despite being extensively studied as a recurrent phenomenon, PAP responses vary significantly between individuals (1), yet the origin of this variability remains largely unexplored. Given the importance of addressing response variability for precision exercise science (2) and the optimisation of individualised prescriptions to enhance performance outcomes, this study is the first to examine individual baseline torque metrics and their relationship with PAP dynamics.

METHODS: This randomized, two-period, two-sequence crossover trial involved 14 male handball athletes (Age: 22.6±2.8 years, height: 180.3±5.9cm, BM: 72.3±7.9kg). Each participant performed a familiarization visit and two exercise interventions consisting of 4 sets of 6 plantar flexion maximal voluntary isometric contractions (MVIC) with a 15s inter-repetition and 2min inter-set rest interval. The interventions differed in MVIC duration only (3s vs. 6s) and were spaced by one week. Twitch torque (TT) was recorded at baseline and 2s after each MVIC, via tibial nerve stimulation. Baseline MVIC torque was also measured. Linear mixed models examined the effects of baseline MVIC, TT, and TT/MVIC on the change (%) in TT after each MVIC relative to the baseline. Model comparisons assessed significance against a null model (ΔAICc > 2) and case bootstraps provided 95% confidence intervals (CIs).

RESULTS: TT and TT/MVIC both improved model fit, but MVIC did not. The TT/MVIC model explained more variance due to fixed effects than TT (3s: +6.84%, 6s: +14.91%), accounting for 29.6% (3s) and 52.5% (6s) of variance in responses. TT/MVIC had a negative relationship with TT% in 3s (β = -6.94, 95% CI: -11.05 to -1.52) and 6s (β = -11.75, 95% CI: -16.42 to -7.64). This relationship was positively moderated by sets in 3s (β = 1.67, 95% CI: 0.08 to 2.66), with a trend in 6s (β = 1.12, 95% CI: -0.06 to 2.27). It was also positively quadratically moderated by repetitions in 6s (β = 0.40, 95% CI: 0.14 to 0.57), with a trend in 3s (β = 0.21, 95% CI: -0.02 to 0.45).

CONCLUSION: Athletes with lower baseline TT/MVIC are more likely to exhibit greater PAP responses, following a pronounced quadratic rise and fall of PAP across repetitions, especially at higher-load contractions (6s vs. 3s). Lower TT/MVIC may indicate reliance on fast-twitch fibers, which are less efficient at low stimulation rates (e.g., single-pulse stimulation) due to lower calcium sensitivity. This may contribute to a lower TT/MVIC presentation at baseline. Our study highlights for the first time the role of individual baseline torque-related measures on the prediction of PAP dynamics, which is essential for personalized conditioning strategies.

REFERENCES:

1.Xenofondos et. al., Int J Sports Physiol Perform, 2023

2. Ross et. al., Br J Sports Med, 2019

**THE SELF-SELECTED INTERVAL METHOD IS RELIABLE FOR ASSESSING POST-ACTIVATION PERFORMANCE ENHANCEMENT IN TRAINED INDIVIDUALS**

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INTRODUCTION: The duration of the recovery interval between the conditioning activity (CA) and the verification test influences the responsiveness to post-activation performance enhancement (PAPE). Evidence suggests that the self-selected interval (SSI) method is as effective in eliciting PAPE in trained individuals as the fixed interval method. However, no studies have investigated the reliability of such method. We aimed to evaluate the reliability of the SSI employed by trained individuals in two identical sessions at different days.

METHODS: Nine strength-trained individuals (six men and three women: 26.6 ± 6.9 years; 73.0 ± 15.1 kg; 173 ± 0.1 cm) participated in three laboratory visits after familiarizations and one-repetition maximum (1RM) assessment (155.46 ± 43.1 kg). In the experimental sessions (EXP1 and EXP2), PAPE was induced by a CA consisting of three sets of three squats with

87% 1RM, followed by countermovement jump (CMJ) performance tests employed after a SSI. In the control session (CON), participants performed a light warm-up instead of the CA protocol, and CMJ was assessed at a time corresponding to the average SSI from EXP1 and EXP2. Baseline CMJ performance tests were employed at all sessions. The length of the SSI in EXP1 and EXP2 was compared using paired t-tests. A two-way repeated measures ANOVA assessed changes across sessions and conditions, with Cohen's d calculated as an ES measure. Intraclass correlation coefficients (ICC), coefficient of variation (CV), and percentage variation were calculated with 95% confidence intervals (CI) for the length of the SSI and CA-induced changes in CMJ performance. Statistical significance was set at $p < 0.05$.

RESULTS: No significant differences were found in SSI durations between EXP1 and EXP2. ANOVA revealed significant effects of session, condition, and session-condition interaction. No significant differences were found between baseline CMJ values in all sessions. Following CA, both EXP1 and EXP2 showed statistically superior performance compared to CON, with no differences between EXP1 and EXP2. In CON, CMJ performance did not change after CA (37.38 ± 12.45 cm vs. 37.25 ± 12.23 cm; $p > 0.05$). CMJ performance increased by 9.6% in EXP1 (37.49 ± 12.16 cm vs. 41.09 ± 12.96 cm; ES = 0.3; $p < 0.001$), and by 11.2% in EXP2 (37.56 ± 12.21 cm vs. 41.77 ± 12.94 cm; ES = 0.3; $p < 0.001$). Test-retest reliability demonstrated excellent reliability for changes in CMJ performance (ICC: 0.997; 95% CI: 0.969-1.000; CV: 1.241%; $p < 0.001$) and the length of the SSI (ICC: 0.930; 95% CI: 0.705-0.984; CV: 6.671%; $p < 0.001$).

CONCLUSION: A novel finding of this study was that both changes in CMJ performance and the length of the SSI were reproducible in trained individuals, with the former being more consistent than the latter. Therefore, these findings corroborate the effectiveness of adopting the SSI method for PAPE while also suggesting that both its effects and duration are consistent and reproducible in trained individuals.

## Invited Symposium

### IS-MH06 Diversity in mechanisms underlying impairments to exercise and recovery in Type 1 Diabetes.

**MECHANISMS FOR IMPAIRED CARDIORESPIRATORY FITNESS IN TYPE 1 DIABETES**

LESSARD, S.
*VIRGINIA TECH*

Improved cardiorespiratory fitness is a key benefit of aerobic exercise training. However, individuals living with type 1 diabetes often display lower cardiorespiratory fitness (i.e. VO2max) than those without diabetes- even when exercise training levels are matched. This may indicate a resistance toward the positive metabolic and physiological adaptations that lead to improved cardiorespiratory fitness with aerobic training in people with diabetes. This presentation will outline the key clinical features of low cardiorespiratory fitness in type 1 diabetes. The potential role for chronic hyperglycemia in impaired aerobic adaptation will be discussed. In addition, hypothesized molecular mechanisms whereby chronic hyperglycemia may alter the structure and remodeling of skeletal muscle with exercise will be proposed. Specifically, the role of hyperglycemia-induced changes to the skeletal muscle extracellular matrix, and how these may alter muscle signal transduction and key muscle remodeling events with exercise will be discussed. Recent data from human participants and pre-clinical (animal and cell culture) models will be shown. Potential strategies to improve the cardiorespiratory response to exercise in people diabetes will also be considered.

**METABOLIC, INFLAMMATORY AND OXIDATIVE STRESS RESPONSES TO EXERCISE IN PEOPLE WITH TYPE 1 DIABETES**

KRAUSE, M.
*FEDERAL UNIVERSITY OF RIO GRANDE DO SUL*

Type 1 diabetes (T1D) is a chronically progressive autoimmune disease that affects approximately 1% of the population in the developed world. This adverse immune response is induced and promoted by the interaction of both genetic and environmental factors. Individuals with T1D shared several cardiometabolic complications such as endothelial dysfunction, changes in glomerular filtration/kidney function, low-grade inflammation, oxidative stress, blood coagulation, mitochondrial dysfunction, anabolic resistance, metabolic inflexibility, and gut microbiota dysbiosis. The treatment of these conditions and the management of glucose balance includes pharmacological, and particularly, changes in lifestyle such as exercise and nutritional interventions. Exercise is the most effective non-pharmacological tool to prevent and treat cardiometabolic diseases related to both types of diabetes. A large body of evidence has shown that the combination of resistance and aerobic exercise can improve glycemic control, metabolism, oxidative stress, inflammation, and skeletal muscle anabolic adaptations in T1D people. Despite the negative adaptations caused by T1D in the skeletal muscle (e.g., mitochondrial dysfunction, inflammation, and regeneration), exercise training can decrease glucose fluctuations, the occurrence of hypoglycemia, and improve skeletal muscle dysfunction. In this presentation, we aim to present evidence that different types of exercise can improve inflammatory status and oxidative stress, thus causing positive metabolic adaptations in mitochondrial function, insulin sensitivity, and glycemia management. In addition, we will also discuss the potential underlying mechanisms that allow exercise to reduce inflammatory-related complications in T1D people. We understand that this topic is of particular interest to people working with diabetes management since most of the conducted research involves people with type 2 diabetes. Our discussion can potentiate the interest of the researchers in the

field to include more investigation on T1D, thus providing scientific shreds of evidence for new guidelines and exercise prescriptions in this population.

**DISUSE, RECOVERY AND REPAIR OF SKELETAL MUSCLE IN TYPE 1 DIABETES**

HAWKE, T.
*MCMASTER UNIVERSITY*

Despite the importance of skeletal muscle to our physical and metabolic well-being, changes to skeletal muscle health in those with Type 1 Diabetes (T1D) is not well defined. Our published and preliminary data highlight alterations to muscle health in those with T1D. In particular, we have noted reduced mitochondrial function, particularly in females and a loss of mitochondrial density in older adults with T1D. Functionally, there was a loss of upper and lower body maximal voluntary contraction (quadriceps, handgrip) in those with T1D after the age of 35. In young adults with T1D, force recovery from damaging exercise was significantly delayed along with increased extracellular matrix protein content and delayed satellite cell activation. Collectively, these alterations suggest there are impairments to skeletal muscle's ability to respond to stressors and that strategies to maximize muscle health are urgently needed to mitigate the loss of muscle health and the resulting inability to undertake activities of daily living.

## Invited Symposium

### IS-BM05 Cyclic propulsion in sports

**VELOCITY AND POWER IN CYCLING RACES**

CLANET, C.
*ECOLE POLYTECHNIQUE*

Velocity is usually easy to measure in sports, while measuring power is, in general, more delicate. However, in cycling, both measures are accessible, and this leads us to first focus on track cycling races. Knowing the instantaneous power injected by the cyclist on the pedals, what is the velocity of the bike? The usual way to answer this well-paused question is via energy conservation. But the system (cyclist+bike) is both open and deformable. To avoid the full complexity of the problem, we develop a phase average theory that "solidifies" artificially the system and allows us to predict the velocity of the centre of mass (and thus of the bike in this solid limit), provided the power is averaged over a pedal cycle. Thus, if the power is known the velocity can be calculated theoretically. However, the power developed by a cyclist is not known in advance and, moreover, it depends on the velocity! The second part of the presentation will thus be devoted to addressing the question of power production and the resolution of the Power-Velocity coupled system.

**VELOCITY AND FREQUENCY IN CYCLIC SPORTS**

CARMIGNIANI, R.
*HYDRAULIC SAINT VENANT LABORATORY*

The principle of cyclic force application is a common thread across various forms of locomotion, be it on land, in water, or in air. This force application is essential to maintain a target average velocity of motion. In running, force is exclusively applied during ground contact. In cycling, force is consistently applied, but it exhibits a cyclic evolution during the rotation of the pedals. In kayaking, the force is applied when the paddles are in the water. In swimming, the force is similarly applied during the time the arm is in water, with the exception of certain strokes. Understanding the relationship between the velocity of motion of the center of mass and the frequency of gesture is crucial for studying locomotion. This understanding allows us to explore the link between speed and muscle contraction velocity, which is believed to be significant in building race control models to assist athletes in managing their pacing. In cycling, this relation is purely geometric and is fixed by the gear ratio. However, observations in running, swimming, and kayaking show linear, square root, and cubic root relations on an incremental test. To better understand these evolutions, a simplified model is proposed. This model enables us to identify the key parameters that can be monitored to track progress and characterize athletes. By doing so, we can gain a deeper understanding of the dynamics of locomotion and potentially improve athletic performance.

**ACTIVE DRAG AND ADDED MASS IN WATER SPORTS**

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*UNIVERSITY OF VERONA*

Swimming is a racing sport similar to biking, running, rowing or kayaking, where the goal is to cover a given distance in the shortest possible time (e.g. at the fastest possible velocity). In these sports, the race starts with a standing start and the velocity gradually increases toward a maximum value that the athletes should try to maintain up to the end. This is not the case in swimming where, in pool races, a swimmer must accelerate after each turn. In addition, cyclic variations in speed could be observed, in swimming, even at "constant average speed" because of the fluctuations in resistive and propulsive forces that occur within each stroke. Only few studies attempted to quantify the hydrodynamic force that counteracts

swimmers when the flow pattern changes with time. In this case, some of the water around the swimmer is set in motion and this can be thought of as an added mass the swimmer has to accelerate, in addition to body mass, during a change in velocity. These matters could be investigated using a novel method consisting of a series of tests (a standing start test, a full tethered test and semi-tethered tests) through which it is possible to gather the data required to compute the added mass and the active drag of a swimmer. The standing start test could also be utilized to assess these matters in boat locomotion (e.g. kayaking).

# Oral Presentations

## OP-AP23 Team Sports VI - Female Football

### GENDER AND SIDE DOMINANCE EFFECTS ON CURVILINEAR SPRINT PERFORMANCE IN YOUTH FOOTBALL: AN ANALYSIS OF PEAK SPEED, ACCELERATION, ACCELERATION-SPEED PROFILES, DEFICIT, AND ASYMMETRIES

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*UNIVERSITY OF PRIMORSKA: UNIVERZA NA PRIMORSKEM*

INTRODUCTION: The curvilinear sprint (CS) is the most frequently performed type of sprint in football matches and is an important speed skill for footballers [1]. It requires a different running technique than the linear sprint, which leads to performance deficits and asymmetries [2]. While the specificity of CS performance in football players is well established [3], potential sex differences, especially in youth, remain unclear. Furthermore, most research has focused on split times, overlooking key performance metrics that could provide deeper insights into CS demands. The aim of this study was to investigate the effects of sex and CS side dominance on performance, deficits and asymmetries in adolescent football players using a global navigation satellite system.

METHODS: Twenty male (16.4±1.2 years, 70.0±6.6 kg, 179.4±6.1 cm) and 20 female (16.3±1.2 years, 58.1±7.2 kg, 167.1±4.6 cm) national team football players completed a linear 30 m and a left/right CS (radius 9.15 m). Distance, speed and acceleration were measured using the GPEXE It system (Exelio SRL, Udine, Italy). Peak speed (Speak), peak acceleration (Apeak), and acceleration-speed (AS) profiles (A0, S0, ASslope) were calculated. The side with the higher Speak was categorised as stronger. In addition, deficits and asymmetries were calculated from Speak and AS profiles (Sdeficit, ASdeficit, Sasymmetry, ASasymmetry). A two-way ANOVA assessed the effects of dominance (weaker vs. stronger) and sex (male vs. female) on the variables, with partial eta squared ($\eta^2$) for effect size and Bonferroni post-hoc adjustments. Unpaired t-tests were used to assess differences in Sasymmetry and ASasymmetry. The significance level was set at $P<0.05$.

RESULTS: A significant interaction effect was found for Apeak ($F=6.5$, $p=0.019$, $\eta^2=0.03$), A0 ($F=5.8$, $p=0.026$, $\eta^2=0.02$), and Sdeficit ($F=5.8$, $p=0.026$, $\eta^2=0.02$). Males had significantly greater Apeak and Sdeficit on the stronger side than females (MD=0.43 m/s² and 2.46%; $p<0.001$). Sex and dominance significantly influenced Speak ($F\geq98.9$, $p<0.0001$, $\eta^2\geq0.73$) and S0 ($F\geq62.7$, $p<0.0001$, $\eta^2\geq0.43$), with males achieving higher speeds (MD≥0.87 m/s, $p<0.0001$) and higher speeds observed on the stronger CS in both sexes (MD≥0.16 m/s, $p<0.001$). Only dominance influenced ASslope ($F=44.7$, $p<0.0001$, $\eta^2=0.27$) and ASdeficit ($F=89.1$, $p<0.0001$, $\eta^2=0.59$). Weaker CS had steeper ASslope (MD≥0.08 $s^{-1}$, $p<0.015$) and greater ASdeficit (MD≥21.49%, $p<0.0001$). Females had greater Sasymmetry than males (M=2.24 vs. 3.72%, $t(38)=2.46$, $p=0.019$), but no differences in ASasymmetry were found ($p=0.380$).

CONCLUSION: Male footballers accelerate faster, reach a higher top speed and have greater deficits, while female show greater asymmetries in CS performance. CS dominance, rather than sex, appears to influence AS profiles. For male footballers, it is important to focus on CS deficits whereas for female footballers, top speed and asymmetries should be the focus of training.

1 Caldbeck et al. 2022, 2 McBurnie et al. 2021, 3 Grazioli et al. 2024

### EFFECTS OF A 4-WEEK OFF-SEASON TRAINING PROGRAMME ON AEROBIC FITNESS AND SPRINT ENDURANCE ABILITY IN UNDER 15 FEMALE SOCCER PLAYERS

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*UNIVERSITY OF GENOA*

INTRODUCTION: High-Intensity Interval Training (HIIT) has been shown to mitigate performance declines in professional male soccer players during the off-season1. However, its effects in youth female soccer players remain unexplored. This study investigates the impact of a 4-week off-season high-intensity training program on aerobic fitness and sprint endurance in Under-15 female soccer players.

METHODS: Fifteen U-15 female soccer players from a professional team completed a 4-week training program consisting of two weekly sessions of small-sided games (SSG) consisting of 4 × 4 minutes with 3 minutes of active recovery (running at low intensity) between bouts, and two weekly sessions of repeated sprint training (RST) consisting of 5 reps x 3 sets of 40-m sprint with a 180° change of direction with a rest of 20 seconds between repetitions and 4 minutes between sets. Performance assessments before and after the intervention Yo-Yo intermittent recovery level 1 test (YYIR1) and 30-second test (30s Test) were performed. Aerobic fitness level and sprint endurance ability were assessed though the YYIR1 and 30s Test, respectively. Furthermore, physiological responses were monitored using heart rate (HR) and blood lactate concen-

tration ([La]+) as internal workload indicators, and total distance (TD), moderate speed distance (DMS), high speed distance (DHS), acceleration distance (≥3 m-s-2, DACC) and deceleration distance (≤3 m-s-2, DDEC) as external workload indicators.

RESULTS: Following the intervention, TD significantly increased in both the YYIR1 (p = 0.000) and the 30s Test (p=0.004, respectively). HR and [La]+ significantly increased only in the YYIR1 (p = 0.001), but not in the 30s Test (p = 0.572). A strong correlation was observed between time spent >85% HRmax and TD in the 30s Test (r = 0.73, p = 0.002). Moreover, a significant correlation between time spent at intensity >85% HRmax and percentage change in TD in the 30s test (r=0.73, p=0.002) was observed. Similar correlations were found between time spent >85% HRmax and TD (r = 0.91, p = 0.000) and percentage change in TD (r = 0.83, p = 0.001) in YYIR1.

Finally, strong correlations were observed between DMS and TD in YYIR1 (r = 0.78, p = 0.001), and DHS and TD in the 30s Test (r = 0.88, p = 0.000).

CONCLUSION: A 4-week high-intensity off-season training program effectively enhances both aerobic fitness and sprint endurance in U-15 female soccer players. These findings highlight the efficacy of HIIT-based training in mitigating performance losses during the off-season, enabling players to resume the season with improved conditioning.

References:

1) Silva JR, Brito J, Akenhead R, Nassis GP. The Transition Period in Soccer: A Window of Opportunity. Sports Med. 2016; 46(3): 305-13.

**GAME ON: DECODING INTERNAL AND EXTERNAL LOAD DURING SMALL-SIDED GAMES (1V1 AND 2V2) AMONG FEMALE ATHLETES OF DIFFERENT MATURITY STATUS**

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INTRODUCTION: The development of young athletes is not only influenced by skill level and training but also by their biological maturity (Albaladejo-Saura et al., 2021; Malina, 2014). In basketball, where physical demand and technical execution are key, understanding how maturity levels affect a player's internal load, external load, and technical behaviour (Guimarães et al., 2019; Johnson et al., 2022; Towlson et al., 2021)can provide insights that help tailoring training programs and talent identification processes.

Small-sided games (SSGs) are widely recognized as an effective training modality to develop technical, tactical, and physical capacities in soccer(Arede et al., 2021; Clemente et al., 2019).. Previous literature has predominantly focused on male players or larger group formats (e.g., 4v4, 5v5). However, limited research has been dedicated to female players and, in particular, to smaller formats such as 1v1 and 2v2 competitions.

This study aims to investigate these relationships by testing U14, U15, and U16 athletes in 1v1 and 2v2 game scenarios. The general aim of the scientific study is to investigate the internal and external loads experienced by female soccer players of different maturity levels during 1v1 and 2v2 small-sided games., in comparison to performance outcomes driven by technological methods or random-based approaches.

METHODS: 18 female soccer players between the ages of 13 and 17 was tested. PHV categories were determined using biological maturity to classify them into different maturity groups. This approach helps to address the influence of maturation status on performance.

After participating in each game scenario, players recorded their perceived exertion using the Borg scale, providing insight into subjective performance differences between the groups

RESULTS: Results showed that mean and peak heart rates were generally higher in the 1v1 format as compared to the 2v2 format across all maturity groups.

RPE scores corroborated the HR findings,External load metrics indicated that more mature players covered greater absolute total distances and engaged in more high-intensity sprints during both game formats.

1v1 formats showed a higher frequency of accelerations and decelerations per minute, consistent with greater changes of pace and direction required.

This was especially evident in pre-mature players, who spent more effort changing direction, reflecting their developing neuromuscular control abilities.

CONCLUSION: Game Format Differences show that it is Higher Intensity in 1v1, and Greater Distance in 2v2.

Post-mature players demonstrate higher absolute physical outputs (e.g., distance, sprints) due to their advanced physical development. However, when normalized to body mass or HR max, the relative loads are comparable across maturity groups.

This study demonstrates that 1v1 and 2v2 small-sided games impose distinct internal and external load demands on female soccer players, with significant differences observed across maturity levels.

**SMALL-SIDED GAMES IN ELITE FEMALE FOOTBALL PLAYERS: THE IMPACT OF PLAYING AREA AND PLAYER NUMBER ON DIFFERENTIAL RPE AND LOCOMOTION**

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*LIVERPOOL JOHN MOORES UNIVERSITY*

INTRODUCTION: Coaches use small-sided games (SSGs) to develop players skills. Varying pitch size, team numbers, and rules allow coaches to target specific objectives and influence workload. While these factors impact movement, they do/may not fully capture physiological load. Differential RPE (dRPE) can be used to discriminate between different dimensions of effort/ internal load; central, peripheral and cognitive. This study investigated the influence of team size and playing area on internal load and locomotion.

METHODS: 35 female academy soccer players (17±1 years) completed nine SSGs using 25%, 50%, and 75% of a competitive playing area with 5v5 (4x4 min), 7v7 (3x6 min), and 9v9 (3x8 min) formats (including goalkeepers). After each game, participants rated perceived exertion using CR-10 (RPE) and CR-100 scales (dRPE). Player tracking (Catapult S7) provided total distance (TD), high-speed running distance (HSRD; 12.5-19.0 km/h), very high-speed running distance (VHSRD; 19.0-22.5 km/h), sprint distance (SD; >22.5 km/h), and accelerations/decelerations (ACC-DEC). Goalkeepers were removed from the analysis and locomotor variables were normalised for SSG duration (m/min). A univariate ANOVA was conducted, with team size and playing area as fixed factors and post-hoc tests with Bonferroni corrections; (significance set at $p<.05$).

RESULTS: Team size did not impact any dRPE. However, there was a significant interaction between team size and playing area for central ($p<0.001$) and peripheral ($p<0.001$) RPE scores, which both peaked at 75% in 5v5, 50% in 7v7 and 25% in 9v9. Cognitive RPE showed a significant change with playing area ($p=0.02$), with smaller playing areas resulting in greater scores (25%: 44±13, 50%: 43±12, 75%: 39±15). Team size and playing area had a significant interaction effect on TD and HSR. TD peaked at 75% in 5v5 (96±43m/min), 50% in 7v7 (136±68m/min), and 75% and 9v9 (150±46m/min). While HSR increased with playing area, there were greater demands placed on the smallest compared to the largest team size at 50% (21±8 vs. 15±8 m/min), and 75% (23±10 vs 18±8 m/min) of competitive playing area. Larger pitch sizes significantly increased VSHR and SD ($p<0.001$), irrespective of team size. Whereas the number of ACC-DEC decreased with larger team sizes ($p<0.001$) and larger playing areas ($p=0.004$), with no significant interaction.

CONCLUSION: There was a distinct difference in dRPE based on team size and playing area. Central and peripheral RPE depended on the interaction of team size and playing area but neither individually. Smaller areas would better develop agility and decision-making drills due to the increased cognitive and ACC-DEC demands and could be incorporated on less physically demanding training days. Larger pitch sessions should be incorporated into high-intensity training days due to the central and peripheral load, and to elicit greater HSRD and SD. Adjusting these variables helps optimize training intensity and recovery.

## Invited Symposium

### IS-AP03 Optimising the Warfighter: Applying Sport Science in the Military Context.

**HUMAN PERFORMANCE OPTIMISATION (HPO) FOR THE WARFIGHTER: A KEY TO READINESS?**

NEVIN, J.
*BUCKINGHAMSHIRE NEW UNIVERSITY*

The contemporary military operational environment places unique and intense physiological, psychological, and cognitive demands upon the modern warfighter which can negatively impact upon operational effectiveness. Therefore, the aim of this session will be to review the impact of these demands and to argue that a high level of physical readiness, psychological resilience, and cognitive capability developed under a conceptual Human Performance Optimisation (HPO) framework is essential to improve warfighter readiness and maintain operational performance.

**MODERNIZED TRAINING FOR WOMEN IN GROUND CLOSE COMBAT ROLES**

GREEVES, J.
*MINISTRY OF DEFENCE*

Servicewomen experience similar increases in strength and aerobic fitness as men with training, but still perform less well on most performance measures due to lower baseline physical performance. Fewer women than men can reach the Physical Employment Standards for ground close combat roles after three months of periodised strength and aerobic training, suggesting different strategies may be required to maximise performance of both sexes. Therefore, this session will aim to discuss potential training strategies by which to optimally prepare woman for ground close combat roles.

**RESEARCH ON THE REDUCTION OF MUSCULOSKELETAL INJURIES**

FRIEDL, K.

*U.S. ARMY RESEARCH INSTITUTE OF ENVIRONMENTAL MEDICINE*

A US Army report on training injuries "the hidden epidemic" thirty years ago led to a intensive body of research which aimed to define and solve the problem. Leading the effort was a focus on bone stress injuries, a problem that was relatively unique to military training. As a result major programs investigating the pathogenesis of bone stress fracture were conducted in both the US and UK militaries. This session will review the findings from this body of work and will discuss how several practical interventions to reduce the incidence of musculoskeletal injuries in military personnel have been applied. Part of this included simple changes/modernization of training programs as well as the need to address initial fitness of today's youth and prospective recruits. The problems are largely understood and await implementation of a range of solutions.

## Oral Presentations

### OP-MH24 Fitness and Cognition in Older Adults

**IMPACT OF SIMULTANEOUS MOTOR-COGNITIVE TRAINING ON MOTOR CAPACITIES IN OLDER ADULTS WITH OR WITHOUT COGNITIVE IMPAIRMENT: PRELIMINARY RESULTS OF THE COGAPA PROJECT**

GODARD, J., HUET, A., ROZEC, M., BOILET, L., LE BERRUYER, L., CHARTIER, C., HUMEAU-HEURTIER, A., NOURY, B., DURAND, S.

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INTRODUCTION: Ageing is associated with a progressive functional decline of various systems in the human body. Moreover, ageing is a risk factor in the development of several pathologies, including neurodegenerative diseases. The systemic decline negatively impacts motor and cognitive abilities which are associated with poor autonomy. Despite methodological heterogeneity, there is a growing scientific interest on motor-cognitive training to contribute on a healthy ageing [1]. Simultaneous combinations of trainings appear to be relevant [2] for motor abilities but the comparison of the effect of different modalities (additional and incorporated trainings [3]) in older adults (OA) has not been studied yet. The COGAPA project aims at testing the effects of two simultaneous motor-cognitive trainings (SMCt) on motor abilities in OA with or without cognitive impairment.

METHODS: Two groups of participants (n = 20) were included. People were aged 60 or older and had a score higher than 6 at the short physical performance and battery and a score higher than 22 at the mini mental state examination. OAs were randomized into two SMCt: dual-task (DT) and synergical (SYN). The DT group (n = 10) consisted of physical exercises with an additional cognitive task. The SYN group (n = 10) performed physical exercises with a cognitive task incorporated [3]. All groups practiced exercises for 8 weeks with one session/week. We compared the results of both groups before and after the intervention on the Berg balance scale (balance), the 6-minute walking test (walking capacity), the timed up and go test (functional mobility), and the 30-second chair sit to stand test (muscular strength).

RESULTS: All OAs (n = 20) completed the program. Mixed model with a covariate (initial level of physical activity) shows significant improvements on balance ($p<0.01$) and functional mobility ($p<0.05$) after both SMCt (DT and SYN) without any significant difference between groups.

CONCLUSION: Preliminary results of the COGAPA project reveal the potential effect of simultaneous motor-cognitive training (DT and SYN) on motor abilities like balance and functional mobility. However, no significant benefits were observed on walking capacity and muscular strength. Moreover, without any significant difference between groups, we cannot highlight a particular modality of SMCt. With a larger sample size and upcoming results of a group with 2 sessions/week of SMCt (DT and SYN) as well as a control group (physical exercises only), we will potentially demonstrate the incidence of adding a cognitive task simultaneously to physical exercises, the benefits of higher training frequency, and the optimal modality of SMCt for OAs with or without cognitive impairment.

[1] Gavelin HM et al (2021) https://doi.org/10.1016/j.arr.2020.101232

[2] Gallou-Guyot M et al (2020) https://doi.org/10.1016/j.neucli.2020.10.010

[3] Herold F et al (2018) https://doi.org/10.3389/fnagi.2018.00228

**EFFECTS OF PHYSICAL TRAINING ON COGNITIVE FUNCTION AND P300 IN OLDER ADULTS – AN ONGOING ERP-STUDY.**

GERTEN, S., KOESTER, D., SCHACK, T.

*BIELEFELD UNIVERSITY*

INTRODUCTION: Various types of physical activity positively impact cognitive function (CF) and brain activity [1,2]. It is unclear whether additional forms of physical training - which emphasize technique improvement - also affect cognitive functions and brain activity. Therefore, this study evaluated the effect of a track and field athletic training (TFA; short put, long jump & sprint; motor skill training) on behavioral CF and brain activity of elderly, when compared to walking training (WT, cardiovascular training) and to relaxation and stretching training (RS, active control group).

METHODS: The 16-week training took place two times a week for one hour each. Participants were screened for physical or mental illness (PAR-Q) and dementia (Montreal Cognitive Assessment, MoCA). Pre and post intervention questionnaires, motoric and cognitive test batteries were completed in two separate days. CF were assessed in different domains: Global CF (MoCA), attention (d2-revision Test, Trail Making Test A, TMT), executive function (TMT B, Flanker- & Stroop-task) and working memory (n-back task). Brain activity was measured via Electroencephalography (EEG) during the flanker task. P3 was defined as the average electrical potential 350-550 ms after stimulus onset and was calculated at Fz, Cz, and Pz. Data were analyzed via mixed ANOVA.

RESULTS: Sixty-six older adults (age 64 ± 5, female 33, MoCA 27 ± 2) were included in the study. There were 16 dropouts, and 7 individuals were excluded due to poor EEG data quality. A Flanker effect was shown in reaction times ($F(1,42) = 172.1$, $p \leq .001$, $\eta p2 = .804$). There was no interaction effect between the factors time (2) and group (3), but a main effect of group for MoCa: $F(2,41) = 4.54$, $p = .017$, $\eta p2 = .181$, TMT-A: $F(2, 42) = 3.50$, $p = .039$, $\eta p2 = .140$ and TMT-B: $F(2, 39) = 8.15$, $p \leq .001$, $\eta p2 = .295$ and a main effect for time for d2: $F(1, 42) = 26.07$, $p \leq .001$, $\eta p2 = .383$, TMT-A: $F(1, 43) = 4.56$, $p = .038$, $\eta p2 = .096$, and P3 amplitude in the incongruent condition at Pz: $F(1, 38) = 4.40$, $p = .043$, $\eta p2 = .023$.

CONCLUSION: The analyses so far do not indicate an interaction effect of CF or brain activity after 16 weeks of WT, TFA, or RS. However, we could show a group-independent improvement in concentration, attention and P3 amplitude (especially in the incongruent condition). A larger P3 amplitude indicates enhanced cognitive processing efficiency and increased attentional resources, which indicates an enhancement in CF. The results suggest that besides cardiovascular training also motor skill training, and relaxation and stretching training can lead to an improvement in CF and brain activity in elderly.

[1] Falck R S et al. (2019). Impact of exercise training on physical and cognitive function among older adults: a systematic review and meta-analysis. Neurobiology Of Aging, 79: 119–130.

[2] Rodríguez-Serrano L M et al. (2024). Changes in EEG Activity and Cognition Related to Physical Activity in Older Adults: A Systematic Review. Life, 14 (4): 440.

**ASSOCIATION OF PHYSICAL FITNESS WITH COGNITIVE FUNCTION IN COGNITIVELY HEALTHY OLDER PERSONS**

AKALP, K., BESIKCI, H., RAMA, L., FERREIRA, J.P., SILVA, A.R., COSTA, A., PIRES, L., RAINHO, A.M., RAINHO, M.A., COSTAS, B., RIBEIRO, M.J., TEIXEIRA, A.M.

*UNIVERSITY OF COIMBRA*

INTRODUCTION: Aging can be accompanied by decline in cognitive function and physical fitness. Exercise may prevent cognitive decline and improve physical fitness components (PFC) including body composition, physical functionality and cardiorespiratory fitness. Although research demonstrated the association between some PFC and cognitive functions [1] this relationship remains unclear and more research is needed looking at different PFC and cognitive domains. Exploring the associations between various cognitive domains and physical fitness may facilitate the development of effective exercise programs for preserving cognitive function during aging. Thus, this study aims to explore the association between body composition, physical functionality and cardiorespiratory fitness components with cognitive flexibility, sustained attention, and working memory cognitive domains.

METHODS: Seventy-two cognitively healthy participants (32 men and 40 women) with age 66 ± 6 years old participated in the physical and cognitive assessments. Body composition was assessed by bioimpedance (Inbody 770, Biospace), physical fitness using hand grip strength, 30 seconds chair stand test, time up and go test, and peak oxygen consumption capacity (VO2 Peak) with submaximal cycle ergometry (Lode Excalibur, Netherlands). The cognitive assessment was done with the following tests from the CANTAB Connect Research: Multitasking Test (MTT – cognitive flexibility), Rapid Visual Information Processing (RVP – sustained attention), and Spatial Working Memory (SWM).

RESULTS: Age-corrected correlations revealed small to medium size correlations: MTT incongruency cost negatively correlated with VO2 Peak (r=-.292, p=.023), and ventilatory threshold (r=-.292, p=.017). RVP median latency negatively correlated with the chair stand test (r=-308, p=.01), VO2 Peak (r=-.277, p=.023), and positively correlated with fat percentage (r=.294, p=.014), fat mass (r=.319, p=.008), fat to muscle ratio (FMR) (r= .346, p =.004). SWM Strategy negatively correlated with hand grip strength (r=-.267, p=.025), and positively correlated with fat percentage (r=.302, p=.012) and FMR (r=.275, p=.023).

CONCLUSION: Our results suggested that, in cognitively healthy older persons, different aspects of physical fitness were associated with different features of cognition. Cardiorespiratory fitness was associated with increased processing speed; Lower extremity endurance and cardiorespiratory fitness were associated with better sustained attention, and muscle strength was associated with working memory accuracy and confidence. Finally, fat tissue was negatively associated with sustained attention and working memory abilities. These findings support an association between physical fitness and cognition, supporting the role of physical activity in the prevention of age associated cognitive decline.

References:

1. Zhao X,Huang H, and Du C. Association of physical fitness with cognitive function in the community-dwelling older adults. BMC Geriatr, 22(1): 868,2022.

**CARDIORESPIRATORY FITNESS, WHITE MATTER, AND COGNITIVE PERFORMANCE IN OLDER ADULTS**

TINNEY, E., WARREN, A., OBRIEN, A., ODOM, H., AI, M., SUTTON, B., JAIN, S., KANG, C., HUANG, H., WAN, L., OBERLIN, L., GROVE, G., JAKICIC, J., COLLINS, A., SEWELL, K., BURNS, J., VIDONI, E., MCAULEY, E., KRAMER, A., ERICKSON, K., HILLMAN, C.
*NORTHEASTERN UNIVERSITY*

INTRODUCTION: Age-related cognitive decline occurs, in part, due to diminishing white matter integrity. Higher cardiorespiratory fitness (CRF) may mitigate cognitive decline by preserving white matter structure and function, yet the mechanisms underlying these associations remain poorly understood. While prior studies have suggested that white matter microstructure mediates the relationship between CRF and cognition, they have been limited by the use of tensor-based diffusion imaging metrics, which are less sensitive to crossing fibers and complex white matter architecture.

METHODS: In this study, we leveraged a novel and more sensitive analytical approach, fixel-based analyses (FBA), to provide estimates of fiber density (FD), fiber cross-section (FC), and their combined measure (FDC) in multiple directions within each voxel. Using a uniquely large sample of 636 cognitively normal older adults aged 65–80 years (mean age = 69.8 years; 71% female), we hypothesized that FBA metrics would reveal robust relationships between CRF and white matter microstructure and mediate associations between CRF and cognition.

RESULTS: In whole-brain analyses, higher CRF was associated with greater FD, FC, and FDC. Furthermore, these FBA-derived metrics statistically mediated the relationship between CRF and cognitive performance in the domains of visuospatial abilities, processing speed, working memory, and executive function/attentional control, but not episodic memory.

CONCLUSION: These findings further highlight the potential for CRF to be associated with preserved cognitive function in aging through its relationship with white matter micro- and macro-structural properties, providing novel insights into the neurobiological mechanisms of fitness-related cognitive resilience.

**EXPLORING DUAL SIMULTANEOUS COGNITIVE AND PHYSICAL TRAINING FOR OLDER ADULTS**

QUAGLIAROTTI, C., PADULO, C., ROMAGNOLI, R., CAZZOLI, B., LI, Y., PIACENTINI, M.F., MANDOLESI, L., GIGLIOTTA, O., MANCINI, M., CHIRICO, A., LUCIDI, F., ZELLI, A., FAIRFIELD, B.
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INTRODUCTION: The increase in longevity, a dynamic relationship between health, cognition and social abilities of an individual, requires a re-valorisation and maintenance of skills fundamental to daily life and wellbeing in older adults. Training different cognitive abilities and physical activity, as well as social abilities, is crucial to enhancing wellbeing in older adults. Notably, reviews have highlighted how cognitive training [1] and physical exercise [2], separately and combined [3], improve cognitive and physical performance in healthy older adults, especially when tasks are progressive and based on individual performance [3].

This project aimed to develop a dual simultaneous cognitive and physical training for older adults, evaluating the effects on individual skills and behaviours.

METHODS: Five (three females) older adults (age: 70±3.9y) performed eighteen 30 minute training sessions over a period of six weeks. Training sessions included strength and aerobic exercises (2:1 ratio) and a modified categorization working memory span task. Before (Pre) and after (Post) training, participants were evaluated for total weight, body mass index (BMI), percentage of body fat, and for cognitive (Corsi Block-Tapping and Digit Span tests to evaluate visuo-spatial and verbal short term working memory, respectively) and physical skills (30-s chair standing and arm curl tests). The Positive and Negative Affect Schedule scale and the International Physical Activity Questionnaire for Elderly were administered to evaluate social and physical behaviours Pre and Post. Non-parametric statistical analysis was performed to evaluate differences between Pre and Post.

RESULTS: A significative decrease in total weight (-2.9%: Pre 66.6±17.9kg, Post 64.7±19.2kg), BMI (-2.4%: Pre 24.7±4.4, Post 24.1±4.2) and body fat (-2.3%: Pre 30.4±10.5%, Post 29.7±10.5%) were found. Increased visuo-spatial working memory (+50.0%: Pre 4±1.5, Post 6±4.5) but not verbal (Pre 7±2.5, 8±1) were found after training. An improvement in 30-s chair standing (+9.1%: Pre 16.5±7.5, Post 18±11) and 30-s arm curl right side (+23.8%: Pre 21.0±14.5, Post 26±14.2) but not left side (Pre 17.5±13.5, Post 23.5±10.7, p=.066) was found. A significative decrement of weekly seated time (-36.4%: Pre 330±120 min, Post 210±165 min) was found, as well as a tendency, but not significant, increase of moderate activity (Pre 60±179.5 min, Post 120±277 min) and positive affects (Pre 32±8.5 Post 36±3.5) and a decrease of negative affects (Pre 16±3, Post 15±9.5).

CONCLUSION: Although these data are preliminary, the simultaneous dual cognitive and physical training resulted in an improved visuo-spatial working memory and physical skills in older adults. The training seems suitable for improving general well-being in older adults, and future applications should be explored, such as in an augmented reality environment[4].

[1] Gavelin 2020

[2] Kruger 2009

[3] Wollesen 2020

[4] Chirico 2024

# Oral Presentations

## OP-BM18 Muscle Disuse and Ageing

### ALTERATIONS IN MOTOR UNIT PROPERTIES FOLLOWING 14 DAYS OF STEP REDUCTION PRECEDE FUNCTIONAL DECLINE AND ARE COUNTERACTED BY EXERCISE TRAINING

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INTRODUCTION: Periods of short-term physical inactivity are experienced by nearly all individuals during their lives and can cause several health issues (1). Recent studies employing unilateral lower limb suspension as a model of muscle disuse (2,3) have shown signs of neural alterations at the level of the neuromuscular junction (NMJ) and motor unit (MU) behavior. In step reduction (SR), a milder model of physical inactivity, the change of neural components of muscle control remains largely unknown. In this study, we aim to characterize neuromuscular alterations induced by SR and investigate whether a subsequent exercise intervention can guarantee an adequate recovery.

METHODS: Fifteen healthy young subjects (7 females, age 22 ± 2.3 years) participated in the study. Measurements were taken at baseline, after a 2-week of SR (<1500 steps/day), and following a 3-week exercise training (ET) intervention (3 sessions/week, 1 hour/session). At each time point, we assessed maximal voluntary isometric contraction (MVIC) of knee extensors, and vastus lateralis (VL) muscle activity during trapezoidal isometric contractions at 25% (5s ramp up, 20s steady state, 5s ramp down) and 50% (10s ramp up, 10s steady state, 10s ramp down) of MVIC. Muscle activity was recorded using high-density electromyography (HDEMG, OT Bioelettronica). HDEMG signals were decomposed into individual motor unit (MU) firings, from which we calculated absolute recruitment threshold (RT), derecruitment threshold (DT), and mean discharge rate (DR) at steady state. Statistical analysis included one-way ANOVA for comparing MU properties across time points at the same contraction level, and repeated measures ANOVA for MVIC values, with Bonferroni post-hoc correction (significance at $P<0.017$).

RESULTS: In total, 735 MUs were identified and reconstructed. The MVIC torque did not change among the three sessions ($P=0.339$). A difference was observed between SR and ET for RT at 25% of MVC ($P=0.027$), although it was not significant after Bonferroni correction. No significant differences were found for DT. The DR was reduced from baseline to SR at 25% and 50% of MVC ($P=0.010$ and $P<0.001$, respectively), and it recovered after ET only at 25% of MVC ($P=0.005$).

CONCLUSION: Knowledge of the pathophysiological mechanisms related to short-term physical inactivity is fundamental to overcome its deleterious effects. Muscle force production greatly depends on MU properties and their discharge rate. This is the first study assessing MU adaptations after a period of SR. Our findings suggest that neural degeneration might precede alterations in functional capacity, and exercise can successfully overcome this negative effect.

The study was funded by PRIN project (InactivAge n. 2020EM9A8X) and NextGenerationEU/MUR PRIN 2022 PNRR, (ReActiveAge, Project n. P2022FNCPR).

1 Bowden et al. Ther Adv Endocrinol Metab. 2019

2 Sarto et al. J Physiol, 2022

3 Valli et al. MSSE. 2024

### ANALYSIS OF MUSCLE DIFFERENCES IN ACTIVE AND INACTIVE ELDERLY SUBJECTS: TARGETING ERRA TO COUNTER AGE-RELATED ATROPHY

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INTRODUCTION: Muscle atrophy is a debilitating condition that significantly affects quality of life. Recent studies suggest estrogen-related receptor alpha (ERRα) as a potential therapeutic target to counteract muscle decline associated with aging or inactivity, as it is known to regulate mitochondrial function and contribute significantly to skeletal muscle exercise capacity. The purpose of this study was to evaluate the targeting of ERRα, by treatment with an agonist, SLU-PP-332, in myoblasts isolated from inactive elderly women, to mimic the muscle conditions found in active elderly women.

METHODS: 20 women with a mean age of 70 years undergoing hip arthroplasty for coxarthrosis were enrolled and divided into two groups based on self-reported physical activity: 10 women who practiced moderate physical activity, such as walking or bicycling, at least 30 minutes a day three times a week, and 10 women who did not practice regular, structured physical activity. A clinical and instrumental assessment was conducted during hospitalization, measuring bone mineral density, visual analogue scale (VAS) values, harris hip score (HHS) and handgrip strength test. During surgery, muscle biopsies were taken for histological and western blotting analysis. In addition, primary cultures of myoblasts were set up from the muscle tissue of inactive women and were treated with SLU-PP-332 for subsequent qualitative and quantitative investigations.

RESULTS: The clinical and instrumental evaluation revealed that inactive women were characterized by osteopenic/osteoporotic T-score values, higher VAS values, reduced hip function and significantly lower handgrip strength values. In agreement, the histological and morphometric analysis showed a reduced fiber diameter and increased ex-

pression of NADPH oxidase 4 (NOX4), a producer of oxidative stress, in association with reduced expression of sirtuin 1 (SIRT1), peroxisome proliferator-activated receptor gamma coactivator 1-alpha (PGC-1α), ERRα and fibronectin type III domain-containing protein 5 (FNDC5), all mediators of muscle adaptations to exercise. SLU-PP-332-treated myoblasts showed a reduction in cytotoxicity, intracellular reactive oxygen species (ROS) levels, and senescence β-galactosidase activity, as well as an increase in reduced glutathione. In addition, down-regulation of NOX4 and up-regulation of SIRT1, PGC-1α, ERRα and FNDC5 were detected in treated cells.

CONCLUSION: Exercise counteracts the onset and/or progression of muscle atrophy, presumably through the positive regulation of ERRs. The future perspective of this study is to investigate the modulation of ERRs as potential biomarkers in response to different training protocols to optimize muscle response to exercise.

**SEX-SPECIFIC DIFFERENCES IN THE ASSOCIATION BETWEEN FORCE STEADINESS AND FUNCTIONAL PERFORMANCE IN PHYSICALLY ACTIVE OLDER ADULTS**

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INTRODUCTION: Age-related neuromuscular decline impairs the ability to maintain a steady force during a submaximal voluntary contraction, a measure known as force steadiness (FS). Given its critical role in physical function, reduced FS has been linked to lower functional performance in older adults. This study aimed to investigate the association between FS in the hip abductor, knee extensor, plantar flexor, and performance in functional tests among older adults.

METHODS: Twenty physically active older adults (3275.0±1800.3 METS/week) participated in this study. Participants completed the Short Physical Performance Battery (SPPB) and underwent a gait assessment using the OptoGait system. Additionally, strength tests were performed for hip abductor, knee extensor, and plantar flexor, along with steady submaximal isometric activations at 20%, 30% and 20% of maximum effort, respectively, using an isokinetic dynamometer (HUMAC NORM) on the non-dominant limb. Gait speed over 4m and 6m, Sit-to-Stand (STS) muscle power, Time Up and Go (TUG), coefficient of variation (ST_CV%) and Root Mean Square of the Successive Differences (ST_RMSSD) of step time were recorded to assess the association with FS variables, including CV% (FS_CV%) and RMSSD (FS_RMSSD) of the tested limb. Pearson and Spearman correlations were conducted to determine the strength of the these relationship.

RESULTS: Ten women (67.2±1.3 years; Fat mass percentage 39.0±3.9%), and ten men (69.1±1.4 years; Fat mass percentage 30.3±6.7%), classified as robust according to the SPPB score participate in the study. A moderate correlation was found between FS_RMSSD of hip adductor and ST_RMSSD in the whole sample ($r = -0.46$, $p<0.05$). Interestingly, sex-specific differences in correlation patterns were observed. In women, a significant positive correlation was found between TUG time and FS_RMSSD of hip adductor ($r = 0.65$, $p< 0.05$) and FS_RMSSD of plantar flexor ($r = 0.68$, $p< 0.05$). In contrast, these correlations were weaker and non-significant in men (hip adductor, $r = -0.29$, $p > 0.05$; plantar flexor: $r = -0.48$, $p > 0.05$). Additionally, a strong negative correlation was found between ST_RMSSD and FS_RMSSD of the hip adductor in men ($r = -0.70$, $p<0.05$), whereas this relationship was weaker and non-significant in women ($r = 0.38$, $p > 0.05$). A moderate negative correlation was also observed between ST_RMSSD and CV% of the plantar flexor in men ($r = -0.70$, $p < 0.05$), while in women, this association was weaker and not significant ($r = 0.21$, $p > 0.05$).

CONCLUSION: These findings highlight the role of FS in neuromuscular function and its link to functional performance, emphasizing the need for controlled variability in specific muscles to maintain gait stability. Moreover, they stress the importance of considering sex-specific neuromuscular differences when assessing FS and functionality in aging. Future research should explore these compensatory strategies and their impact on tasks challenging medio-lateral stability, such as obstacle stepping.

**CHANGES IN MUSCLE CONTRACTILE PROPERTIES AND FUNCTION DURING 10-DAY BED REST, RECOVERY, AND POST-COVID-19 LOCKDOWN**

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INTRODUCTION: Changes in muscle structure and function have been observed following periods of bed rest. When aging is combined with such disuse periods, these changes become more pronounced, with severely limited recovery. Tensiomyography (TMG), a method for assessing skeletal muscle contractile properties, has been shown to detect early, pre-atrophic changes, not seen by other methods. This study aimed to identify early TMG alterations during a 10-day bed rest, followed by a 30-day recovery, and to compare these changes to those observed after the COVID-19 lockdown.

METHODS: Ten young males (22.9 ± 5.0 years) participated in a 10-day horizontal bed rest followed by a 30-day recovery. After obtaining ethical approval (No. 0120-123/2023/9), all participants provided written informed consent. TMG was assessed at baseline (BDC), on the i-th day of bed rest (BRi), on the i-th day of recovery (R+i), and after the COVID-19 lockdown (Covid-19) in six muscles. Vertical jump performance was evaluated using countermovement (CMJ) and squat jumps (SJ). Lower back pain was assessed using a visual analog scale.

RESULTS: All participants completed the bed rest study and assessments without complications. By BR10, we found 1.5 kg mass loss, characterized by a 3.8% increase in fat mass and a 0.76 kg decrease in muscle mass. While all anthropometric parameters returned to BDC levels, by R+30, fat mass increased again by 3.9% at Covid-19. At BR10, CMJ height decreased by 10.1% recovered to BDC values by R+30, with no further changes observed at Covid-19. TMG-derived delay

and contraction times increased in the vastus lateralis at BR10 but decreased in the erector spinae. In the biceps femoris, similar increase was observed at BR10 and persisted during Covid-19. TMG amplitude increased in all lower limb muscles from BR1 to BR4, recovered to BDC levels, but increased again at Covid-19, albeit to a lesser extent. In the erector spinae, TMG amplitude initially decreased at BR1, returned to BDC levels by BR4, and was associated with incased lower back pain during the same period.

CONCLUSION: Changes in TMG delay time have not been previously reported. We show inconsistencies across the measured muscles. Electromechanical delay is influenced by action potential generation, the time it needs to reach the muscle, any slack within the muscle before detectable tension is produced. Contraction time followed a similar pattern to delay time, except in the biceps femoris, where it increased after BR4 without recovery. Given that contraction time is correlated with the proportion of MHC-I fibers and jumping power, this finding has significant implications for the ability to generate explosive power. The increase in displacement was consistent with previous studies; however, it was detected much earlier than atrophy with imaging techniques. Notably, this was the first study to report a decrease in Dm in the erector spinae, which was associated with lower back pain, commonly observed in initial days of bed rest or spaceflight.

**MODERATE ENDURANCE TRAINING LEADS TO AN INCREASE IN MUSCLE MASS, STRENGTH AND POWER IN OLDER ADULTS FOLLOWING 10 DAYS OF BED REST**

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INTRODUCTION: Periods of muscle disuse are becoming more common in modern society, either due to sedentary lifestyle, illnesses or hospitalization. Disuse can lead to significant loss of muscle mass, strength and power, especially in the older population. Resistance training (RT) is the modality of exercise commonly chosen to counteract such impairments in muscle mass and function. A recent study from our lab (1) has confirmed RT as a successful strategy for recovering functional and structural muscle properties after 10 days of disuse. However, transcriptomic profile analyses suggest that exposure to short-term muscle disuse could prompt the muscle to primarily restore its metabolic function. Given that endurance training is known to enhance oxidative metabolism, this study aims to investigate whether it may also be effective in restoring disuse-induced impairments to skeletal muscle.

METHODS: Ten healthy male older adults (69 ± 3 years) underwent 10 days of strict horizontal bed rest (BR) without countermeasures, followed by 21 days (9 sessions) of moderate intensity endurance exercising (AR). Sessions consisted of 15min of warm-up, followed by five 15s high intensity cycling sprints, and 30min of cycling at 80-100% of gas exchange threshold. Neuromuscular function assessments and muscle biopsies were performed both before (BR0) and after (BR10) bed rest, and after AR. An isokinetic dynamometer was used to assess maximum voluntary isometric contraction (MVIC) and maximum muscle power (PM) of the knee flexors. The quadriceps femoris (QF) was manually outlined on magnetic resonance imaging (MRI) images obtained every 12mm. QF volume (VOL) was calculated using the truncated cone formula (2). Muscle thickness (MT), fascicle length (FL) and pennation angle (PA) were measured on ultrasound images obtained from the vastus lateralis at 50% of femur length. Transcriptional (RNAseq) analyses on muscle biopsies are ongoing. One-way repeated measures ANOVAs were performed to detect differences over timepoints.

RESULTS: From BR0 to BR10 there were significant decreases in QF VOL (-6.2%, $p<0.001$), MT (-7.4%, $p=0.02$), PA (-7.7%, $p=0.04$) and MVIC (-13.3%, $p<0.001$). Changes in FL (-3.6%, $p=0.06$) and PM (-1.4%, $p=0.84$) were not significant. From BR10 to AR there were significant increases in QF VOL (11.2%, $p<0.001$), MT (13.7%, $p=0.003$), MVIC (8.9%, $p=0.007$) and PM (25.9%, $p<0.001$). Changes in FL (5.3%, $p=0.09$) and PA (9.4%, $p=0.12$) were not significant.

CONCLUSION: Ten days of bed rest resulted in significant muscle atrophy and strength loss. Compared to what is usually observed after endurance training, muscle volume was not only restored, but, surprisingly, its change after retraining exceeded the baseline values, along with marked improvements in muscle strength and power. Ongoing transcriptional analysis will help to elucidate the molecular mechanisms underlying this unexpected hypertrophic and functional gains.

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2. Tracy et al. (2003). MSSE.

## Oral Presentations

### OP-PN08 Nutrition V - Supplements and Superfoods

**EFFECTS OF DIFFERENT DOSES OF ANTIOXIDANT INTAKE ON EXERCISE-INDUCED OXIDATIVE STRESS, ANTIOXIDATIVE CAPACITY AND INFLAMMATORY RESPONSES**

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INTRODUCTION: It is unknown whether an appropriate amount of exogenous antioxidant intake is present to maximize the exercise benefit on lifestyle-related diseases. The purpose of this study was to investigate the effects of two levels of exercise stress and exogenous antioxidant doses on exercise-induced oxidative stress, antioxidant capacity, and inflammatory response.

METHODS: Wistar male rats were divided into two groups; sedentary (SED) and exercise (TR). The exercise was increased from 4 weeks of low-intensity (90 min/week) to 4 weeks of high-intensity (300 min/week). TR was subdivided into low (70 mg/kg: TR+N), medium (350 mg/kg: TR+VE-M), and high (700 mg/kg: TR+VE-H) according to the amount of vitamin E intake. Oxidative stress (d-ROMs), antioxidative capacity (BAP), and inflammatory response (hs-CRP: high sensitive C-reactive protein) were measured with blood samples before and after each exercise load PGC1-α was measured with muscle samples using real-time PCR.

RESULTS: d-ROMs increased as exercise intensity was augmented in all TR and was higher in TR+N and TR+VE-M than in SED after high-intensity exercise, while it was not different between SED and TR+VE-H. hs-CRP increased in TR+N and TR+VE-H after high-intensity exercise as compared with before. PGC1-α increased only in TR+VE-M after high-intensity exercise.

CONCLUSION: Only medium doses of vitamin E intake may suppress the inflammatory response to oxidative stress during a large amount of exercise without inhibiting the expression of the transcription factor PGC1-α, suggesting the presence of an appropriate dose for exogenous antioxidant intake during exercise.

**EFFECT OF AMARANTHUS SUPPLEMENTATION ON AEROBIC CAPACITY AND EXERCISE PERFORMANCE IN COMBAT SPORTS ATHLETES.**

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INTRODUCTION: This study investigated the effects of seven-week Amaranthus hypochondriacus supplementation on aerobic capacity and exercise performance in karate athletes participating in state and national-level tournaments. The research aimed to evaluate the impact of Amaranthus hypochondriacus supplementation as an ergogenic aid on cardiorespiratory fitness markers and muscular strength in combat sports athletes to improve their performance.

METHODS: Forty-three karate athletes (31 male and 12 female) aged (18±0.53years), with body mass index (BMI) of (21±1.04) competing at national and state levels, participated in this study. Participants were randomly assigned to either an experimental group receiving Amaranthus supplementation (n=27) or a control group (n=18) for six weeks. The Amaranthus supplement was administered in a standard dosage of approx. 20g/d, accounting for body weight and training volume. Pre- and post-intervention assessments measured aerobic capacity and exercise performance using Cardiopulmonary Exercise Testing (CPET) (K5 COSMED). Using a hand grip dynamometer, muscle strength was measured through push-ups, hand grip, and squats.

RESULTS: The seven-week supplementation trial yielded notable improvements in the experimental group (EXP) versus the control group (CON). Cardiorespiratory markers showed significant improvements, with an increase of 9.10% in VO2max (ml/kg/min) in the EXP group; CON (35±1.2) and EXP (40±1.12) ($p<0.05$) and improved HRmax(bpm), recovery patterns including respiratory exchange ratio (RER): CON (1.02±0.11), EXP (1.05±0.02)($p<0.05$); Respiratory Quotient(RQ): CON(1.15±0.05), EXP(1.21±0.03)non-significant; Ventilatory Threshold(VT)(ml/min) CON(2244±154), EXP(2274±120)($p<0.05$). Strength parameters demonstrated marked progress in the EXP group, particularly a 2.61% increase in upper body strength. Anaerobic capacity (30-yard sprint) increased in EXP Group.

CONCLUSION: Seven-week Amaranthus hypochondriacus supplementation significantly improved karate athletes cardiorespiratory fitness and strength parameters. Notable enhancements were observed in VO2 max, respiratory markers (RER, VT), upper body strength, and aerobic and anaerobic capacity. These findings provide valuable insights for athletes, coaches, and sports nutritionists in optimizing performance through supplementation strategies.

**TWO WEEKS OF PYCNOGENOL SUPPLEMENTATION HAS NO ERGOGENIC BENEFIT TO PHYSICAL PERFORMANCE IN TRAINED HYBRID ATHLETES**

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INTRODUCTION: Participation in hybrid athletic events, such as CrossFit*TM* and Hyrox*TM*, has led to an increase in hybrid athletes that require well developed strength, endurance, agility, and power. There is a high prevalence of ergogenic aid consumption among hybrid athletes [1]. Understanding the effects of ergogenic aids in improving this performance is crucial. Pycnogenol (PYC) is a dietary supplement extracted from French maritime pine bark, which is marketed for its antioxidant, anti-inflammatory and blood flow modulating effects, which can impact on performance and recovery. This study investigated the effect of 2-week PYC supplementation on physical performance in trained hybrid athletes.

METHODS: In a randomised, single-blind, cross-over study design, 12 (7 female, 6 male, age = 26-38 years) hybrid classified athletes performed a graded exercise test, countermovement jump (CMJ), isometric mid-thigh pull (IMTP), 30 s Wingate test, and back squat 1 repetition maximum (1RM) before and after two weeks of either PYC (260 mg/day PYC) or placebo (PLA: 0 mg/day PYC) daily oral supplementation. Following a 14-day wash-out, participants repeated all tests, which served as the baseline performance for their second counter supplementation period. Post-testing was performed 2-weeks after initial second supplementation period began. Linear mixed models analysed the effect of the treatment × time, adjusting for potential sequence/carry-over effects, sex, and age. Results are expressed as the raw parameter estimate (β) ± 95% confidence intervals.

RESULTS: When controlling for sex and age, no time × treatment effect was present for VO2peak (-0.5 mL/kg/min [-2.28, 1.30]). Fatigue index (-10% [-25, 4]), peak power (-2 W, [-110,105]), relative peak power (-0.1 W/kg [-0.4, 0.3]), and average power (-0.1 W [-48, 5]) achieved during the 30 s Wingate test failed to display a time × treatment effect, when controlling for sex. Similarly, when controlling for age and sex, no time × treatment existed for CMJ height (0.1 cm [-2.7, 2.9]), IMTP rate of force development 200 ms (86.9 N/s [-1016, 1190]), IMTP relative peak vertical force (-1.81 N/kg [-4.16, 0.54]), and back squat 1RM (0.2 kg [-4.08, 4.50]).

CONCLUSION: In our cohort and sample size, 2-weeks of 260 mg/day PYC supplementation provided no benefit compared to a PLA on VO2peak, countermovement jump height, IMTP measurements, 30s wingate measurements and 1RM back squat. Therefore, 2-week PYC (260 mg/day) had no impact on physical performance of hybrid athletes. Future studies should aim to investigate the effect of dosage and supplement duration on hybrid athlete performance.

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**EFFECTS OF 7-DAY TART CHERRY JUICE CONSUMPTION ON RECOVERY, METABOLIC RESPONSE, AND CARDIOVASCULAR FUNCTION IN TRAINED CYCLISTS**

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INTRODUCTION: Tart cherry contains two key antioxidants (anthocyanin and polyphenol) which have been shown prevent/reduce the onset of exercise induced oxidative stress, muscle damage and fatigue. The purpose of this study was to investigate the effects of tart cherry juice on recovery outcomes, metabolic responses, and cardiovascular function in trained cyclists.

METHODS: This study was a randomized, double-blind, placebo-controlled, cross-over design. Seven participants received 30 ml of tart cherry (TC) juice or a placebo (G) twice a day for seven days with a wash-out period of one month. Participants visited the lab 3 times during each supplementation period. On day 1, anthropometric measurements were obtained. Participants completed three 10km time trials on days 1, 6, and 7 with blood glucose and lactate measurements obtained pre- and post-trial. Additionally, on day 6 participants completed a 90-minute cycling test at 65% max heart rate before the 10km time trial. Blood glucose and lactate measures were obtained at baseline and again at 15,30,60 and 90 minutes.

RESULTS: The results showed blood lactate levels decreased after the 90-minute cycling test and increased post 10 km time trial in the TC condition. The 10 km time trial results on the last day of supplementation showed a .31 ± 0.1 faster time in the TC condition compared to G condition. Also, heart rate decreased in the TC condition (118.3 ± 9.6) compared to G condition (121.4 ± 17.1) and stroke volume increased (99.9 ± 24.6) in TC condition compared to G (95.6 ±22.2).

CONCLUSION: In conclusion, tart cherry supplementation appears to improve time trial performance, maintains metabolic response and improves cardiovascular function within trained cyclists. The two key antioxidants (polyphenol and anthocyanin) have anti-inflammatory and free radical reducing properties that help reduce oxidative stress and muscle fatigue, enhances overall performance amongst cyclists.

**SWEET RELIEF: EVALUATING THE EFFECTIVENESS OF DARK CHOCOLATE FOR MENSTRUAL AND HORMONAL CONTRACEPTIVE CYCLE SYMPTOMS MANAGEMENT IN FEMALE ATHLETES**

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INTRODUCTION: Menstrual cycle symptoms (MCS), such as cramps, fatigue, and mood changes, affect over 80% of active women. These symptoms impact the wellbeing, quality of life, sports participation, and perceived performance of female athletes, making it a critical issue for athlete availability and long-term success. An immune-mediated inflammatory response has been suggested as a potential trigger for MCS. To address this, dark chocolate, rich in flavanols (polyphenols with antioxidant and anti-inflammatory properties), was tested as a practical strategy to manage MCS by its potential effect on inflammatory marker modulation.

METHODS: Healthy naturally cycling (NC group, n = 20, 29.5 ± 6 y/o) and hormonal contraceptive using (HC group, n = 8, 27.5 ± 4.6 y/o) female athletes were randomised to consume either 40 g of 70% or 25% cacao chocolate for eight consecutive days across two menstrual or HC cycles, following two baseline measure cycles. Menstrual cycle symptom (MCS) frequency and severity were evaluated using a Menstrual Distress Questionnaire (MDQ) (1). Serum C-reactive protein (CRP), a key marker of systemic inflammation, was used as an indicator of the immune response magnitude to MCS in the presence and absence of chocolate. Factors such as body composition, athlete calibre, diet and training load, were accounted for.

RESULTS: Menstrual cycle symptoms (MCS) frequency or severity did not significantly correlate with consuming chocolate ($p = 0.269$; $p = 0.482$) or the type of chocolate consumed ($p = 0.187$; $p = 0.84$). Nevertheless, there was a trend towards a negative relationship, with lower overall MCS frequency and severity reported during cycles when chocolate was consumed, and surprisingly with consuming 25% cacao chocolate compared to 70% cacao chocolate (rpb = -0.05, rpb = -0.06, respectively). CRP levels followed a similar trend, showing a non-significant negative correlation with consuming

chocolate (rpb = -0.04, p = 0.316) and type of chocolate consumed, favouring 25% cacao over 70% cacao chocolate (rpb = 0, p = 0.928). Furthermore, as shown through mediation analysis, neither chocolate consumption, type of chocolate, nor CRP levels appeared to be significant predictors of MCS frequency or severity. Interestingly, MCS frequency/severity outcomes and CRP levels reduced as athlete calibre increased (Tier 2 > Tier 3 > Tier 4 athletes).

CONCLUSION: A desire for chocolate is common prior to menstruation or bleeding. Higher cacao chocolate consumption (70% cacao) did not reduce MCS. However, a non-significant trend suggested that lower cacao (25%) chocolate consumption might be associated with a small reduction in MCS frequency and severity. CRP levels had a tendency to be lower when 25% cacao was consumed. The capacity of chocolate to mediate MCS warrants further investigation.

REFERENCE

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## Oral Presentations

### OP-AP21 Training and Testing VI - Cognitive Performance and Coordination

**COGNITIVE AND PHYSIOLOGICAL FACTORS IN RESPONSE TIME TASKS: DIFFERENTIATING TEAM SPORT ATHLETES**

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INTRODUCTION: Athletes who can perceive situations more quickly and execute movements more rapidly have a significant advantage in team sports. In particular, decision making and perceptual abilities are frequently identified as crucial factors that differentiate between different levels of playing ability. However, the underlying mechanisms remain largely unknown [1]. This study aims to investigate the role of cognitive and physiological factors in response time tasks using general stimuli and their influence on expertise differences in female team sport athletes.

METHODS: A total of n = 23 high-level (2nd-4th league, age: 23.80 ± 2.95 years) and n = 22 low-level (7th league, age: 28.80 ± 7.60 years) female team handball athletes performed an Eriksen-Flanker-Task and four measurements on the SpeedCourt (a sensor-based system for assessing speed and reactive performance). Jump height, five-second tapping, and response times under both simple and complex conditions were assessed. Reaction and movement time were measured following a sport-specific response. Simple mean comparisons and correlation analyses were conducted to examine the relationships between dependent variables. The influence of test complexity and performance level was analyzed using a repeated-measures multivariate analysis of variance (rmMANOVA).

RESULTS: Reaction and movement time in the response time tasks increased significantly with increasing test complexity ($p < 0.001$). Only movement time distinguished between high- and low-level team handball players, with high-level players demonstrating significantly shorter movement times (MDiff = -0.037 s, 95%-CI [-0.001 s, -0.072 s], $p < 0.05$). Faster movement times were significantly correlated with jump height (moderate, r = -0.48, r2 = 0.24, $p < 0.01$). Other cognitive-psychological factors, such as performance on the Eriksen-Flanker-Task, showed no significant group differences or a correlation with reaction time in the complex response time task ($p > 0.05$).

CONCLUSION: In conclusion, physiological factors, as indicated by movement time, contribute to differentiating female team sport athletes in response time tasks using general stimuli. These findings reflect sport-specific requirements for optimizing response time tasks and highlight implications for improving reactive agility. Future studies should incorporate sport-specific stimuli to systematically analyze the impact of anticipation and visual search behavior on movement times and expertise differences, which could provide valuable insights for training interventions in team sports.

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**EFFECTIVENESS OF AN 8-WEEK SPORT VISION TRAINING PROGRAM ON VISUO-MOTOR REACTION TIME AND OCULOMOTRICITY IN YOUNG FOOTBALL PLAYERS**

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INTRODUCTION: Football is a highly dynamic sport that requires players to rapidly process visual stimuli, make decisions, and execute motor actions under pressure. Sport Vision Training (SVT) has been proposed as a method to enhance visuomotor skills, yet its application in football remains underexplored. This study aimed to evaluate the effectiveness of an 8-week, field-based SVT protocol on Visuo-Motor Reaction Time (VMRT) and oculomotricity in young football players.

METHODS: Thirty- five male players (aged 11–12 years) were recruited for the study. Baseline orthoptic evaluation ensured normal visual function before intervention. VMRT was measured using BlazePod devices across upper- and lower-limb tasks, while oculomotricity was evaluated using the Northeastern State University College of Optometry (NSUCO) test. Participant competed an 8-week SVT intervention, consisting of twice-weekly 20-minute training sessions integrated into football practice. Exercises focused on peripheral vision, saccadic movements and visual-motor reaction drills. General-

ized linear mixed models (GLMMs) and cumulative link models (CLMMs) were used for statistical analysis, with p-values adjusted for multiple comparisons.

RESULTS: Post-intervention analysis revealed significant improvements in VMRT for upper-limb tasks, with reductions in reaction times for right hand ($\beta = -0.15$; $p < 0.001$), left hand ($\beta = -0.14$; $p < 0.001$), and both hands ($\beta = -0.11$; $p < 0.001$). However, no significant improvements were detected in lower-limb reaction time ($p > 0.05$).

The NSUCO test showed significant improvements in saccadic movement precision ($\beta = 2.11$; $p = 0.02$) and reduced head/body movement during saccadic tasks ($\beta = 0.11$; $p < 0.001$), but no notable changes in pursuit movement precision ($\beta = -0.62$; $p = 0.37$).

CONCLUSION: Findings suggest that field-based SVT can effectively enhance upper-limb visuomotor reaction time and saccadic eye movement precision, supporting the integration of SVT in football training. However, its impact on lower-limb reaction time remains inconclusive, suggesting that additional training or a longer intervention period may be necessary to enhance reaction times in the lower extremities. Further investigation is needed. The study highlights the potential of integrating cost-effective SVT programs into football teams training routines, allowing coaches to systematically enhance athletes' visual-motor processing without disrupting standard practice sessions. Future research should explore longer intervention periods and assess the transferability of SVT improvements to match performance. And assess long-term retention of visual-motor adaptations.

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**THE EFFECTS OF A SOCCER-SPECIFIC IMMERSIVE TECHNOLOGY TRAINING INTERVENTION ON PERCEPTUAL-COGNITIVE SKILLS OF YOUTH SOCCER PLAYERS**

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INTRODUCTION: Innovative soccer-specific training tools, such as SoccerBot360 (SB360), offer multidimensional perceptual-cognitive training (PCT) using soccer-specific motor tasks with 360-degree stimuli. These technologies can overcome the limitations of conventional PCT tools that often isolate perceptual-cognitive skills from physical activity, such as virtual reality systems [1]. However, evidence on the effectiveness of SB360 and other PCT using these technologies is still limited, particularly among skilled populations. Therefore, this study evaluated the effects of a 6-week SB360 PCT intervention on perceptual-cognitive-motor task performance in skilled youth soccer players.

METHODS: Thirty-one male youth soccer players from a Category One English Premier League Youth Academy (age = 13.7 ± 0.9 years) participated in a longitudinal crossover design. They were divided into two groups: one group completed a 6-week block of SB360 PCT (15-mins/week) followed by another 6-week control block where they continued their regular soccer training, whereas the sequence was reversed for the other group. Following familiarisation, intervention effects were assessed before, between, and after each training/control block using standardised SB360 motor tasks designed to test choice response time, cognitive flexibility, anticipation, and inhibition. Linear mixed models were employed for analysis of test response accuracy (RA) and response time (RT), reporting r-squared values as an effect size measure. Significance was set at $P<0.05$.

RESULTS: RT in all four tasks was significantly faster at the 6-week mid-point and the end of the 12-week study compared to baseline. However, there were no between-group differences in RT at any test, including at the 6-week mid-point, where the intervention group was hypothesised to show faster RT than the control group. RA in the anticipation task was significantly greater at the end of the 12-week study compared to baseline. RA did not significantly differ across tests for the other three tasks, and again, there were no between-group differences in RA across all tasks. Effect size analysis indicated that individual differences accounted for the largest proportion of variance (0.54-0.80) when compared to time and group factors (0.00-0.10). Additionally, six of nine testing variables showed significant improvements ($P < 0.05$) between familiarisation and first cognitive test.

CONCLUSION: Individual variation between players had a stronger effect on SB360 testing performance than the intervention. Therefore, we recommend a longer duration and increased frequency of SB360 training, as well as tailoring task difficulty and specificity to individual needs, so as to minimise individual variation and maximise training effects. Future study should also incorporate a familiarisation test to minimise misinterpretation of cognitive intervention results.

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**MOTOR-COGNITIVE INTERFERENCE APPLIED TO TABLE TENNIS**

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INTRODUCTION: In fast-paced sports like Table Tennis, athletes must allocate cognitive resources to process multiple stimuli, potentially impairing performance under dual-task conditions [1][2]. This study examined how table tennis athletes manage single- and dual-task conditions and in particular their ability to balance motor and cognitive demands.

METHODS: Thirteen expert table tennis players (M age = 20.4 ± 5.3 years) participated in this study. Each athlete completed three single-task and two dual-task conditions. The single tasks included an Auditory Free-Recall Memory Task (MT), in which participants memorized 20 words and recalled them at the end of the task, and two table tennis tasks. These in-

cluded a SimpleTask (ST), where participants returned ball throws by a robot using a Simple technique (drive), and a Complex Task (CT), using a Complex technique (top spin). In the dual-task conditions, participants performed the MT simultaneously with either ST (MT+ST) or CT (MT+CT). The NASA-TLX scale was used to assess physical demand (PD) and mental demand (MD) after each trial.

RESULTS: Significant differences were found in memory performance across conditions ($p < .001$). MT performance was higher in the single-task condition and significantly declined in both dual-task conditions. However, no significant differences were observed between MT+ST and MT+CT. When analyzing word recall patterns, performance was significantly lower in both dual-task conditions compared to the MT single-task for the first five words. No differences emerged between the two dual-tasks. For the last five words, MT recall was superior to both dual-task conditions, and MT+CT performance was better than MT+ST.

Mental and physical demands varied significantly across conditions ($p < .001$). The lowest PD was registered in MT, and the highest were recorded in CT and MT+CT. MD was significantly higher in MT+CT compared to all the other conditions.

CONCLUSION: Results indicate significant cognitive-motor interference even in expert Table Tennis players: the more difficult the Table Tennis task becomes, the fewer words are remembered. These data are also supported by the higher PD and MD detected in MT + DT compared to all the other sessions. These findings highlight the role of cognitive-motor interference in table tennis and display the challenges athletes face when distributing attentional resources in demanding conditions.

**OPTIMIZING FENCING COORDINATIVE ABILITIES: INSIGHTS FROM INTERMITTENT VISION TRAINING AND EYE MOVEMENT ANALYSIS**

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INTRODUCTION: Rapid visual processing and reaction time are crucial in fencing. Stroboscopic training, which intermittently occludes vision, may enhance visuomotor coordination. This study evaluated the effects of stroboscopic glasses training on eye-tracking parameters and reaction time, comparing an experimental group (EG) to a control group (CG) undergoing conventional training.

METHODS: Twenty-four experienced fencers (age:16.1±2.5y; BMI:21.8±3.19kg/m²) were randomly assigned to two groups: an experimental group (EG) and a control group (CG). The 5-weeks intervention included three phases: initial assessment; training; and final assessment. Performance measurements included the reaction time evaluation by administering 5 trials using the Electronic Fencing Target (EFT-1) and 5 Ruler Tests (RT). During the trials, an eye tracker was used to record visual behavior, and monitor fixation count, saccades, and gaze dispersion. Both groups followed the same training protocol using EFT-1 while wearing stroboscopic glasses. The training protocol required the experimental group to alternate between the ON condition, where intermittent occlusion limited vision, and the OFF condition, with unrestricted vision. The occlusion mode and frequency, randomly administered, were chosen to create a more demanding perceptual environment and enhance visual and reaction abilities.

RESULTS: Eye-tracking data showed a significant increase in fixation count ($p=0.05$) and saccadic movements ($p=0.01$) in the experimental group. Gaze azimuth and elevation shifted toward a more centralized focus on the target, reducing deviations (pre:2.5°±4.3°; post:1.2°±2.1°; pre:3.0°±3.8°; post:1.5°±1.9°, respectively). EFT-1 results indicated an average 8.6% improvement in reaction times (pre: 290ms±15; post: 265ms±12), with the ON-ON-OFF-OFF sequence proving particularly effective. The control group showed no statistically significant changes. The Ruler Test did not reveal any significant differences between pre- and post-training results in either group, suggesting that this test may not accurately capture the sport-specific reflex demands of fencing.

CONCLUSION: Stroboscopic training improved gaze efficiency and reaction time in fencers, while the control group showed no notable progress. The stroboscopic effect likely enhances feedforward mechanisms, forcing athletes to refine anticipatory and perceptual strategies under visually challenging conditions. The lack of significant changes in RT suggests that general reaction time assessments may not effectively measure sport-specific visuomotor improvements in fencing. This could be because the test used was not specific to the motor task required nor sufficiently discriminative to capture the perceptual-motor skills developed in this sport. These findings support the use of stroboscopic glasses as a tool to optimize training and pre-competition preparation. Future studies should explore long-term effects and refine training protocols to validate these promising results further.

## Oral Presentations

### OP-AP19 Training and Testing V - Hyrox, CrossFit and Rowing

**HYROX© - PHYSIOLOGICAL DEMANDS AND PERFORMANCE PREDICTORS OF A NOVEL HIGH INTENSITY FUNCTIONAL FITNESS TREND**

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INTRODUCTION: Hyrox© is a fitness modality combining 8 functional exercises with running in a comprehensive competition format. Within this first scientific study on Hyrox©, acute physiological responses, relative perceived exertion (RPE), and possible performance determinants were assessed during a simulated Hyrox© competition to derive training recommendations and potential practical applications.

METHODS: Eleven recreational Hyrox© athletes (27 % women, Hyrox© experience (median (interquartile range): 18 (19) months) participated. In a pre-test, height, body composition, hand grip strength (HGS), maximum oxygen consumption (VO2max), and volume of resistance and endurance training were assessed. After 48 hours rest, a simulated Hyrox© was conducted according to the competition-standards of the "Individual Open Division". Heart rate (HR) was tracked throughout the Hyrox©. Blood lactate (BL) and RPE were recorded at the beginning and after each run and exercise station. Differences between runs and exercise stations for HR, BL, and RPE were analyzed via Wilcoxon signed rank test. Spearmans rank correlation test was conducted to identify associations between completion times (Hyrox©, runs, exercise stations) and participant characteristics. Values are given as median (interquartile range).

RESULTS: Completion time of the Hyrox© was 86.5 (14.5) minutes, whereby runs (51.2 (14.1) minutes) were significantly longer than the exercise stations (32.8 (6.1) minutes) ($p = .003$). Most of the Hyrox© was performed at very hard and hard intensities (79.5 (21) % and 19.6 (20.7) %) of maximum HR). Maximum BL was higher during the exercise stations (8.5 (5.4) mmol/L) compared to the runs (7.7 (4.6) mmol/L) ($p = .006$). Similar results were found for maximum RPE (exercise stations: 18 (2), runs: 16 (2), $p = .003$). The highest values for HR, BL, and RPE occurred during the last exercise (wall balls). The exercise stations with the heaviest loads were completed the fastest (sled push: 128 (34) seconds, sled pull: 155 (38) seconds). Faster Hyrox© completion correlated significantly with higher VO2max ($p = .01$), greater endurance training volume ($p=.04$), and lower body fat percentage ($p = .03$).

CONCLUSION: Hyrox© is a HIFT modality with an emphasis on endurance capacity and moderate to low requirements in terms of maximum strength, coordination, and mobility when compared to other forms HIFT. Hyrox© may be suitable for health promotion and tactical population training.

**THE LONGITUDINAL IMPACT OF CROSSFIT ON STUDENTS GOAL-SETTING, RESILIENCE, AND ACADEMIC SUCCESS: A THREE-SEMESTER STUDY**

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*POLITECNICO DI MILANO*

INTRODUCTION: CrossFit, a dynamic fitness program, significantly impacts students physical health, psychological well-being, and academic performance. By enhancing essential qualities like goal-setting, self-awareness, and resilience, CrossFit provides students with the tools to overcome challenges in both physical and academic areas, supporting their overall development. This study, part of the Leonardo project at Politecnico di Milano, explores the intersection of physical fitness and academic success, investigating how CrossFit can help students improve their academic performance while fostering personal growth.

METHODS: To assess the longitudinal impact of CrossFit on students goal-setting and self-awareness over time, we conducted a study spanning three semesters, involving an experimental group and a control group. The experimental group participated in CrossFit three times a week throughout the semester, while the control group maintained their usual activities. The impact of CrossFit was measured using validated psychological questionnaires that assessed students psychological resilience, stress management, and coping strategies. Additionally, academic goal-setting behaviors were evaluated through questionnaires designed to gauge how realistic and attainable students were in setting their academic objectives.

At a statistical level, we implemented statistical tests to compare the results of the two groups. These analyses allowed us to examine the relationships between participation in CrossFit and changes in psychological resilience, stress management, and goal-setting behaviors. By comparing the outcomes between the experimental and control groups, we could assess whether the CrossFit program had a significant impact on students ability to set realistic academic goals and manage the psychological challenges associated with academic life. The threshold for statistical significance was set at 0.05, and we used this criterion to evaluate the results of our tests.

RESULTS: The results indicated that students in the experimental group demonstrated improved psychological resilience, which was reflected in their ability to manage academic challenges such as exams. These students showed a higher degree of realism in setting achievable targets. They also exhibited better stress management and coping strategies.

The statistical tests showed that the differences between the experimental and control groups were significant, with p-values significantly below the significance level, indicating that the improvements observed in the experimental group were significant.

CONCLUSION: Incorporating CrossFit into the academic experience provides students with a powerful framework for developing essential skills such as goal-setting, resilience, and self-awareness. The study demonstrates that physical training through CrossFit can complement academic growth by helping students refine their goal-setting abilities and become more resilient to challenges.

**PERFORMANCE PREDICTION AND ATHLETE CATEGORIZATION USING THE ANAEROBIC POWER RESERVE FRAMEWORK IN ROWING**

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INTRODUCTION: With the rowing distance reduced to 1500 m for the 2028 Olympic games, the anaerobic power reserve (APR) framework [1] has been proposed to evaluate anaerobic performance and differentiate physiological profiles [2]. This study investigated performance predictions and athlete profiles using the APR framework and related physical performance measures.

METHODS: Thirty-one female (simulated 2000m performance (P2k) = 285.1 ± 36.0 W) and 63 male (P2k = 422.8 ± 62.2 W) German rowers competing at a national level or higher (53 highly trained [Tier 3], 21 elite [Tier 4], and 20 world-class athletes [Tier 5]) [3] completed tests for maximal oxygen uptake (VO2max), maximal lactate accumulation rate (cLamax), peak power output (PPO), power output at VO2max (MAP), 2 mmol·L$^{-1}$ (P2) and 4 mmol·L$^{-1}$ blood lactate (P4), and P2k. Backwards stepwise regression models and commonality analyses were used to predict P2k and assess the contribution of each predictor, while k-means clustering based on the power reserve ratio (PRR = PPO·MAP$^{-1}$) identified athlete subgroups.

RESULTS: For P2k prediction, P4, PPO, and VO2max in females (P2k [W] = 22.42186 + 0.7254·P4 [W] + 0.09277·PPO [W] + 16.10299·VO2max [L·min-1] + ε, R2 = 0.91, SEE = 11 W), and P4, MAP, and PPO in males (P2k [W] = 15.95316 + 0.64991·P4 [W] + 0.24085·MAP [W] + 0.11641·PPO [L·min-1] + ε, R2 = 0.94, SEE = 16 W) showed excellent model fits. Commonality analyses revealed ~90% shared variance contributions among predictors. K-means clustering identified sprint-type (females: PRR ≥1.52; males: PRR ≥1.66) and endurance-type rowers (females: PRR ≤1.43; males: PRR ≤1.62) along the PRR continuum. Male rowers identified as sprint-type showed statistically significant higher PPO (845.4 ± 102.8 vs. 686.8 ± 142.6 W, $p < 0.001$) and cLamax (0.45 ± 0.10 vs. 0.35 ± 0.11 mmol·L-1·s-1, $p < 0.001$), while exhibiting a lower VO2max (60.4 ± 5.2 vs. 69.4 ± 7.0 ml·kg-1·min-1, $p < 0.001$) compared to endurance-type athletes. In females, sprint-type athletes showed statistically significant higher PPO (474.8 ± 28.7 vs. 431.6 ± 68.4 W, $p = 0.020$) and cLamax (0.31 ± 0.05 vs. 0.24 ± 0.07 mmol·L-1·s-1, $p = 0.006$), while exhibiting a lower VO2max (50.9 ± 5.7 vs. 55.8 ± 4.6 ml·kg-1·min-1, $p = 0.013$) and MAP (290.5 ± 27.5 vs. 337.8 ± 51.3 W, $p = 0.002$) compared to endurance-type athletes. Interestingly, in both sexes, world class performance was identified in both clusters.

CONCLUSION: Key predictors of P2k highlight the interplay between the aerobic and anaerobic energy systems. Moreover, the identification of distinct sprint- and endurance-type clusters underscores the physiological diversity within highly trained rowers, even among athletes with similar performance outcomes. Longitudinal PRR assessments may support talent identification and facilitate individualized training strategies.

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**PREDICTING THE RATE OF PERCEIVED EXERTION IN ROWING: ENHANCING TRAINING MONITORING AND FATIGUE DETECTION.**

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INTRODUCTION: The Rating of Perceived Exertion (RPE) is a widely used metric in sports science and an accepted measure of internal load in athletes. RPE is closely related to other internal load variables (e.g., heart rate (HR)) and external load (e.g., mechanical power output (watt)). This allowed us to develop a regression model giving an expected RPE for national elite-level rowers solely based on external load features that a coach can know and influence before a session.

Assuming sufficient reliability of the models opens the possibility of predicting an expected RPE based on other training variables. A subsequent analysis comparing predicted and reported RPE enables valuable interpretations of shifts in training status and athlete performance, i.e., a higher reported RPE suggests a decline in an athlete's performance.

METHODS: 2,160 ergometer training sessions from 20 female and 11 male rowers were considered. We used mean power output, duration, and training type as features in our model. Rowing experts have refined the features to ensure the model captures more detailed shifts in the underlying relationships. Finally, to avoid bias through non-exercise-related effects, we excluded particularly good or bad days based on self-reported well-being for training the model.

We selected the best-fitting regression from an ensemble of models for every new data point to make reliable predictions on an individual level. Based on the data, we determined a 95% confidence interval (CI) for the prediction accuracy of 1.16 au.

We also analyzed which factors had the largest influence on the prediction using Gradient Boosting machine learning models in Python.

RESULTS: This study is the first to predict RPE in rowing. Our ensemble method identified training sessions where the actual RPE fell outside the confidence interval for 71% of the athletes, indicating a shift in training status on those days.

Regarding predictive power, our method achieved an RMSE of 0.81 RPE units and an MAE of 0.62 RPE units across the entire dataset. Notably, our approach outperforms more complex models from various sports disciplines by 5-64%.

The feature importance analysis showed that for 84% of the athletes, power output had the biggest impact. For the rest, the session duration or type played a more substantial role.

CONCLUSION: Navigating the complexities of sports-tracking data poses considerable challenges; thus, leveraging domain-expert insights is crucial in developing robust models. Their contributions have led our models to outperform numerous more complex machine learning alternatives in accuracy and practical application.

Further, we show that most athletes correctly understand RPE as a measure of intensity rather than duration.

This research connects sports with applied data science by categorizing training status as decreasing, stable, or improving. Integrating insights on training status with individual factors influencing RPE, we deliver a scalable, interpretable, and actionable tool for practitioners.

**THE RESEARCH ON PACING CHARACTERISTICS OF WOMENS QUADRUPLE SCULLS AT TOP INTERNATIONAL REGATTAS**

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INTRODUCTION: As a competitive sport, rowing requires athletes to distribute their energy effectively throughout the race. The pacing characteristics exhibited by athletes during the race, which reflect how energy is allocated, have a significant impact on the final results. This study aims to investigate the pacing characteristics of world-class rowing events and explore their influence on final performance, with the goal of enhancing rowing outcomes.

METHODS: The data for this study were sourced from www.worldrowing.com, analyzing the race time data for each 500m segment from all teams in the A-finals of the Womens Four-Person Double Sculls (W4+) event at the Olympic Games and World Championships from 2013 to 2024. The analysis compared the 500m segment times, speed variations, and the coefficient of variation (CV) of normalized speeds, as well as the sum of relative differences, between the medalist groups (1st to 3rd place) and non-medalist groups (4th to 6th place). A t-test was used to explore differences between medalists and non-medalists, and Pearson correlation analysis was conducted to examine the relationship between speed metrics and final performance.

RESULTS: (1)Over the past decade, the primary pacing strategies used by teams in the finals were Reverse J-shaped, J-shaped, Fast start and fade, and Other. The medalist teams predominantly employed the Reverse J-shaped strategy, while non-medalist teams were more likely to use the Fast start and fade strategy. Since 2017, higher-ranked teams have increasingly adopted the Reverse J-shaped pacing strategy.(2)In terms of pacing stability, medalist boats (CV=1.96%) demonstrated greater stability than non-medalist boats (CV=2.10%), though the difference was not statistically significant (t=-0.83, p=0.41). Furthermore, after 2018, there was a significant improvement in pacing stability among athletes (p=0.00404).(3)In terms of speed across race segments, the correlation between speed and total time was negative for each segment: the start phase (r=-0.94), the middle phase (r=-0.97), and the sprint phase (r=-0.90). This suggests that faster speeds (shorter times) are associated with better overall performance.(4)Regarding speed variation, the correlation was negative for the start phase (r=-0.43) and positive for the sprint phase (r=0.43), indicating that faster speeds in the start phase lead to shorter total race times, and that accelerating in the sprint phase contributes to improved overall performance.

CONCLUSION: This study highlights the importance of pacing strategies in the Womens Four-Person Double Sculls. The findings offer practical insights for coaches to optimize pacing stability and speed management, helping athletes effectively distribute energy throughout the race for better performance.

Oral Presentations

OP-MH11 Mental Disabilities

**UNRAVELING THE DOSE-DEPENDENT LINK BETWEEN MOTOR COMPETENCE AND PHYSICAL FITNESS TRAJECTORIES IN YOUTH WITH INTELLECTUAL DISABILITIES**

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INTRODUCTION: Intellectual disability is the most common disability among children and adolescents, typically associated with lower physical fitness (PF) and delayed fundamental movement skills (FMS) [1-2]. Improvement in FMS plays a crucial role in supporting PF development [3]. However, existing research primarily focuses on the linear correlation between physical activity and FMS [4] or specific characteristics of children with intellectual disabilities [5]. We hypothesize that PF is associated with FMS levels in a dose-response relationship in this population.

METHODS: FMS was assessed using the Test of Gross Motor Development, 3rd Edition (TGMD-3). PF indicators included body mass index (BMI), cardiopulmonary function, muscular strength and endurance, speed and agility, balance, and flexibility. Logistic regression and segmented linear regression analyses were performed using R (4.4.0) to explore the relationship between FMS and PF.

RESULTS: A total of 191 participants (135 boys and 56 girls) aged 7–18 years were included in the study. Regression analysis indicated a significant positive correlation between FMS and PF. Across all age groups, object control skills showed a slightly stronger correlation with PF compared to locomotor skills. After adjusting for age, regression analysis demonstrated a dose-response relationship between FMS and PF, where higher FMS levels corresponded to better PF levels (trend test, $P < 0.001$). Further threshold analysis identified a significant nonlinear relationship between FMS and PF, with inflection points of 17 and 27 observed in boys and the total sample, respectively ($P < 0.001$). This suggests that the impact of FMS on PF varies significantly across different threshold levels ($P < 0.001$). However, no similar nonlinear relationship was observed in girls.

CONCLUSION: Age-stratified analysis revealed fluctuations in the correlation between FMS and PF, with the strongest effect observed during adolescence. After adjusting for age, a clear dose-response relationship between FMS and PF was identified, with a nonlinear trend at specific FMS thresholds. These findings underscore the importance of designing individualized physical activity intervention strategies that consider gender differences to enhance motor skills and overall physical fitness, particularly in the intellectual disabilities.

**COMPARISON OF COGNITIVE AND PHYSICAL ABILITIES IN AUTISTIC AND NON-AUTISTIC CHILDREN**

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*UNIVERSITÉ MARIE ET LOUIS PASTER*

INTRODUCTION: Autism is characterized by atypical cognitive and motor development [1]. While research generally explores these domains separately, few studies have directly compared physical and cognitive performances in autistic (AC) and non-autistic children (NAC) [2, 3]. This study aims to investigate potential differences between these groups across physical, sensorimotor and cognitive tasks, providing insights into potential intervention strategies.

METHODS: A total of 41 children (19 AC and 22 NAC; matched for age: 14.5 ± 4.02 years old) participated in this study. Physical performance was assessed using the Handgrip Strength Test, 200-Meter Fast Walking Test, and Standing Broad Jump. Sensorimotor abilities were measured with a Fitts Task (speed-accuracy trade-off), and a Mental Rotation Test (spatial cognition). Cognitive aptitudes were tested by using the Bells Test (visual attention), Go-NoGo Test (inhibitory control), and Trail Making Test (cognitive flexibility). Statistical analyses were conducted to compare group performances.

RESULTS: Our results revealed significant differences between AC and NAC in all physical variables. Autistic children performed worse than their non-autistic peers in the Handgrip Strength Test, Standing Broad Jump, and 200-Meter Walking Test. In sensorimotor tasks, AC exhibited longer movement durations than NAC in the Fitts' Task and longer reaction times in the Mental Rotation Task. Finally, NAC outperformed AC in the Go-NoGo and Trail Making Tests, although performance in the Bells Test was similar across groups.

CONCLUSION: The results indicate that AC may experience both motor and cognitive difficulties compared to their non-autistic peers. Specifically, our data highlight impairments in overall physical fitness, motor planning and control, as well as executive functions. However, it is noteworthy that visual attention performance was similar between groups. Understanding these differences is crucial for developing targeted interventions that combine both motor and cognitive training. Future studies should investigate the effects of integrated cognitive-motor programs to improve the overall functioning of children with autism.

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**RELIABILITY OF THE SPORT-SPECIFIC TEST FOR IN INTELLECTUALLY IMPAIRED PARA-KARATE ATHLETES**

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INTRODUCTION: Para-karate has emerged as a competitive sport for athletes with intellectual impairments (II) and Down Syndrome (DS), supported by classification systems to ensure fair participation. Following the re-inclusion of II athletes in the Paralympics (London 2012), the IPC mandated evidence-based classification systems to enhance fairness in competition. To support the WKF's goal of including para-karate in the Paralympic program, this study aimed to develop reliable kata memory-specific tests to assess memory determinants in para-karate.

METHODS: The study included 41 para-karate kata athletes with II or II and DS, who participated in the WKF World Championships in Budapest 2023. Assessments took place before the competition, on a 6x6m Tatami Mat, recorded from three perspectives. Athletes practiced a karate sequence three times before performing it independently. Performance was evaluated on: (1) correct execution of movements according to the original pattern, (2) correct direction of movements, (3) errors involving incorrect limb use (-0.5 per error), and (4) hesitations disrupting flow (-0.5 per hesitation). Kata memory scores were calculated as the sum of correctly executed and directed movements, with penalties for errors.

To assess intra-rater reliability, performances were evaluated by the same observer via video analysis with a one-week interval. Statistical analysis included Cohen's Kappa for ordinal data and the Wilcoxon T-test to evaluate differences, with significance set at $p < 0.05$ was conducted.

RESULTS: Descriptive analysis showed a mean kata memory test score of 8.75 ± 1.1 in the first assessment and 8.80 ± 1.0 in the retest, with scores ranging from 5 to 10 across participants. It indicates minimal variability, underscoring the tests reliability in assessing kata memory performance. The consistency of scoring across different time points supports the potential for its inclusion in official classification processes.

A Kappa value of 0.98 indicated almost perfect agreement between test and retest evaluations, demonstrating exceptional intra-rater reliability. No significant differences were found between test and retest evaluations ($p > 0.05$), supporting the consistency of the specific memory test.

CONCLUSION: The developed test demonstrates high reliability for assessing memory determinants in para-karate athletes with II or DS. These findings highlight the robustness of the test, suggesting it could play a vital role in standardizing classification systems for para-karate.

Future research should focus on validating the test across a broader population and exploring its sensitivity to subtle differences in cognitive performance, ensuring its applicability in diverse competitive environments. This will further enhance the fairness and transparency of para-karate classification processes.

The study was supported by the Ministry of Education, Science, Research, and Sport of the Slovak Republic, VEGA project no. 1/0611/23.

**EFFICACY OF A SLOW WALTZ-BASED PROGRAM ON GAIT AND BALANCE PROBLEMS IN PARKINSON'S DISEASE**

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INTRODUCTION: Parkinson's disease (PD) is a progressive neurodegenerative disorder characterized by motor impairments such as tremor, rigidity, bradykinesia and postural instability which significantly impair daily functioning and quality of life1. While pharmacological treatments primarily address motor symptoms, non-pharmacological therapies like exercise have gained recognition for their potential to improve motor function, mobility and mental health2. Among various form of physical activities, studies reported that dance positively influences motor functions in Parkinson's disease3. The primary aim of this study was to examine whether an adapted waltz-based program could improve gait and balance in patients with PD.

METHODS: The project involved 12 subjects (age 72±9 yrs; MMSE score ≥24; H&Y stages 1-4; ability to stand unaided). Participants attended 8 sessions of slow waltz and basic technique exercises at home for 8 weeks. Assessments were conducted at the beginning (T0) and at the end of the program (T1) using Body Sway test, Gait analysis, Stepping in place and Timed Up and Go (TUG) tests.

RESULTS: Data are expressed as median and interquartile range (IQR) and compared using Mann-Whitney test in 9 out of 12 participants. Results showed that Mean distance A/P (T0:3,9±5 vs T1:3,4±3,4 mm), Mean distance M/L (T0:1,5±1 vs T1:0,8±0,8 mm) and Area (T0:158,8±349 vs T1:82,7±109,1 mm2) in Body sway test with opened feet improved during the 8 weeks. The same trend was shown with closed feet in Mean distance A/P (T0:5,3±2 vs T1:4,8±2,1 mm), Mean distance M/L (T0:4,8±3 vs T1:2,6±3,8 mm) and Area (T0:755±646 vs T1:271,8±476,1 mm2). Parameters of Gait analysis showed an enhancement in Stride time (T0:1,5±0 vs T1:1±0,2 s), Cadence (T0:0,9±1 vs T1:1±0,1 steps/sec), and Velocity (T0:1±0 vs T1:1,1±0,4 m/s), while Stride length (T0:123,4±31 vs T1:113,8±12,1 cm, p=0,001) decreased. Stepping in place test revealed significant improvements in A/P Displacement (T0:1,5±1 vs T1:0,4±1,5 cm, p=0,0077) as well as improvements in R/L Displacement (T0:-0,2±1 vs T1:0,1±0,5 cm) and Area (T0:10,7±9 vs T1:9±10,2 cm2). Lastly, significant positive shifts in performance were observed in the TUG as indicated by the reduced task completion time (T0:13,4±8 vs T1:8,6±2,1 s, p=0,0051) and the increased score in the assessment of biomechanical strategies tool (T0:43±2 vs T1:44±2 score, p=0,018).

CONCLUSION: The data are highly encouraging, indicating that a slow waltz-based program can improve gait and balance in patients with PD. However, a longer experimental period should likely lead to even more marked improvements.

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**COMBINING EXERCISE AND BRAIN STIMULATION FOR MOTOR AND NON-MOTOR SYMPTOMS IN PARKINSON'S DISEASE.**

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INTRODUCTION: Promising results have been reported for the use of intermittent theta-burst transcranial stimulation (iTBS) or exercise training on Parkinsons Disease (PD) symptoms. Moreover, maximal strength training (MST) is showing positive results on locomotor force. However, it is not clear the effectiveness of these 2 treatments on upper limb. With the aim to investigate the efficacy of MST and iTBS in the upper limb symptoms of PD, we have hypothesized that the combination of iTBS with MST can unlock central-mediated neuromuscular limitations and consequently magnify the positive results of the single treatments.

METHODS: 16 patients with PD were randomly assigned to 8-week treatment sessions (3xW) including: a) sham (s-iTBS), inducing any significant effect on the brain. b) iTBS, consisting of brain stimulation at 80% resting motor threshold; for 3 minutes. c) s-iTBS+MST, immediately after s-iTBS stimulation, patients performed MST with lat-machine executed at maximal force mobilization at 90% of 1RM. d) iTBS+MST, was the combination of the iTBS and MST protocols.

PRE-POST assessments following the interventions and PRE assessment for CTRL group of 6 healthy volunteers utilized the following tests:

UPDRS for assessing PD severity, maximal voluntary contraction (MVC) was determined via isometric ergometer. The resting twitch (RT) force was generated using muscle electrical stimuli. Voluntary activation (VA) was determined via the interpolated twitch technique. The cross-sectional area (CSA) of the elbow flexor muscles was measured by ultrasound.

RESULTS: At baseline, MVC normalized for the CSA was 10.5±1.4 Nm/cm2 in the PD group while the CTRL exhibited 20±4% greater force ($p<0.01$). After the training, the MVC for the s-iTBS+MST and iTBS+MST showed significant ($p<0.05$) improvements, with greater results for the latter (+11.2±1.4% and +15.8±1.7%, respectively). At baseline, PD patients exhibited significantly impaired VA (79±3.4%), in comparison to the CTRL (97±2.4%) $p<0.01$. After the training period only the iTBS+MST showed significant improvements in VA (91±2.5% $p<0.05$) in comparison to the s-iTBS (78±2.8%), iTBS (81±3.5%) and s-iTBS+MST (85±3.8%). In PD the RT was significantly reduced before treatments (-18±2.2% $p<0.05$) in comparison to the CTRL but was tempered after the training with iTBS+MST (+13±4.3%). The UPDRS, were lessened for motor symptoms in the s-iTBS+MST (-8.0±2.2%), and (-12.0±2.3%) for iTBS+MST. Significant correlations were retrieved between pre- to post-intervention changes in the UPDRS and both MVC and VA ($r = 0.83$ and 0.78, respectively).

CONCLUSION: The results of the current investigation indicate the efficacy of a program of MST and iTBS in the upper limb motor and non-motor symptoms of PD. Indeed, the combination of iTBS with MST generated a neuroplasticity that unlocked central-mediated neuromuscular limitations and boosted the positive effect of the MST intervention.

## Oral Presentations

### OP-SH04 Sociology II - Gender

**ORTHOREXIA ATHLETICA IN FORMAL AND INFORMAL SPORT: AN EXPLORATION OF DEVIANT BEHAVIOURS AND ATHLETE WELLBEING**

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Orthorexia Athletica (OA) is a relatively new condition that is yet to be formally recognised by the American Psychiatry Association (APA). OA is characterised by the compulsive use and abuse of healthy food and obsessive exercise. This paper reports on research that is directed towards sport and exercise professionals and providers who seek to support individuals to establish and maintain active and healthy lifestyles. As a sociological study, it advances knowledge pertaining to OA by exploring incidence of different behaviours and societal influences in both formal and informal sport; that is, sport participation occurring both within and beyond established sporting structures and organisations.

Using the concept of healthism and Becker's (1963) sequential model of kinds of deviance and recognising its limitations, this paper explores new possible hybrid models of deviant behaviours related to OA and healthism in formal and informal sport. Photo elicitation interviews with vignettes were conducted with nine participants who were regular exercisers. We constructed three different hybrid scenarios from the interview data and the theoretical approach: 1. Anna: The pure secret deviant, 2. John: The enjoyable semi-deviant, and 3. Maria: The healthy critical semi-deviant. These scenarios demonstrate the complexity of OA, particularly in informal sport.

The participants are also shown to be highly reflective and critical in terms of (un)healthy behaviours. They were well informed about (Western) health and they were critical towards health information sources. The definitions of and bounda-

ries between deviant and non-deviant behaviours related to exercise and eating seem to be notably fluid. However, we are now also witnessing these extreme behaviours and extreme self-surveillance being normalised among recreational exercisers and in informal sport participation. This adoption and/or alignment in behaviours points towards arguably interesting social and cultural tensions, in that recreational and/or informal sport contexts are often portrayed as contrasting to the elite and/or formal contexts that the norms have previously been associated with. In this regard our data prompts further exploration of the social and cultural influences shaping behaviours in different sport participation contexts.

This paper demonstrates the need for more evidence-based foundations for targeted educational initiatives that focus on increasing awareness and understanding of eating and exercise disorders amongst key stakeholders, including participants who can be regarded as everyday exercisers. In evidencing the incidence of OA in participants engaging in both formal and informal sport, this research also calls for stakeholder engagement that goes beyond formal sporting structures and organisations.

**BOOSTING SUSTAINABILITY IN FEMALE COACHING: WHAT ORGANISATIONS CAN DO**

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*LUNEX*

INTRODUCTION: Sports governing bodies, national and international policymakers have highlighted the need for greater access and opportunities for female coaches. Despite efforts, female coaches remain underrepresented and struggle with long-term career sustainability. The organisational mindset plays a key factor in retention. It directly shapes operational functioning. Therefore, a shift in mindset is necessary to drive meaningful structural change. This study explored female coaches' perspectives on organisational strategies for improving retention and career sustainability.

METHODS: Forty-four female coaches completed an online questionnaire covering demographics, experience, and organisational strategies to improve retention. Descriptive statistics were used to present the findings.

RESULTS: Results highlight key areas for improving support for female coaches. Top needs include individual support (75%), better hiring practices (65.91%), and equal pay (63.64%). Other priorities are access to coaching courses (59.09%), education for federation stakeholders (47.73%), and support for mothers (45.45%). Policies on sexism (36.36%) and harassment (31.82%), along with diversity education for players (29.55%), were also emphasised.

Discussion: Governance structures and policies impact coaching environment, opportunities, support and are important in addressing systemic barriers for female coaches. This study did not include a description of support, but previous research has highlighted that support must be tailored to each individual's needs and with acknowledgement of both overlapping and unique challenges. HR are key role players who can restructure hiring practices, ensure equal compensation and begin the process of educating and training all organisation employees in factors related to creating safe and welcoming spaces for female coaches. This should be accompanied by practical and relevant policies for safeguarding of female coaches. Opportunities and investment of upskilling of female coaches also require attention. Additional training costs can often hinder female coaches continued professional development. Support for coaches who are mothers reflects the broader societal challenge of balancing professional and caregiving responsibilities. Implementing family-friendly policies, such as flexible scheduling and childcare support, could make coaching a more viable and attractive career path. Diversity education for players offers a proactive way to shift cultural norms within teams, fostering respect and inclusion from the ground up. Federations can empower female coaches with the skills and confidence needed to thrive, while also educating decision-makers on the value of gender diversity in coaching roles. Implementing and acting on the identified strategies would ensure a comprehensive support system, increase career sustainability, valuing their expertise while simultaneously addressing structural barriers that hinder long-term retention.

**RESEARCH ON SPORTS AND LEISURE ACTIVITY EXPERIENCES OF IMMIGRANTS AND REFUGEES IN MONTREAL, CANADA**

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Research on Sports and Leisure Activity Experiences of Immigrants and Refugees in Montreal, Canada

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INTRODUCTION: Turkey currently hosts over 3.7 million refugees, making it one of the countries with the highest number of refugees globally [1] .It was argued that migration is a social phenomenon that has significant effects on the social structures, economies, and cultures of nations, causing major changes in society [2] Recent research indicates that participation in sports activities positively impacts the integration and peaceful coexistence of migrants and refugees in their newly resettled countries [3]. Canada has been accepting immigrants for many years and has implemented sports and recreation programs to aid in the integration of refugees and immigrants into society. Therefore, we aim to investigate individuals participating in leisure and sport activities could provide insight into their effectiveness in addressing the problems caused by Turkeys large migration flow.

METHODS: 16 refugees/immigrants living in Montreal from various countries including Afghanistan, Bangladesh, Belarus, Denmark, Ghana, Iran, India, Mexico, Nigeria, Syria, and United States of America took part in semi-structured interviews.

All participants were older than 18 years old and participating different sports and leisure activities in Montreal. Thematic analysis was used for data analysis.

RESULTS: The findings showed that there were three main themes: Lack of Time and Money to Attend Leisure and Sport Activities in Montreal, including the themes, paperwork for permanent residency, settling down, job search, cold weather. Feelings of Marginalization by Newcomers, including the themes, not feeling welcomed generally by locals, feeling more comfortable around racialized people, language barrier makes it difficult to communicate. Merging the French Courses with Leisure and Sports Activities.

CONCLUSION: The study reveals key challenges newcomers in Montreal face in leisure and sports, mainly due to time, financial constraints, and harsh winters. They feel unwelcome and alienated, often finding support within racialized communities due to language barriers. A solution could be combining language courses with leisure activities for better social interaction. Adapting this model in Turkey might involve incorporating cultural activities to create inclusive environments, easing newcomers social and economic burdens and aiding their integration.

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Note: This research study has been reviewed by the McGill University Research Ethics Board (REB protocol number 24-03-076) and is funded by Scientific and Technological Research Institution of Turkey

**EXPERIENCES OF INCLUSION AND ACCESSIBILITY OF RECREATION CENTRES AMONG THE LGBTQIA+ COMMUNITY**

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INTRODUCTION: The substantial health and wellbeing benefits of physical activity participation are well established, and global physical activity guidelines have been developed that align with attaining these benefits. However, individuals identifying as lesbian, gay, bisexual, transgender, queer, intersex, asexual, and other diverse (LGBTQIA+) are more likely to be insufficiently active and have poorer health compared to their counterparts. Recreation centres offer physical activity opportunities but are under-utilised by LGBTQIA+ persons, who may disproportionately face barriers to using these settings. Little is known about LGBTQIA+ individuals' recreation centre experiences and perceived strategies for improving the inclusion and accessibility of recreation settings to enhance access to physical activity opportunities. This study sought to explore recreation centre experiences of LGBTQIA+ individuals and strategies for enhancing inclusion and accessibility.

METHODS: Nineteen qualitative interviews were conducted with adults (68% aged <35 years) who identified as LGBTQIA+ and who were employees, regular visitors, or residents of a Melbourne municipality. An interview schedule with questions based on an adapted version of the 7 Pillars of Inclusion framework was used to conduct the interviews. Participants were asked about their views on using three recreation centres but were not required to have had previous experience at these centres and could be current or previous users of recreation centres elsewhere. Interviews were audio-recorded, transcribed verbatim, and analysed using content analysis.

RESULTS: The key themes spanned providing accessible and inclusive facilities, tailored programs, accessible communications (e.g., marketing materials personalised to LGBTQIA+ community), welcoming centre culture for all users, and partnerships with organisations affiliated with LGBTQIA+ community. Although most participants mainly had positive experiences with the recreation centres' programs and facilities, they identified accessibility barriers (e.g., inaccessible changing rooms, lack of privacy) and offered recommendations for improvement (e.g., offering classes tailored to LGBTQIA+ community, gender-neutral changing facilities, private cubicles) of recreation centres generally. Participants also recommended having events for the LGBTQIA+ community and their allies, staff training on inclusion, displaying rainbow signage, using inclusive language, and an ongoing commitment to LGBTQIA+ inclusion.

CONCLUSION: This research adds essential knowledge regarding LGBTQIA+ individuals' experiences of recreation centres and provides actionable recommendations for improving inclusion and accessibility in recreational settings. These results may be applicable to other recreation and physical activity contexts (e.g., sport, physical education) and may potentially improve physical activity and health outcomes among the LGBTQIA+ community.

**NAVIGATING THE CHALLENGES OF EXTREME SPORTS FANDOM IN CHINA: AN ANALYSIS OF DISTORTED PRACTICES AND GOVERNANCE STRATEGIES**

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INTRODUCTION: Sports fandom plays a critical role in the sports ecosystem, fostering community engagement, enhancing athlete visibility, and contributing to the commercialization of the industry. However, in recent years, a phenomenon known as sports fanquan (饭圈) has emerged in China, representing an extreme and irrational form of sports fandom that has developed alongside the growth of the internet. Characterized by online conflicts, privacy invasions, and irrational behavior, sports fanquan has led to negative incidents and increasing societal concern. This study explores the characteristics of sports fanquan, investigates its underlying causes, and proposes governance strategies.

METHODS: This study adopts a qualitative approach, combining in-depth interviews and participant observation. Interviews were conducted with 16 sports fanquan members from table tennis and diving, as these two sports are particularly

prone to the sports fanquan, each lasting between 20 and 50 minutes. Additionally, a six-month participant observation was carried out on 30 highly active sports fanquan social media accounts on platforms such as Sina Weibo and Red Note, where fan engagement is particularly intense.

RESULTS: Findings indicate that sports fanquan is rooted in excessive personal idolization, displaying exclusivity and irrational behavior. Unlike traditional sports fans, who focus on athletic performance, sports fanquan members prioritize athletes' private lives, interpersonal relationships, and emotional affairs, showing limited interest in sports competitions or participation in physical activities.

Several factors contribute to the emergence of sports fanquan. First, Chinas emphasis on elite sports has heightened athlete visibility, increasing public interest. Second, athletes' marketable images and physical appeal have attracted commercial investment, leading to their portrayal as entertainment celebrities. Third, sports journalism and social media have increasingly shifted towards entertainment-focused narratives. Lastly, widespread societal anxiety has led to athletes becoming emotional focal points for public identification and attachment.

Discussion: Addressing sports fanquan issue requires a dual governance approach: regulatory enforcement and cultural intervention. Strict administrative measures, legal frameworks, and platform monitoring are necessary to curb the excessive influence of sports fanquan. Meanwhile, mainstream media and athlete communication can help reshape fandom culture by promoting rational and constructive support. Establishing a collaborative governance network—led by sports authorities and supported by media, social platforms, and academic institutions—will be crucial in mitigating sports fanquan's negative impact. While regulatory measures offer immediate containment, sustainable solutions require a long-term cultural shift through media influence, education, and responsible athlete engagement.

## Oral Presentations

### OP-SH15 Physical Education II

**THE EFFECT OF COGNITIVELY ENRICHED SHOTOKAN KARATE TASKS ON CHILDRENS WORKING MEMORY PERFORMANCE: A RANDOMIZED CROSSOVER CLINICAL TRIAL**

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INTRODUCTION: Shotokan Karate (SK) is a martial art originally conceived to promote holistic (i.e. motor, affective and cognitive) human development. Cognitively enriched SK tasks may enhance executive functions (EFs), improving goal-directed behaviors, and transferring them to life skills [1] . However, scientific support for EFs parameters manipulation is scarce [2]. This study compared the effects of distinct parameters manipulation to cognitively enrich SK tasks on performance of a particular EF domain –working memory (WM).

METHODS: Twenty-four neurotypical children (11 girls; mean age: 9.73 ± 1.27 years), with at least two years of practice of SK took part in three trials (AE – addition of elements; AS – alteration of sequences; CO – control condition). In each trial, they individually performed twelve bouts of the kata – i.e. a sequence of 21 blocks of SK techniques – manipulated according to AE and AS cognitive enrichment parameters focused on WM. The WM was ecologically assessed with the Behavior Rating Inventory of Executive Function (BRIEF). Acute effects of enriched tasks on WM were assessed with pre- and post-trials performance in the Corsi Block test. Real-time evaluation of WM demands of SK's enriched tasks was analyzed through notational analysis, assessing executive errors such as intra- and inter-block errors, omissions/additions, and buffer episodes. Data notation occurred on four time points - bouts one (time 1), six (time 2), seven (time 3) and twelve (time 4) - of the 12 katas' executions. A single observer (sports scientist, black belt SK coach) collected all data (reliability assessment - Cohen's Kappa: 1.0). Generalized Estimating Equations (Tukey adjusted post-hoc) were used to compare WM performance within and between trials (alpha = 0.05).

RESULTS: BRIEF scores were within acceptable range: WM Scale (54.39 ± 9.07), Metacognition Index (55.43 ± 10.46), and Global Executive Composite (54.52 ± 8.98). Corsi Block accuracy did not change across conditions (negative time effect, $p < 0.05$). WM manipulation during kata in AE, AS, and CO trials presented significant interactions among conditions, times, and error types ($p < 0.05$): i) AS had a lower performance than AE in time 1 for intra-block errors and buffers; ii) In AE, intra-block errors increased from times 1 to 3; iii) In AE, buffers increased from times 1 and 3-4, 2 and 3-4.

Discussion: This study cognitively enriched SK's tasks with precise dose parameters. A main time effect in Corsi Block test indicated a general WM decline after trials. Enrichment strategies (AE and AS) differed in cognitive demands as indicated by error types and increment rates, particularly from time 1 to 3-4 since cognitive demands progressively increased [2]. Evidences should contribute to parameterization of cognitively enriched sportive tasks design by coaches and on-task performance evaluation approaches.

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**ORIGINAL PE CRITERIA-BASED TESTS BATTERY FOR THE ASSESSMENT OF K-8 STUDENTS' FUNDAMENTAL MOTOR SKILLS: VALIDATION PROCESS AND INTEGRATION INTO THE PEDAGOGICAL ASSESSMENT-TEACHING-LEARNING SEQUENCES**

IANCU, H., PICARD, Y., RICHARD, J.F., BÉLANGER, M., RICHARD, J., SAVOIE, R., HEBERT, P.A., CORMIER, B.
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Introduction: A key role of quality school physical education (PE) is to enable children to learn and control motor skills. The assessment of fundamental motor skills (FMS) therefore becomes essential. Limitations of existing measurement tools include being designed exclusively for clinical and sport contexts, having age restrictions (3 - 10 years old) and not emphasizing, as much as it should, the pedagogical purposes of PE learnings. Accordingly, we developed an original battery of 25 representative tests for the evaluation of students fundamental psychomotor (13) and sociomotor (4) skills.

Objective: To assess the feasibility, validity and reliability of the battery's 25 FMS tests.

Methods: Following established standards of the psychomotor domain's tests development, we identified the skills to be assessed, developed assessment parameters by focusing on the performance's execution process (quality) rather than the product (quantity), and determined the tests procedures. Extensive testing took place in 9 schools (n = 4706 students, 5 to 14 years old). Each test was administered to targeted age groups students (in the last grade level of each learning cycle K-2, 3-5 and 6-8) to assess the test's feasibility, content validity and to refine evaluation parameters. This process was repeated following modifications of testing procedures aimed at improving psychometric properties. Inter-rater reliability and construct validity (more precisely, concomitant validity) were assessed with Kendall's W tests, Pearsons chi-squared and Kappa statistics, and Cramers V symmetric measurements.

Results: After the first test administration and the first feedback from PE teachers on test parameters, we modified instructions to improve clarity and adjusted the estimated time of administration for some tests of certain grade levels and the training of raters. Following the 2nd and 3rd school's visits and modifications of testing procedures, moderate to very good indices of inter-rater reliability (Kendall's W = 0.596-0.935) and construct validity (Pearsons Khi-square $\chi 2$ = 124.732-186.631, likelihood ratio L2 = 120.592-178.090, linear by linear association $\chi 2$ = 78.047-106.214, Cohens Kappa = 0.696-0.798 and Cramers V symmetric = 0.703-0.850) were found for final versions of the tests.

Conclusions: Our study shows that the development of this criteria-based test battery following a rigorous methodological process was complex and time intensive (over 7 years). Nevertheless, the statistical analyses led to an appropriate validity and intra-rater reliability. Also, a process of establishing standardized measuring procedures is already in place. This test battery could become a standard measuring tool for assessing the FMS related to the PE learning outcomes, either for diagnostic, formative or summative purposes, within different assessment-teaching-learning sequences (ATLS) for each learning cycle of the French school curricula in New Brunswick, Canada.

**SYSTEMATIC AUDIT OF EXISTING PROFESSIONAL STANDARDS – SETTING THE SCENE FOR INTERNATIONAL SPORTS SCIENCE STANDARDS**

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Sports scientists are in high demand internationally and employment in the field continues to grow to satisfy the ever-increasing focus within the sporting world on optimising performance. In a number of countries, sports science practice is founded on a set of standards that outline base level knowledge, skills and competencies to define the roles and scope of practice for the profession. Standards additionally guide certification and accreditation frameworks. Despite the practice of sports science having many common features regardless of the country in which it is conveyed, and the workforce being highly internationalised, a harmonised set of international standards does not exist. PURPOSE: To systematically audit the professional standards that underpin a national certification system of the five countries identified through an environmental scan as having existing national certification systems for Sports Scientists. METHODS: The audit process was conducted using a modified scoping review protocol based on the documentation provided by British Association of Sport and Exercise Sciences (BASES), Canadian Society for Exercise Physiology (CSEP), Exercise & Sports Science Australia (ESSA), National Strength and Conditioning Association (NSCA), and Sports and Exercise Science New Zealand (SESNZ). Three reviewers independently extracted data from the standards documents and results were cross checked by relevant experts from each jurisdiction. RESULTS: There was commonality of themes for 43% for all content extracted. The overall coverage of themes was 22%, 27%, 38%, 54% and 76% from UK, US, Australia, NZ and Canada respectively. Two of the five sets of standards relied on a pre requisite foundational exercise science set of professional standards and this, in the US and Australia, accounted for an additional 3% and 38% of the elements respectively. CONCLUSION: There is a common core of themes covered by all current national standards for Sports Science across the five nations audited, but there is variable coverage in the remaining 57%. Whilst in some countries a portion of this can be attributed to a foundational set of exercise science professional standards, these findings are important for understanding the differences in current training and certification of Sports Science professionals, and how this might influence the internationalisation of the profession. It could be proposed that this audit of Sports Science standards sets the foundation for developing an international set of Sports Science professional standards that will promote harmonisation of the profession across jurisdictions.

**DOES SPORTS COMPETENCE INFLUENCE ENJOYMENT IN PHYSICAL ACTIVITY IN PREADOLESCENCES?**

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In the sport and physical activity (PA) field, enjoyment is (Scanlan & Simons, 1992) and it can also be considered an important factor in promoting active lifestyles and regular PA among school-aged children (Carraro, Young, & Robazza, 2008). Although PA enjoyment depends primarily on intrinsic factors, sport competence may influence PA enjoyment (Carroll & Loumidis, 2003). We investigated here the effects of perceived sport competence on PA enjoyment, initially, expecting that perceived sport competence could be predictive of high levels of PA enjoyment. This study was carried out to increase the existing body of knowledge about the relationship between perceived sport competence and enjoyment.

Participants were 794 pupils (403 boys and 391 girls) aged between 12 and 14 years (M = 13.2; SD = .86) and recruited from a randomized number of schools located in a northeastern region of Italy. They completed an Italian version of the Physical Activity Enjoyment Scale (PACES; Carraro et al., 2008) and the Physical Seld-description Questionnaire-Short (PSDQ-S; Marsh, 1996). The Italian version of the PSDQ-S (Scarpa, Gobbi, Paggiaro, & Carraro, 2010) contains five factors of physical self-concept which are used to assess perceived sport competence: endurance, flexibility, strength, coordination, and sport skill.

Questionnaires were completed in groups in the classroom. All respondents and their parents gave their informed consent and were assured that individual data would be kept confidential.

Pearson's correlation test was used to measure the association between variables. Multiple linear regression analysis was conducted to investigate the correlation between PSDQ-S scores (independent variables) and PACES total score (dependent variable). Pearson's correlation test revealed the following positive associations between PSDQ-S variables and PACES total score: endurance ($r = .828$, $p < .0001$); flexibility ($r = .507$, $p < .001$); strength ($r = .665$, $p < .0001$); coordination ($r = .427$, $p < .001$); sport skill ($r = .546$, $p < .001$). Multiple linear regression analysis showed the following score indices: SE = 8.86; $t = 22.81$; $R2 = .455$; $F(1, 794) = 64.13$; $p < .001$. Our results highlighted positive associations between physical self-concept scales and PA enjoyment, and our hypothesis that perceived sport competence can be considered a good predictor of PA enjoyment was confirmed. The results could contribute to our understanding of the processes involved in the promotion of active lifestyles and regular PA among young people.

**THE INFLUENCE OF PHYSICAL EXERCISE ON IDEOLOGICAL AND POLITICAL EDUCATION: A QUANTITATIVE STUDY ON THE EXAMPLE OF BADMINTON PROGRAM**

SUI, X., NAZARUNDIN, M.N., MU, Y., JIANG, S., ZHANG, G., YU, M., MA, T., WU, R.

*THE NATIONAL UNIVERSITY OF MALAYSIA*

Chinese higher education faces the challenge of improving students comprehensive quality, and ideological and political education is an important part of cultivating correct values and moral standards. Meanwhile, the role of physical exercise in students lives has been increasingly emphasized, but its impact on ideological and political education has still not been fully explored. Badminton is a popular sport among Chinese college students, which not only enhances physical fitness but also positively influences students ideological and political literacy through teamwork and sportsmanship. Using a quantitative research design,320 college students were randomly divided into two groups: an experimental group (160 students) and a control group (160 students). The experimental group participated in a 12-week structured badminton training program, while the control group did not participate in any organized sports activities other than their daily activities. Data were collected at four-time points: baseline (T1), immediately after the intervention (T2), and at 2-month (T3) and 4-month (T4) follow-ups using standardized questionnaires, behavioral observation checklists, and learning records. The experimental group received a 12-week badminton training program with two 90-minute sessions per week focusing on basic skills, team training, and competitive play, followed by discussions on sportsmanship and strategic thinking. To assess the impact of the badminton intervention on ideological and political education, a repeated measures analysis of variance (RM-ANOVA) was conducted with group (experimental vs. control) as the between-subjects factor and time (T1, T2, T3, T4) as the within-subjects factor. Repeated-measures analysis of variance (RM-ANOVA) indicated that significant between-group interactions existed for all three ideological outcomes, with associated F-values, p-values, and effect sizes reflecting both statistical significance and practical importance. Post hoc tests indicated that the experimental group showed significant improvements in all outcomes at T2, T3, and T4 compared to T1, while the control group showed no significant change. This study demonstrates the positive and sustainable impact of badminton training on the ideological and political education of university students, highlighting the importance of sport in an integrated educational approach. The findings provide valuable insights for educational policymakers and practitioners, emphasizing the role of physical activity in promoting the holistic development of students. Future research should further explore the mechanisms underlying the relationship between physical activity and ideological and political education, assess the long-term impact of different sports on students development, and explore the potential synergies between physical education and other educational interventions.

## 11:30 - 12:45

Plenary Session

PS-PL02 Mechanisms of Human Skeletal Muscle Hypertrophy: Sorting the Wheat from the Chaff

**MECHANISMS UNDERPINNING HUMAN HYPERTROPHY: FROM APPLICATION TO OMICS**

PHILLIPS, S.

*MCMASTER UNIVERSITY*

Human skeletal muscle hypertrophy is a complex and multi-faceted process primarily driven by mechanical overload facilitated through resistance exercise. This talk will investigate the current understanding of the mechanisms that underpin hypertrophy and strength gain with resistance training (RT). A key focus will be on the role of external factors – protein, resistance training variables, and certain supplements – used in combination with RT to shift the balance towards net protein accretion, leading to hypertrophy and the development of strength.

This talk will also address practical applications, discussing how specific training variables—such as load, frequency, and volume—modulate the hypertrophic response. These variables directly influence intracellular signalling cascades, demonstrating the interaction between applied training methods and the underlying molecular mechanisms. This knowledge is essential for designing optimal training programs for athletes and older adults looking to maintain muscle mass and strength.

This presentation is particularly relevant for the ECSS community, which focuses on improving athletic performance and physical health. Understanding the biological basis of hypertrophy allows for more effective training prescriptions, rehabilitation strategies, and nutritional interventions. It also opens the door for personalized approaches to muscle growth, making it highly applicable to both sports scientists and clinical practitioners.

By combining traditional knowledge with the latest in an understanding of hypertrophy mechanisms, this talk will offer a comprehensive overview of skeletal muscle hypertrophy and strength gains. Attendees will gain a deeper understanding of both the applied and underpinning mechanisms driving muscle growth, bridging the gap between practical training techniques and advanced scientific discovery.

**DON'T FORGET, HYPERTROPHY IS NOT JUST FOR THE BEACH - THE STRUCTURAL AND CELLULAR DRIVERS AND FACILITATORS OF HYPERTROPHY**

MACKEY, A.

*UNIVERSITY OF COPENHAGEN, AND BISPEBJERG HOSPITAL*

In addition to protein turnover measures and OMICS type data, the cellular and structural aspects of the entire muscle-tendon unit are key to understanding the full picture of mechanisms driving skeletal muscle hypertrophy. This talk will build on Professor Phillips' comprehensive coverage of the topic and delve into: 1. Changes in whole muscle architecture 2. Myofibre and myofibril addition 3. The role of muscle damage 4. The key cell types facilitating adaptation and their memories 5. Hypertrophy is not just for the beach Skeletal muscle hypertrophy is defined as increases in the cross-sectional area (CSA) of a single muscle or group of muscles. However, load-induced growth of muscle alters muscle architecture, including pennation angle and muscle length, which necessitate adaptation of the muscle extracellular matrix and its attachment to the tendon for safe and effective transmission of forces. Activity of many cell types is therefore required. Hyperplasia, the addition of myofibres, remains the stuff of legend as a key factor in reaching extreme muscle hypertrophy. This talk will examine the evidence for and against hyperplasia as well as the potential cellular mechanisms facilitating this feat in the adult. Zooming in on individual myofibres, changes in myofibril size and number during hypertrophy will also be considered. Myofibre damage will also be explored – from the point of view of mechanism or consequence of load-driven hypertrophy. As the increased protein synthesis translates into larger myofibres, extra myonuclei are required to sustain further growth. Elegant animal models have shown that satellite cells are the sole source of these new myonuclei, and it is becoming increasingly clear that other cell types in the muscle interact with satellite cells to regulate adaptation of the muscle as a whole. In this context, immune cells, fibroblasts, tenocytes and the motoneurone itself will be considered. Lastly, hypertrophy is not just for the beach. This talk will end by putting hypertrophy into the perspective of healthspan and lifespan. Building muscle mass is possible at any stage of life. However decades of inactivity may lead to accelerated loss of myofibres. Depending on whether new myofibres can be added in the adult state, myofibre loss may be a permanent event and therefore a severe limitation to the capacity to develop hypertrophy later in life and even in midlife. Furthermore, cells remember previous events, so building up "positive memories" by mechanical loading throughout life may provide a valuable resource for rebuilding muscle lost during periods of forced inactivity such as illness or injury. Attendees of this session will be presented with evidence for and against the fundamental mechanisms driving, facilitating and remembering hypertrophy, as well as the broader perspectives for muscle health.

**13:45 - 15:00**

## Oral Presentations

### OP-PN33 Physiology of Fatigue IV

**TRYPTOPHAN METABOLITES AS POTENTIAL MARKERS OF FATIGUE IN PROFESSIONAL FOOTBALL PLAYERS**

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*WROCŁAW UNIVERSITY OF SPORT AND HEALTH SCIENCES, POLAND*

INTRODUCTION: Chronic fatigue can lead to inflammation, resulting in disruptions in tryptophan metabolism [1]. The majority of tryptophan is metabolized via the kynurenine pathway [2]. Increased kynurenine levels, observed under stress conditions, may contribute to mood deterioration and impaired psychophysiological function [1,2], significantly affecting the athletic performance of players. This study explored the potential role of tryptophan metabolites as biomarkers of fatigue in professional athletes.

METHODS: Thirty male professional football players from the highest Polish league participated in the study. Blood samples were collected throughout the season: after transition (P1, P6), preparatory (P2, P7), and competitive periods of the Fall (P3–P5) and Spring Rounds (P8, P9). Tryptophan metabolites – kynurenine (KYN), 3-hydroxykynurenine (3HK), kynurenic acid (KA), xanthurenic acid (XANA), quinolinic acid (QA), picolinic acid (PA), anthranilic acid (AA), and 3-hydroxyanthranilic acid (3HAA) were quantified using liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS). Data normality was assessed with the Shapiro-Wilk test, variance homogeneity with Levene's test, and differences in tryptophan metabolite concentrations between different training periods were analyzed using Welch's t-test.

RESULTS: The study results indicated changes in the levels of pro-inflammatory tryptophan metabolites during the annual training cycle in football players. 3-HK levels were significantly higher during the competitive period compared to the transition period (8.4±3.2 nmol/L – P5 vs. 6.8±2.6 nmol/L – P1; p= 0.04). Similarly, QA reached its highest concentration during the competitive period and its lowest after the transition phase (157.6±57.6 nmol/L – P5 vs. 119.3±31.4 nmol/L – P1; p= 0.006).

Furthermore, changes in the levels of anti-inflammatory tryptophan metabolites were observed throughout the training macrocycle. XANA concentrations were lowest at the end of the competitive period of the Fall Round (13.2±3.69 nmol/L – P5), while AA levels progressively decreased across training periods (94.0±22.6 nmol/L – P1 vs. 29.3±13.8 nmol/L – P9; p< 0.001).

CONCLUSION: In conclusion, the study indicates an increase in pro-inflammatory and a decrease in anti-inflammatory tryptophan metabolites during the competitive period in football players. Elevated 3-HK and QA levels may result from intense physical exertion, contributing to fatigue. Further research is needed to confirm these associations and clarify kynurenine pathway regulation under prolonged physical effort.

This study was funded by the National Science Centre, MINIATURA_7 grant no. 2023/07/X/NZ4/00199.

References

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**THE THRESHOLD OF LOW-INTENSITY ECCENTRIC CONTRACTIONS OF THE ELBOW FLEXORS TO INDUCE MUSCLE DAMAGE**

CHEN, T.1, CHEN, H.L.2, NOSAKA, K.3

*1 NATIONAL TAIWAN NORMAL UNIVERSITY, 2 NATIONAL CHIAYI UNIVERSITY, TAIWAN, 3 EDITH COWAN UNIVERSITY, AUSTRALIA*

INTRODUCTION: An acute bout of 30 low-intensity (10% of maximal voluntary isometric contraction strength: MVC) eccentric contractions of the elbow flexors did not induce significant changes in indirect markers of muscle damage (1). However, lowering a dumbbell of 9% of MVC 1800 times resulted in significant changes in MVC, range of motion (ROM), upper arm circumference, delayed onset muscle soreness (DOMS) and plasma creatine kinase (CK) activity (2). These suggest that low-intensity eccentric contractions (LIECs) still induce muscle damage when the number of the contractions exceeds a certain level. However, the threshold number of contractions to induce muscle damage is unknown. The present study investigated how many LIECs would result in significant changes in muscle damage markers.

METHODS: A pilot study to compare 30, 60, 120, 240, 480 and 960 LIECs using a dumbbell set at 10% MVC at 90o elbow flexion showed that 960 LIECs resulted in significant changes in all muscle damage markers, but no such changes by 30-480 LIECs. Thus, 52 sedentary young men performed a bout of 600, 720, 840 or 960 LIECs (n=13 per group) using their non-dominant arm consisting of many sets of six eccentric contractions per set until the total number reached to 600, 720, 840 or 960. The participants lowered a dumbbell from an elbow flexed (90°) to a fully extended position (0°) in 3 s, and the investigator removed the dumbbell at the extended position and the arm was returned to the flexed position without load. The interval was 10 s between contractions, and 2-min between sets. Changes in maximal voluntary concentric contrac-

tion torque (MVCcon), ROM, DOMS, plasma CK activity, and echo-intensity (EI) were assessed before, immediately after, 1, 2, 3, 4 and 5 days post-exercise. Changes in these variables over time were compared among the groups by a mixed-design of two-way ANOVA.

RESULTS: All variables changed significantly (P<0.05) after 960 LIECs (MVCcon: –14%, ROM: –3% at 1-day post-exercise, peak DOMS: 21 mm in a 100-mm visual analogue scale, peak CK: 786 IU/L, peak EI increase: 10%), but they returned to the baseline by 3-4 days post-exercise. The 600, 720 and 840 LIECs showed a significant decreases in MVCcon and ROM at immediately post-exercise (–10 - –2%), without significant changes in DOMS, CK and EI.

CONCLUSION: These results indicate that the threshold was 960 repetitions, but the magnitude of muscle damage was minor. Considering the fact that 30 maximal-intensity eccentric contractions of the elbow flexors induce large changes in the muscle damage markers (e.g., MVCcon: –49%, ROM: –11%, peak DOMS: 66 mm, peak CK: 6192 IU/L, peak EI increase: 39%) lasting for more than 10 days (3), the muscle damage etiology seems different between low-intensity and high-intensity eccentric contractions.

1. Chen et al. J Sci Med Sports 21:1068-72, 2018.

2. Nosaka et al. Med Sci Sports Exerc 34:920-7, 2002.

3. Chen et al. Appl Physiol Nutr Metab 37:680-9, 2012.

**EXPLORING THE EFFICACY OF SODIUM BICARBONATE SUPPLEMENTATION ON REDUCING MARKERS OF ACUTE KIDNEY INJURY (AKI) DURING PHYSICAL WORK IN THE HEAT**

SIEGLER, J., BUTTERICK, B., FREIRE, R., SPECHT, J., AMORIM, F.

*ARIZONA STATE UNIVERSITY*

INTRODUCTION: Many workers worldwide are exposed to prolonged and hazardous heat stress, physical activity, or a combination of both. Occupations such as mining, farm work, construction, and wildland firefighting involve various physical tasks that impose different degrees of metabolic, ergonomic, and cognitive stress, which can be worsened by adverse environmental conditions. The stress imposed by either the climate or the physical demands of these vocations can be dangerous, potentially limiting human productivity and performance and exacerbating pre-existing conditions like high blood pressure, obesity, and. One organ particularly at risk is the kidney. Numerous studies have documented that prolonged exposure to heat and physical activity can lead to acute kidney injury (AKI). Repeated episodes of AKI induced by such exposure have been linked to chronic kidney disease, particularly chronic kidney disease of unknown origin (CKDu).

Research on effective strategies to reduce the incidence of AKI has explored various approaches, including heat acclimation, hydration and pre-cooling, and adjustments to physical work rates and durations (e.g., increasing rest periods or breaks). A novel and relatively low-cost strategy that has not been widely studied is using sodium bicarbonate (SB) to maintain hydration, and potentially improve exercise tolerance. While SB has traditionally been used in athletic settings to enhance performance, it has also been shown to increase plasma volume and reduce markers of oxidative and inflammatory stress. Given these effects, SB's potential impact on kidney function under prolonged heat stress and physical activity merits further investigation. As such, this pilot study investigated whether SB supplementation could mitigate AKI during moderate-intensity outdoor work in a hot environment.

METHODS: Fourteen healthy adults were randomized into SB or placebo (PLA) groups using a double-blind crossover design. Participants completed two experimental trials, during which they rotated through a circuit of five workstations over two hours. During the circuit, participants were encouraged to maintain a moderate intensity effort (e.g., 11 – 13 RPE (Borg 6 – 20)), and the stations consisted of digging, wheelbarrow pushing, cinderblock carry, and shoveling activities. All work was completed outdoors in the Sonoran Desert during June, with an average wet bulb globe temperature of 34.8°C.

RESULTS: SB supplementation significantly increased blood bicarbonate (mean difference: 4.5 ± 0.7 mmol/L, $p < 0.001$) and base excess (mean difference: 4.5 ± 0.6 meq/L, $p < 0.001$). Core temperature increased slightly with SB compared to PLA (mean difference: 0.2 ± 0.1°C, $p < 0.05$), as did heart rate (mean difference: 9 ± 3 bpm, $p < 0.01$). However, as measured by urine-specific gravity, hydration status and fluid intake did not differ significantly between conditions ($p = 0.72$). No significant differences were found between SB and PLA for kidney stress markers, including IGFBP-RP1 (condition $p = 0.51$; time $p = 0.74$; interaction $p = 0.87$), TIMP-2 (condition $p = 0.13$; time $p = 0.11$; interaction $p = 0.81$), and NGAL (condition $p = 0.64$; time $p = 0.88$; interaction $p = 0.54$).

CONCLUSION: These preliminary findings suggest that while SB improved buffering capacity, there was no influence on markers of kidney injury across the two-hour work session in the heat. This study integrated mitigation strategies (e.g., ensuring hydration, following NIOSH work-to-rest guidelines for working in the heat, etc.) that may be present in a standard work environment which could have contributed to the lack of changes in markers of kidney injury. As multiple factors contribute to the development of AKI, future research should explore the relationship between duration and intensity.

**ROLE OF H+ AND PI IN DEPRESSING CROSS-BRIDGE FUNCTION OF HUMAN SKELETAL MUSCLE AT 15°C AND 30°C: INDIVIDUAL OR SYNERGISTIC EFFECTS?**

ROYER, N., SUNDBERG, C.

*MARQUETTE UNIVERSITY*

INTRODUCTION: Studies on chemically permeabilized muscle fibers have observed that the effects of elevating both hydrogen (H+) and inorganic phosphate (Pi) on force and power are greater than what would be predicted from the sum of

the individual metabolite effects – suggesting that these metabolites contribute to fatigue by acting synergistically to depress cross-bridge function. However, this theory comes from studies on rabbit and rodent muscles where the individual and combined metabolite effects were studied on different fibers from multiple investigators, rather than studying the individual and combined conditions on the same fiber. Moreover, it is unclear whether elevated Pi, or just H+, alters the shortening velocity of the cross-bridge. The aim of this study was to investigate the individual (pH 6.2 vs. 30 mM Pi) and combined (pH 6.2 + 30 mM Pi) effects of elevated H+ and Pi on single muscle fiber force, velocity, and power in adult human skeletal muscle fibers at 15°C and 30°C. The second aim of this study was to investigate the effects of elevated Pi (0, 4, 15, 30 mM) on shortening velocity at 15°C.

METHODS: The contractile mechanics (force, velocity, and power) of muscle fibers (n = 126) isolated from the vastus lateralis of 7 young adults (20-23 yrs, 3 women) were compared under six different conditions of elevated Pi and/or H+ at 15°C. At near physiological temperatures (30°C), 4 different conditions were evaluated on contractile function with elevated Pi and/or H+ (n = 46).

RESULTS: In both temperatures conditions, the depression in maximal isometric force (Po), peak power, and unloaded shortening velocity (Vo) was greatest in the combined pH 6.2 + 30 Pi compared to all the individual metabolite conditions in both slow and fast fibers, except for the Po of slow fibers at 15°C where the combined pH 6.2 + 30 Pi did not differ from the 30 mM Pi condition (p=0.99). There was no evidence that the depressive effects from the combined pH 6.2 + 30 Pi was greater than what would be predicted from the sum of the individual metabolite effects, suggesting that the metabolites do not act synergistically to depress cross-bridge function in human skeletal muscle, at cold or near physiological temperatures. Increasing Pi progressively depressed the Vo of both slow and fast fibers, where the depression in Vo at 30 mM Pi either did not differ or exceeded the depression from elevating H+ alone (pH 6.2).

CONCLUSION: These data suggest that H+ and Pi both individually and collectively are important mediators of skeletal muscle fatigue in humans by directly impairing cross-bridge function, but the combined effects of the metabolites are not synergistic at 15°C or 30°C. We also provide novel evidence that elevated Pi depresses shortening velocity in human skeletal muscle to a similar, or greater, extent than elevated H+.

**INNOVATIVE DOSE-RESPONSE CURVE TO ASSESS THE METABOREFLEX IN HUMANS WITH CONTROL OF INTRAMUSCULAR METABOLIC PERTURBATION**

KOUZKOUZ, N., MALLARD, J., HUCTEAU, E., SCHOTT, R., PIVOT, X., DUCROCQ, G.P., HUREAU, T.J.

*INSTITUTE OF CANCEROLOGY STRASBOURG EUROPE*

INTRODUCTION: The metaboreflex plays a critical role in the cardiovascular adjustments occurring during exercise. While the post-exercise circulatory occlusion technique (PECO) is well-established, studies using this non-invasive methodology do not control for the level of peripheral fatigue and usually investigate only one level of activation of the metaboreflex. The lack of control of peripheral fatigue, which reflects the level of intramuscular metabolic perturbation (1), is a key limitation in studies comparing groups, as exercising at a similar relative intensity does not guarantee identical levels of peripheral fatigue between individuals (and therefore similar levels of metaboreflex activation) (2). Therefore, we designed an innovative test to assess the metaboreflex that provides a dose-response curve while controlling for intramuscular metabolic perturbation.

METHODS: Thirty healthy subjects (15 females) visited the laboratory 3 times to complete a familiarization and 2 experimental visits, which aimed to validate the dose-response metaboreflex test and assess its reproducibility. During each experimental visit, participants executed 4 fatigue tasks (FT) interspersed with 2-min of PECO. Each FT involved a sustained isometric contraction of the quadriceps at 20% of the maximal voluntary contraction (MVC) during 1 min (block 1), 2 min (blocks 2 and 3) and up to task failure (block 4). Peripheral fatigue was assessed throughout the test via the pre-to-post exercise changes in quadriceps twitch force (Qtw). Mean arterial pressure (MAP) was continuously recorded. The dose-response curve was determined by plotting post-PECO peripheral fatigue against the % change in MAP during PECO.

RESULTS: ΔQtw was similar between post-FT and post-PECO (P>0.99), indicating that PECO has successfully maintained exercise-induced intramuscular metabolic perturbation between each FT. Peripheral fatigue and MAP increased progressively across the four blocks (P<0.001), confirming that our test induced four distinct levels of intramuscular metabolic perturbation and graded activation of the metaboreflex. These graded levels were linearly associated, as evidenced by a significant correlation between ΔQtw and ΔMAP (r2=0.976; P=0.01). ΔMAP, ΔQtw values and their associated correlation were not statistically different between visit 1 and visit 2 (P=0.543 and P=0.449; r2=0.944; P=0.02, respectively; Fisher's r-to-Z test: Z = 1.58) and were associated with good to excellent reliability (ICC=0.89 for ΔQtw and ICC=0.78 for ΔMAP).

CONCLUSION: Our test provides a new method to evaluate metaboreflex activation in humans. Through the four graded levels of peripheral fatigue and MAP, we demonstrated a dose-response relationship between intramuscular metabolic perturbation and metaboreflex activation. These findings provide evidence that evaluation of the metaboreflex needs to be reconsidered, in particular when between group comparisons are made.

1. Hureau et al., J Physiol 2022

2. Hureau et al., J Physiol 2021

Oral Presentations

OP-PN34 Carbohydrates

**EFFECTS OF CARBOHYDRATE INGESTION IN ELITE MARATHON RUNNERS: AN EVALUATION OF 60, 90 AND 120 G.H-1 AND IMPACTS ON SUBSTRATE METABOLISM AND GASTROINTESTINAL SYMPTOMS.**

RAVIKANTI, S., SILANG, K., MARTYN, H., LOUIS, J., OWENS, D., BAMPOURAS, T., JONES, A., MORTON, J., PUGH, N.
*LIVERPOOL JOHN MOORES UNIVERSITY*

INTRODUCTION: Carbohydrate (CHO) ingestion during endurance exercise improves performance (1). Peak exogenous CHO oxidation of 1.8 g·min-1 has been shown when 2.0 g·min-1 is ingested during cycling exercise (2). While such intakes were well tolerated in cyclists, the feasibility of 120 g.h-1 during running exercise and at higher exercise intensities is unclear, with both being associated with higher gastrointestinal (GI) symptom prevalence (3). This study investigated the effect of varying CHO doses on exercise metabolism and GI symptoms in elite runners exercising in the heavy intensity domain.

METHODS: In a double-blind, randomised crossover design, 8 male marathon runners (PB 02:22:54 ± 00:05:37) completed three trials after a 24h high CHO (8 g·kg-1) diet and pre-exercise meal (2 g·kg-1). Trials consisted of a 120-min run, with 90 min at 94% of lactate turnpoint, flanked by 15 mins at 95% of lactate threshold. Every 15 minutes, subjects consumed U-13C enriched drinks at rates of 60 (1:0, maltodextrin: fructose), 90 (2:1), or 120 (1:1) $g{\cdot}h^{-1}$. CHO and fat oxidation, blood glucose and lactate, running economy, and GI symptoms were measured. A one-way and two-way repeated-measures ANOVA analysis was used for peak exogenous CHO oxidation and time and trial differences, respectively, followed by Bonferroni post hoc analysis. Significance was set at $P<0.05$.

RESULTS: There was a significant main effect of condition ($F_{2, 14} = 25.71$, $p<0.001$), with mean whole body CHO oxidation higher in 120 $g{\cdot}h^{-1}$ (3.06±0.19 $g{\cdot}min^{-1}$) than 90 $g{\cdot}h^{-1}$ (2.46±0.12$g{\cdot}min^{-1}$; $p=0.001$) and 60 $g{\cdot}h^{-1}$ (2.08±0.03 $g{\cdot}min^{-1}$; $p=0.004$). A significant effect of time for whole body CHO ($F_{7, 49} = 40.31$, $p<0.001$) and exogenous CHO oxidation ($F_{7,49} = 150.42$, $p<0.001$) was found. A condition x time interaction for whole body ($F_{14,98} = 2.32$, $p<0.008$) and exogenous CHO ($F_{14,98} = 9.60$, $p<0.001$) oxidation showed that oxidation increased over time more with higher intakes. Peak exogenous oxidation rates were highest ($p<0.001$) at 120 $g{\cdot}h^{-1}$ (1.78±0.2 $g{\cdot}min^{-1}$) compared to 90 $g{\cdot}h^{-1}$ (1.48±0.2 $g{\cdot}min^{-1}$) and 60 $g{\cdot}h^{-1}$ (1.02±0.1 $g{\cdot}min^{-1}$). The incidence of moderate or severe (≥4) GI symptoms was high across all conditions, though not significantly different. All runners reported experiencing one or more moderate or severe symptoms.

CONCLUSION: Consuming 120 $g{\cdot}h^{-1}$ increases whole-body CHO and exogenous oxidation compared to 60 and 90 $g{\cdot}h^{-1}$, with no effect on the incidence of GI symptoms. The high prevalence of GI symptoms in all trials requires further investigation and may be due to the higher exercise intensity. Future research should investigate the impact on performance.

**INCREASED CARBOHYDRATE AVAILABILITY ATTENUATES METABOLIC AND ENDOCRINE RESPONSES TO LOW ENERGY AVAILABILITY**

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*TECHNICAL UNIVERSITY OF MUNICH*

INTRODUCTION: Low energy availability (LEA) is the underlying cause of the Female Athlete Triad and Relative Energy Deficiency in Sports (REDs) and has potentially detrimental effects on health and performance. LEA is typically associated with reduced availability of carbohydrates, a critical substrate for cellular metabolism, energy storage and energy supply of the brain. While current consensus statements on REDs highlight the importance of adequate carbohydrate availability (CA) as a mitigating factor, to our knowledge, no experimental study has directly assessed the effects of varying CA under conditions of LEA.

METHODS: In a randomized, cross-over study, participants (n=11, 36% male, 24±2years) underwent two 4-day intervention phases with a 2-week washout period between conditions. In both conditions, energy availability was reduced to 20 kcal/kg fat-free mass (FFM)/day by clamping energy intake at 45 kcal/kg FFM/day and exercise energy expenditure at 25 kcal/kg FFM/d, which was achieved by cycling at 60% of maximal oxygen uptake. CA, which was defined as the difference between carbohydrate intake and carbohydrate oxidation during exercise, was maintained either at 1.5g/kg/day (LEA-LC) or 4.0g/kg/day (LEA-HC). Assessments included changes in body weight and body composition, substrate utilization and selected metabolic hormones (leptin, insulin, IGF-1).

RESULTS: Both conditions resulted in similar weight loss (-0.6±0.6kg vs. -0.7±0.7kg; $p=0.60$). Maximal fat oxidation increased to a greater degree in LEA-LC than in LEA-HC (+39±31% vs. +7.3±17.9%; $p<0.05$). Changes in leptin (-40±21% vs. -26±29%) and IGF-1 (-24±8% vs. -10±13%) were significantly greater in LEA-LC when compared to LEA-HC (both $p<0.05$). In contrast, changes in insulin were similar between conditions (-15±36% vs. -18±26%; $p=0.56$).

CONCLUSION: Our findings demonstrate the differential effects of high and low CA under conditions of LEA on substrate utilization and endocrine pathways. Low CA amplifies metabolic shifts towards fat oxidation, paralleling metabolic changes seen with carbohydrate restriction at normal energy availability. On the other hand, increased CA preserves nutrient-sensing pathways such as insulin- and leptin-mediated production of IGF-1, thereby mitigating endocrine disruption associated with LEA.

**THE EFFECTS OF HIGH CARBOHYDRATE DOSAGES FROM FRUCTOSE-GLUCOSE MIXTURES ON PERFORMANCE DURING PROLONGED SOCCER-SPECIFIC EXERCISE**

FIELD, A., FISCHER, A., CORR, L., BIRDSEY, L.P., HEARRIS, M., MORGAN, P., HODSON, N., MARTINHO, D., FLEMING, J., MOHR, M., KRUSTRUP, P., RUSSELL, M., SALE, C., HARPER, L.D.

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INTRODUCTION: Higher carbohydrate (CHO) availability is a key factor in enhancing endurance performance during prolonged exercise. The combination of fructose and glucose has been shown to improve CHO absorption and oxidation, offering an effective means of increasing overall CHO availability. However, the optimal dosage of this combination, particularly in the context of team sports like soccer, remains unclear. Studies on endurance cyclists have demonstrated that a 90 $g \cdot h^{-1}$ fructose-glucose mixture can enhance performance, but its impact on prolonged intermittent exercise, such as the extra time phase in soccer, has not been well established. Extra time, a 30-min period added when matches are tied, is a common feature in major tournaments like the FIFA World Cup. This study aimed to investigate the effects of a higher CHO dose, provided in gel form through a fructose-glucose mixture (1:2 ratio), on performance during a 120-min simulated soccer match, compared to a lower dose of glucose only.

METHODS: Fifteen semi-professional soccer players (7 males, 8 females) participated in two 120-min soccer-specific exercise sessions, completed in a randomised, single-blinded crossover design. Participants consumed either 60 $g \cdot h^{-1}$ glucose or a combination of 0.5 $g \cdot min^{-1}$ fructose and 1.0 $g \cdot min^{-1}$ glucose (90 $g \cdot h^{-1}$) at pre-exercise, halftime, full-time, and midway through extra time. Assessments at 0, 45, 90, and 120 min included gastrointestinal (GI) discomfort, mental fatigue, passing accuracy, neuromuscular performance (reactive strength index, countermovement jump height, peak power output), and sprint performance (15 m and 30 m sprints). Blood glucose and lactate concentrations were measured every 15 min.

RESULTS: Countermovement jump height, peak power output, and sprint performance declined over time in both conditions ($p < 0.05$). Fructose-glucose co-ingestion increased blood glucose by 0.41 mmol·L from 105 min compared to glucose-only ingestion ($p = 0.006$, $d = 1.2$), but did not preserve performance ($p > 0.05$). GI symptoms were more pronounced with fructose-glucose, including greater fullness at 90 min (+9.9%, $p = 0.013$, $d = 0.9$) and increased abdominal cramps at 45 min (+9.3%, $p < 0.001$, $d = 1.7$) and 90 min (+9.0%, $p < 0.001$, $d = 1.6$). Glucose-only ingestion led to higher gastric reflux at 45 min (+7.8%, $p = 0.011$, $d = 0.9$) and flatulence at 120 min (+3.3%, $p = 0.003$, $d = 1.1$). No other variables were significantly affected ($p < 0.05$).

CONCLUSION: Fructose-glucose co-ingestion increased blood glucose availability during the latter stages of exercise but did not prevent declines in neuromuscular or sprint performance compared to glucose-only ingestion. Additionally, the higher CHO dose caused greater GI discomfort, which may limit its practicality for soccer players during extended match play. Future research should refine CHO intake strategies for intermittent sports, balancing performance benefits with GI tolerance.

**DOSE-RESPONSE OF PRE-EXERCISE DIETARY CARBOHYDRATE AVAILABILITY FOR SKELETAL MUSCLE GLYCOGEN SYNTHESIS IN ENDURANCE TRAINED CYCLISTS**

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INTRODUCTION: Carbohydrate (CHO) loading is a well-established strategy that enhances the limited endogenous muscle glycogen stores within the human body, resulting in improved exercise capacity and endurance performance (Bergström et al., 1967; Burke et al., 2017). Therefore, optimisation of pre-exercise CHO intake and resultant muscle glycogen synthesis is crucial for endurance athletes. As such, the current study investigated the dose-response relationship of dietary CHO intake and whole muscle glycogen synthesis.

METHODS: In a counterbalanced repeated measures design, 11 endurance trained participants (8 males, 3 females; 24±5 yrs, 71.2±12.0 kg, VO2max 55.8±6.2 mL/kg/min) undertook 3 x 5-day periods of dietary control and prescribed exercise designed to mimic the pre-competition practices of competitive endurance cyclists. Days 1 and 2 standardised nutritional status and glycogen content with a moderate CHO intake (4 g/kg/d) followed by glycogen depleting cycling exercise and an acute re-feed of CHO (1.2 g/kg and 2 g/kg 2 h later). Participants consumed either 6, 8 or 10 g/kg/d of CHO for the next 48 h, completed light cycling sessions (one per day at 164±49 W) and subjective gut discomfort scales at regular intervals, before returning to the laboratory (day 5) for a total body water measurement using bioelectrical impedance, high CHO breakfast (2g/kg) and muscle biopsy of the vastus lateralis 2 h post-prandial.

RESULTS: Muscle glycogen content was significantly higher ($P<0.03$) following 10 compared to 6 and 8 g/kg/d CHO intake (635.5±78.0, 460.9±100.7 and 506.1±124.0 mmol/kg dry mass, respectively), however there was no significant difference between 6 and 8 g/kg/d ($P=1.00$). Stomach fullness was higher in 10 versus 6 and 8 g/kg/d ($P<0.01$), however median scores were low in severity (<4). All other gut comfort symptoms were unaffected by CHO availability ($P>0.05$). There were no changes in body mass (71.8±11.9, 71.5±11.3 and 71.6±11.3 kg, $P=0.52$), total body ($P=1.00$), extra- ($P=0.25$) or intracellular water ($P=0.58$) between conditions.

CONCLUSION: The current study suggest 10 g/kg/d of CHO is necessary to optimise muscle glycogen storage in real world training conditions. All levels of CHO intake were well tolerated, with minimal impact on gut comfort and body water.

**FLUID RESTRICTION DECREASES EXOGENOUS GLUCOSE OXIDATION DURING PROLONGED CYCLING COMPARED TO MAINTAINING EUHYDRATION**

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INTRODUCTION: Dehydration during exercise is common amongst endurance athletes. Exercise in the heat with concomitant dehydration reduces exogenous glucose oxidation [1,2], but the independent effects of hydration are unclear. This study investigated the effect of low (dehydration) or high (euhydration) fluid intake during exercise on exogenous glucose oxidation during prolonged cycling in thermoneutral conditions.

METHODS: Nine trained male cyclists/triathletes (22 ± 4 y; 59 ± 6 mL/kg/min; 15 ± 7 h/week endurance training) completed a V̇O2peak test and two experimental trials where they cycled for 160 min at 50% Wpeak in a laboratory (~23°C) with minimal fluid intake (LOW) or fluid intake to replace sweat losses (HIGH) in a randomised order. A glucose drink enriched with 0.2% [U-13C]-glucose was provided in both trials (equal boluses every 20 min to provide 60 g/h). In HIGH, additional water was provided to maintain body mass (<0.5% mass loss). Subjective measures, skin and gastrointestinal (GI) temperature, and expired breath samples were collected every 20 min, whilst venous blood samples were collected pre- and 30 min post-exercise. Data are mean ± standard deviation, $P \leq 0.05$ indicated statistical significance.

RESULTS: Peak (HIGH: 0.79 ± 0.12 g/min; LOW: 0.70 ± 0.14 g/min; P=0.041) and mean 40-160 min (HIGH: 0.61 ± 0.09 g/min; LOW: 0.51 ± 0.11 g/min; P=0.021) exogenous glucose oxidation rates were reduced in LOW. The largest between-trial difference was observed at 60 min (HIGH: 0.49 ± 0.11 g/min; LOW: 0.33 ± 0.13 g/min; P=0.015). LOW, but not HIGH, produced significant body mass loss post-exercise (LOW: -2.8 ± 0.4%; HIGH: -0.2 ± 0.4%; P<0.001). There were trial*time interaction effects for plasma volume change, plasma osmolality, thirst and plasma glucose ($P \leq 0.048$), with LOW producing decreased plasma volume (HIGH: +0.6 ± 3.7%; LOW: -3.5 ± 3.9%; P=0.034), and increased plasma osmolality (HIGH: 290 ± 3 mOsmol/kg; LOW: 302 ± 5 mOsmol/kg; P<0.001), thirst (HIGH: 1 ± 1; LOW: 7 ± 2; P<0.001), and plasma glucose (HIGH: 5.9 ± 1.3 mmol/L; LOW: 7.0 ± 1.3 mmol/L; P=0.021) post-exercise. Thermal sensation, skin/GI temperature, GI discomfort, intestinal fatty acid binding protein (a marker of GI damage), plasma lactate and insulin concentration were not different between trials ($P \geq 0.05$).

CONCLUSION: Exogenous glucose oxidation was reduced with low fluid intake that produced significant dehydration post-exercise, with differences observed as early as 60 min (dehydration ~1% BML). This suggests that low fluid volume, rather than dehydration per se, might underpin these observations. Participants did not report increased GI discomfort with higher fluid intake, meaning matching fluid intake to sweat loss may benefit athletes looking to maximise the utilisation of glucose provided within a drink, at least where urination is possible.

1. Jentjens et al. 2002; J Appl Physiol 92: 1562–1572.

2. Reynolds et al. 2024; Med Sci Sports Exerc Online ahead of print.

## Oral Presentations

### OP-AP24 Swimming II - Recovery and Sleep

**TAPERING PRACTICES OF ELITE SWIMMERS LEADING INTO THE 2024 PARIS OLYMPIC AND PARALYMPIC GAMES: A DESCRIPTIVE STUDY**

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INTRODUCTION: Tapering is an important aspect of swimmers competition preparation. It involves a planned reduction in training load before an event, aiming to optimise performance by maintaining intensity while decreasing overall workload (1). Despite well-established tapering recommendations, it remains unclear whether coaches adhere to these guidelines. Understanding whether the taper designed by elite coaches is consistent with current evidence is essential to determine if athletes are in peak condition for competition.

METHODS: This study examined the current tapering strategies of elite Australian swimmers (n = 9 males, n = 7 females) in the lead-up to the 2024 Australian Olympic and Paralympic Trials, as well as the 2024 Paris Paralympic Games and aimed to describe changes in training volume, intensity, frequency and duration during a taper. This study also described differences between non-disabled and para-athletes as well as sprint and middle distance athletes. Total training volume and distance in Zones 1-3 were collected during training using Commit Swimming and the AMS (Athlete Management System).

RESULTS: In the lead-up to the Australian Swimming Trials, the Paralympic group reduced total training volume by 42.2% (sprint) and 45.6% (middle distance), while the Olympic group tapered volume by 43.3% (sprint) and 30.8% (middle-distance). Paralympic swimmers reduced training in Zone 1 by 34.8% (sprint) and 42.0% (middle-distance), in Zone 2 by 68.2% (sprint) and 72.0% for (middle-distance), and in Zone 3 by 54.9% (sprint) and 47.0% (middle-distance). Olympic swimmers decreased Zone 1 volume by 41.1% (sprint) and 29.7% (middle-distance); Zone 2 volume by 67.7% (sprint) and

55.3% (middle-distance); and Zone 3 volume by 50.6% (sprint) and 53.2% (middle distance). Leading into the Paralympic Games, training volume was reduced by 54% (sprint) and 61.8% (middle-distance). Para sprint swimmers decreased Zone 1, 2, and 3 training by 44.6%, 73.2 % and 83.5%, while middle-distance athletes reduced Zone 2 and 3 training volume by 88.9% and 89.0%. Across all groups, high-intensity training (Zones 2 and 3) experienced the largest reductions, often exceeding 70% in the lead-up to both Trials and the 2024 Paralympic Games.

CONCLUSION: Several groups exhibited tapering strategies inconsistent with the current guidelines. Reduction in total training volume was often lower than recommended, and reductions in high intensity training were mainly responsible for reduced overall training volume. These observations suggest performance may be optimised in these swimmers through more effective tapering strategies, particularly in sprint swimmers. These findings provide valuable insights into real-world tapering practices and their potential effects on elite swimming performance, informing future programming strategies for future Olympic and Paralympic athletes.

1. Mujika I, Padilla S. Scientific Bases for Precompetition Tapering Strategies. Medicine and Science in Sports and Exercise. 2003;35

**THE IMPACT OF A 12-WEEKS SLEEP EDUCATION PROGRAM ON SLEEP AND RECOVERY IN COMPETITIVE SWIMMERS**

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INTRODUCTION: Swimmers have been shown to experience larger sleep deficits than athletes in most other sports [1]. Chronic sleep deficiencies may impair recovery and, in turn, performance, particularly given the role of sleep loss in the development of functional overreaching [2]. While a sleep education program has led to a temporary increase in sleep duration in athletes without sleep deficiency [3], its impact on chronically sleep-deprived athletes has not been investigated yet. Therefore, the aim of the current study was to assess the effect of a 12-week sleep education program on sleep and perceived recovery in swimmers.

METHODS: Nine national level swimmers (1F, 8M; age: 17 ± 1 y) completed two phases of 12 weeks each: a baseline phase followed by an intervention phase during which sleep education was administered. The sleep education program consisted of three ~ 1-hour sleep seminars held in weeks 0, 4 and 8 and two sleep podcasts in week 2 and 6 during the intervention phase. Sleep duration, sleep regularity and perceived sleep quality were measured using a combination of actigraphy (Actigraph wGT3X-BT, Actigraph LLC, Pensacola, FL, USA) and a sleep diary. Perceived recovery was assessed daily using the Short Recovery and Stress Scale for Sport.

RESULTS: A significant interaction between phase and weekday was observed for sleep duration ($F_{6,1042} = 2.84$ ; $P < 0.01$; $\eta 2p = 0.02$). Sleep duration was significantly longer on Friday nights during the intervention phase compared to baseline phase (baseline: 8.2 ± 0.3 h vs. intervention: 9.2 ± 0.3 h; mean difference (md): 1.0 ± 0.4 h; $P < 0.01$). On the other hand, sleep regularity significantly decreased during the intervention phase (baseline: 81 ± 1% vs. intervention: 78 ± 1%; md: -3 ± 1%; $P = 0.02$; $\eta 2p < 0.01$). There were no significant effects of phase on sleep quality ($F_{1,992} = 0.79$; $P = 0.37$; $\eta 2p < 0.01$), perceived recovery ($F_{1,1025} = 2.94$; $P = 0.09$; $\eta 2p < 0.01$) or perceived stress ($F_{1,1035} = 0.54$; $P = 0.46$; $\eta 2p < 0.01$ ).

CONCLUSION: Administering a 12-week sleep education program was associated with increased sleep duration on Friday nights but decreased sleep regularity This may reflect athletes adjusting their sleep schedules within the constraints of school and training, extending sleep when possible but increasing sleep variability. Coaches might consider sleep education to extend sleep duration in competitive swimmers, but scheduling constraints should be taken into account.

1. Sargent C, Lastella M, Halson SL, Roach GD. How much sleep does an elite athlete need? Int J Sports Physiol Perform. 2021;16(12):1746-1757. doi:10.1123/ijspp.2020-0896.

2. Hausswirth C, Louis J, Aubry A, Bonnet G, Duffield R, Le Meur Y. Evidence of disturbed sleep and increased illness in overreached endurance athletes. Med Sci Sports Exerc. 2014;46(5):1036-1045.

3. Caia J, Scott TJ, Halson SL, Kelly VG. The influence of sleep hygiene education on sleep in professional rugby league athletes. Sleep Health. 2018;4(4):364-368.

**EFFECTIVENESS OF SLEEP-ENHANCING STRATEGIES DURING TAPER: IMPACT ON PERFORMANCE IN ELITE SWIMMERS WITH ACUTE AND HIGH FATIGUE LEVELS**

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INTRODUCTION: In swimming, tapering is implemented before major competitions to enhance performance. However, its effectiveness varies depending on the athletes pre-taper fatigue level. While tapering increases performance in swimmers with acute fatigue (+1.8 ± 1.4% [1]), it is less effective or ineffective for those with high accumulated fatigue (-0.5 ± 1.6%, $p<0.05$ [1]). Given the critical role of sleep in recovery, we aimed to evaluate the combined effects of tapering and sleep-enhancing strategies on performance in elite swimmers with acute and high fatigue levels.

METHODS: Physiological, psychological, and biomechanical profiles were assessed in 27 elite swimmers at T0 and T1, scheduled respectively 10 and 3 weeks before their major competition. Sleep profile was evaluated at T0, T1, and throughout the subsequent two taper weeks. External training load was monitored daily. Race times were officially recorded at T1 and during the major competition. Between T0 and T1, athletes participated in a sleep education program [2]. During

tapering, they slept on a high-thermal-conductivity mattress topper and underwent daily cryostimulation (3 min) or contrast baths (28 min) during the first week.

RESULTS: Based on changes in physiological, psychological, and biomechanical profiles from T0 to T1, 13 swimmers (17±2 years old; best performance: 88±3% of the world record) exhibited acute fatigue (AF), and 14 swimmers (17±2 years old; best performance: 89±3% of the world record) demonstrated functional overreaching (F-OR). External training load did not differ between groups. Taper-induced changes in performance were +1.2 ± 1.6% in the AF group and +0.4 ± 2.3% in the F-OR group ($p>0.05$). Notably, 82% of athletes in the AF group and 67% in the F-OR group showed a performance improvement exceeding 0.5% ($p>0.05$). These changes in performance were positively correlated with changes in total sleep time from T0 to T1 and, specifically in the F-OR group, with the average sleep duration during tapering.

CONCLUSION: In overreached swimmers, the combination of tapering and sleep-enhancing strategies resulted in a 0.4% performance improvement, whereas tapering alone was associated with a 0.5% decline [1], thereby mitigating the previously observed disparity in tapering benefits between AF and F-OR swimmers. Furthermore, in the current study, 67% of F-OR swimmers achieved a performance gain exceeding 0.5% (the smallest meaningful enhancement impacting final rankings), compared to 50% with tapering alone [1]. Finally, taper-induced changes in performance observed in this study were linked to changes in sleep duration before tapering. Interestingly, it was also linked to average sleep duration during tapering in F-OR swimmers. These findings highlight the importance of assessing and optimizing sleep before and during tapering, especially in overreached swimmers, to achieve peak performance.

1. Bretonneau et al. (2024) 10.3389/fspor.2024.1353817 2. Pasquier et al. (2023) 10.1123/ijspp.2023-0018

**HEART RATE VARIABILITY AND BLOOD LACTATE LEVELS AFTER INTENSIVE INTERVAL SPRINT LOADING ON ELITE SWIMMERS: THE RECOVERY EFFECT OF FOAM ROLLING**

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INTRODUCTION: Considering the intensity of swimmers' training, their bodies need to recover physically and mentally between two loads. Therefore, proper management of post-exercise recovery processes plays a key role in maintaining performance. There are many methods and techniques that accelerate the recovery process. Stretching, massage, hot and cold applications, passive rest are some of them. Foam rolling (FR) have become popular in the recently years. FR creates a series of effects on athletes' physiological, morphological and neuromuscular functions by increasing blood flow in the area where it is applied. However, it is still unknown whether FR is superior to other recovery methods. The main aim of present study was to examine the acute effects of FR on heart rate variability (HRV) and blood lactate (BL) in elite swimmers after intensive interval sprint swimming load.

METHODS: A total of fifteen female and male elite swimmers between the ages of 15-26 participated in the study voluntarily (mean age 17.5 ± 3.1 years, height 178.2 ± 7.6 cm, weight 69.3 ± 7.9 kg). The volunteers participated in three sessions, one week apart with a "randomized-crossover" method from experimental research designs. The first session was defined as the familiarization session. In the second and third sessions; warm-up, pre-test, swimming (50m), test-1, swimming (3 x 50 m), test-2, recovery and post-test were performed. In one of these sessions (FRS), active rest (750 m low tempo swimming; 10 min) and foam rolling (10 min) were applied during recovery. In the other session (ARS), only active rest was performed (1500 m low tempo swimming, 20 min). HRV time-domain (RR, RMSSD and SDNN) and frequency-domain (VLF, LF and HF) parameters were determined using a Polar H7 V800. BL were taken from the fingertips with Lactate Pro2 device. The obtained data were analyzed using Two Way ANOVA repeated measures variance analysis test (2 experiment x 4 time) in SPSS 29.0 for Windows statistics program. Bonferroni test was used for pairwise comparisons.

RESULTS: A statistically significant difference was found in favor of all HRV parameters and BL recovery in the changes depending on time in FRS and ARS protocols. There were no significant differences between FRS and ARS protocols for RR ($F = 1.526$; $\eta_p^2 = .122$), SDNN ($F = 1.197$; $\eta_p^2 = .325$), RMSSD ($F = .361$; $\eta_p^2 = .029$), VLF ($F = .152$; $\eta_p^2 = .012$), Blood Lactate ($F = 1.302$; $\eta_p^2 = .098$) and RPE ($F = .704$; $\eta_p^2 = .055$). Statistically significant differences were found between FRS and ARS protocols in terms of changes in LF ($F = 17.6$; $\eta_p^2 = .595$) and HF ($F = 2.43$; $\eta_p^2 = .169$).

CONCLUSION: In conclusion, from our findings FR applied to elite swimmers after intensive interval swimming load during active recovery is effective on some time-domain parameters and frequency-parameters of HRV and BL. These suggest that FR can be useful tool for enhancing recovery and autonomic modulations of cardiovascular and nervous systems.

**INTER-EFFORT HYPOXIA RECOVERY EXACERBATES INTERNAL LOAD DURING ACUTE SPRINT INTERVAL TRAINING SESSIONS WITHOUT COMPROMISING PERFORMANCE IN SWIMMERS**

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INTRODUCTION: Considering that exercise intensity can be reduced when performed under continuous hypoxia, we recently argued that adding hypoxia exclusively during the recovery periods between efforts in interval training sessions [i.e., inter-effort hypoxia recovery (IEH)] could be a more effective approach than performing the entire training session under hypoxia to avoid decreases in external training load [1]. This study aimed to compare the acute effects of IEH during two sprint interval training (SIT) sessions on swimming performance and psychophysiological markers of internal training load.

METHODS: Eight trained/developmental swimmers (22.0 ± 1.8 yrs; 178 ± 10 cm; 74.0 ± 10.2 kg) performed two SIT sessions in front crawl, each consisting of twenty 25-m efforts separated by ~1.5 min of recovery (SIT20x25m). Additionally, sixteen highly trained/national-level swimmers (20.9 ± 3.0 yrs; 177 ± 6 cm; 69.0 ± 10.5 kg) performed two SIT sessions, each consisting of ten 50-m efforts separated by ~3 min of recovery (SIT10x50m). For the SIT10x50m protocol, specific in-water resistance training equipment was used to enhance swimmers engagement. In a randomized order, one session was performed in normoxia (NOR; $FiO_2$ = 20.9%), while the other included the addition of normobaric hypoxia (IEH; $FiO_2$ = 13.3%) during the recovery periods. Swimming velocity (Sv), heart rate (HR), peripheral oxygen saturation ($SpO_2$), blood lactate concentration ([La]), and ratings of perceived exertion (RPE) were compared using Students t-test for paired samples. The level of statistical significance was set at $p < 0.05$.

RESULTS: Swimming velocity was not significantly different between conditions (SIT20x25m: NOR = 1.63 ± 0.19; IEH = 1.66 ± 0.19 $m \cdot s^{-1}$ andSIT10x50m: NOR = 1.71 ± 0.23; IEH = 1.72 ± 0.22 $m \cdot s^{-1}$, $p > 0.05$). During recovery, HR values were higher in IEH condition (SIT20x25m: NOR = 127.1 ± 27; IEH = 141.1 ± 19 bpm and SIT10x50m: NOR = 127.0 ± 17; IEH = 134 ± 13 bpm). $SpO_2$ was lower in IEH (SIT20x25m: NOR = 95.0 ± 2.2%; IEH = 77.2 ± 6.2%, $p < 0.05$ and SIT10x50m: NOR = 96.0 ± 1.14%, IEH = 89.0 ± 5.2%, $p < 0.05$). Blood lactate concentration values were not significantly different between conditions (SIT20x25m: NOR = 10.1 ± 5.0; IEH = 11.3 ± 3.6 mM) and SIT10x50m: NOR = 14.9 ± 4.5; IEH = 17.9 ± 4.9 mM). Similarly, RPE was not significantly different between NOR and IEH (SIT20x25m: NOR = 6.4 ± 1.4; IEH = 6.5 ± 1.4 and SIT10x50m: NOR = 8.7 ± 0.1; IEH = 8.5 ± 0.1).

CONCLUSION: Our findings indicate that IEH during SIT sessions in swimming induces hypoxemia and additional exercise stress; however, it preserves exercise performance of swimmers.

1. Papoti et al. 2022.

## Invited Symposium

### IS-BM06 Exercise and the central nervous system: mechanisms, performance, and therapy

**WHEN MUSCLES TALK BACK TO THE BRAIN: THE REGULATION OF NEUROMUSCULAR FATIGUE AND PERFORMANCE DURING EXERCISE**

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Neuromuscular fatigue compromises exercise performance and is determined by central and peripheral mechanisms. Central fatigue is defined as a decrease in neural activation of muscle that can occur at cortical and/or spinal level, while peripheral fatigue is associated to biochemical changes at or distal to the neuromuscular junction that cause an attenuated contractile response to neural output. Interactions between the two components of fatigue can occur via neural pathways, including feedback and feedforward processes. This talk discusses the influence of feedback and feedforward mechanisms on exercise limitation. In terms of feedback mechanisms, particular attention is given to group III/IV sensory neurons which link limb muscle with the central nervous system. Central corollary discharge, a copy of the neural drive from the brain to the working muscles, provides a signal from the motor system to sensory systems and is considered a feedforward mechanism that might influence fatigue and consequently exercise performance. We highlight findings from studies supporting the existence of a 'critical threshold of peripheral fatigue', a previously proposed hypothesis based on the idea that a negative feedback loop operates to protect the exercising limb muscle from severe threats to homeostasis during whole-body exercise. While the threshold theory remains to be disproven within a given task, it is not generalisable across different exercise modalities. The 'sensory tolerance limit', a more theoretical concept, may address this issue and explain exercise tolerance in more global terms and across exercise modalities. The 'sensory tolerance limit' can be viewed as a negative feedback loop which accounts for the sum of all feedback (locomotor muscles, respiratory muscles, organs, and muscles not directly involved in exercise) and feedforward signals processed within the central nervous system with the purpose of regulating the intensity of exercise to ensure that voluntary activity remains tolerable. Using an integrative physiology approach, this talk will provide a structured synthesis of recent insights into the limit of exercise in humans and should be of interest for a large audience, from scientists interested in exercise performance in athletes to those concerned by exercise tolerance in patients.

**NON-INVASIVE BRAIN STIMULATION: IMPLICATIONS FOR EXERCISE SCIENCE RESEARCH AND APPLICATIONS FOR PHYSICAL AND MENTAL HEALTH**

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The brain-muscle interaction has always been an area of interest among researchers due to its importance for exercise regulation and for the development of exercise induced fatigue in healthy and clinical population. Despite its importance, some aspects of the feedforward mechanism from the motor system to recruit the muscle (i.e. neural drive) are still poorly understood. Experimental evidence provided by brain imaging techniques are mostly correlative and crucial for identifying the neural processes for motor task. Over the last three decades, the current understanding of brain function for motor execution has been significantly increased by research involving non-invasive brain stimulation (NIBS) techniques. NIBS

are laboratory techniques capable of altering brain function in a safe, reversible and temporary manner by delivering magnetic field or electrical current to targeted neural networks. As such, the manipulation of neural networks allows researchers to establish cause-effect relationships between brain function and motor performance. This unique property of NIBS application has opened new possibilities for understanding the role of different neural networks relevant for exercise regulation and for the development of fatigue The application of transcranial magnetic stimulation (TMS) provided important knowledge about the neural mechanisms within the motor pathway responsible for the development of central and supraspinal fatigue. More recently, another NIBS technique called transcranial direct current stimulation (tDCS) has been used in exercise science. tDCS can alter spontaneous firing rate of targeted neurons beyond the stimulation time as its effect can last over 1 hour for acute administration (i.e. single administration) or months when administered repeatedly (i.e. over several days). Collectively, the tDCS administration demonstrated significant enhancement of maximal voluntary strength, sport-specific motor performance and endurance performance alongside a significant reduction in perceived exertion. The current knowledge provided by NIBS led to groundbreaking findings on the neural basis of brain function during exercise with the possibility to develop novel non-pharmacological interventions in healthy and clinical populations for improving exercise tolerance. In this talk, I will present the most updated findings and applications for NIBS in healthy populations and their relevance to understand the role of neural component on feedforward mechanism for exercise regulation and fatigue related mechanisms. Furthermore, I will provide experimental evidence on novel network-based approaches to optimise the synergy between NIBS and physical exercise for improving physical and mental health. By covering a research topic related to the role of the brain during exercise and NIBS, this talk aims to attract the interest of audience including physiologists, clinicians and neuroscientists.

**NEUROPLASTICITY MEETS FATIGUE AND PAIN: EXPLORING NEUROMODULATION IN CLINICAL POPULATIONS**

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Physical fatigue and pain are common and complex symptoms experienced by many clinical populations including Multiple Sclerosis (MS), cardiovascular disease, cancer and older adults. Its development can be influenced by physiological and psychological factors. Neuromodulation is an emerging therapeutic approach for managing psychophysiological fatigue. It involves the use of techniques such as repetitive transcranial magnetic stimulation (TMS) and transcranial direct current stimulation (tDCS) that alter nerve activity and neurotransmitter function to improve physical function and ameliorate fatigue and pain. Studies concerning the viability of neuromodulation applied to the brain have yielded positive, yet, often variable results in both responsiveness of the brain and motor behaviour (e.g. exercise performance and pain ratings). High intra and inter-individual variability in response to neuromodulatory techniques is thought to be related to both intrinsic (e.g. age and sex) and extrinsic (e.g. experimental parameters) factors. For example, more robust and less variable neurophysiological outcomes have been produced in studies involving the application of priming neuromodulation prior to subsequent application of neuromodulation, with a short interval in between; a concept known as metaplasticity. In the treatment of clinical fatigue and pain, application of tDCS for example has been shown to be potentially efficacious, but, understanding of the exact mechanisms is incomplete, and the evidence on the influence of priming and subsequent neuromodulation application on fatigue remains scarce. In this talk, I will discuss some of the underlying factors that contribute to the variable neurophysiological and sensorimotor responses seen with different neuromodulatory approaches. I will also provide some limited experimental evidence of metaplastic responses to neuromodulation and fatiguing exercise in people with MS and older adults. As the field of neuromodulation continues to evolve, it is imperative to address the variable outcomes through future research focused on enhancing efficacy and applicability of neuromodulation therapies. I will provide a critical appraisal of these key areas including individualised treatment approaches, longitudinal studies, standardised protocols for comparison across studies and clinical populations, neurological and non-neurological mechanistic insights, study of diverse clinical populations, and combination with other therapies (pharmacological and lifestyle modifications).

## Oral Presentations

### OP-AP20 Training and Testing VII - Middle age and older adults

**THE IMPACT OF HOME-BASED HIGH-INTENSITY INTERVAL TRAINING ON PHYSICAL FUNCTION IN HEALTHY OLDER ADULTS**

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INTRODUCTION: Resistance training is widely recommended to enhance physical function (PF) in older adults (1). High-velocity resistance training receives particular attention due to the strong link between muscular power and functional movement (2). High-intensity interval training (HIIT) has also shown promise for improving power-related adaptations in older populations (3). As a time-efficient and generally well-tolerated training modality, HIIT offers a viable exercise option for older adults (4). However, its efficacy in enhancing PF among this population remains unclear. Furthermore, the effectiveness of HIIT under free-living conditions as part of broader public health strategies has not been adequately investi-

gated (5). Therefore, the present study aimed to assess the impact of a 6-month home-based HIIT program on PF in healthy older adults.

METHODS: Healthy older adults (n=233, aged 60-84, 54% female) from Norway and the UK were randomly assigned to either a HIIT group (mean age±SD: 67.6±5.9yr) or a non-exercising control group (mean age±SD: 67.0±5.2yr). The exercising group participated in a 6-month, thrice weekly HIIT intervention (2 interval and 1 circuit sessions per week).

PF measures at pre- and post-intervention included Grip strength, 30-sec-chair-stand, Chair-sit-and-reach, Back scratch, Timed-up-and-go, and One-leg standing. Additionally, PF was calculated as a composite Z-score (PF Z-score) based on all aforementioned tests.

General Linear Models were used to assess between-group differences in post-intervention scores for each standardized test and the PF Z-score, with pre-intervention scores, age, sex, and country of residence as covariates, and group as a fixed factor. Effect sizes (ES) were calculated using mean differences (pre-post), pooled standard deviations, and sample sizes for the exercise and control groups. Alpha level of 5% was chosen for statistical significance, with 95% CI presented.

RESULTS: Significant between-group differences at post-intervention were observed for PF Z-score (β=0.24, [0.17;0.30] (ES:0.97), Grip-strength (β=1.8 [0.8;2.8] kg (ES:0.48), 30-sec-chair-stand (β=1.3 [0.7; 1.8] repetitions (ES: 0.63), Back scratch (β=2.1 [0.8;3.5] cm (ES:0.43), and Timed-up-and-go (β=−0.3 [−0.4;−0.2] seconds (ES:0.71).

No significant between-group differences post-intervention were observed for Chair-sit-and-reach and One-leg standing tests.

CONCLUSION: These findings indicate that healthy older adults can enhance their PF through a 6-month home-based HIIT intervention. However, no significant effects were observed in joint flexibility of the lower extremities or static balance ability. Nonetheless, these findings reinforce the potential of HIIT as a valuable component in public health strategies for promoting physical function in healthy older adults.

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**EFFECTS OF VIVIFRAIL D-LEVEL EXERCISE PROGRAM ON FUNCTIONAL FITNESS AND VASCULAR HEALTH IN HEALTHY OLDER ADULTS**

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INTRODUCTION: The Vivifrail D-Level exercise program is a multicomponent training approach designed to maintain functional capacity and prevent frailty in older adults. However, previous evidence suggests that standard Vivifrail protocols may be insufficiently challenging for healthier older adults (D-level), thus potentially limiting training adaptations [1,2]. This study investigated the effects of an Vivifrail D-level exercise regimen on functional fitness, peripheral arterial stiffness, and body composition in healthy older adults.

METHODS: Forty-one participants aged ≥ 65 years (including 55–64 years for Indigenous people) classified as D-level via the Short Physical Performance Battery (SPPB) were divided into an Advanced Health Group (AHG, n = 22) and a General Health Group (GHG, n = 19), based on sit-to-stand performance. Both groups underwent an enhanced 12-week Vivifrail D-level exercise program (1 supervised session/week plus 4 self-administered sessions/week). Outcome measures included brachial-ankle pulse wave velocity (baPWV), ankle-brachial index (ABI), handgrip strength, biceps curl (30 s), 30 s sit-to-stand, 4 m walk, 2 min step test, and DXA-assessed body composition at baseline and post-intervention.

RESULTS: Following the 12-week intervention, the GHG showed significant improvements in biceps curl ($p = .002$), 30 s sit-to-stand ($p < .001$), 4 m walk speed ($p = .012$), and 2 min step test ($p = .040$), as well as left-side ABI ($p = .015$). In contrast, the AHG exhibited only a modest improvement in biceps curl ($p = .031$), with no significant changes in other variables.

CONCLUSION: This study's findings indicate that an advanced Vivifrail D-level exercise program effectively enhances functional fitness and peripheral vascular health in older adults with lower baseline performance. The General Health Group showed significant gains in muscular endurance, walking capacity, and improved ankle-brachial index, aligning with previous multicomponent exercise research [1] (Courel-Ibáñez et al., 2022). In contrast, the Advanced Health Group's limited adaptation suggests a "ceiling effect," pointing to the need for higher-intensity or more personalized protocols [3]. Recent studies further underscore the value of progressive, individualized training for older adults of varying fitness levels [4,]. Future interventions should incorporate greater overload and modality variety, particularly for those with higher initial capacity, to maximize neuromuscular and cardiovascular benefits in older populations.

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**THE EFFECT OF FAMILIARIZATION ON SQUAT POWER AND VELOCITY IN OLDER ADULTS USING A FLYWHEEL DEVICE**

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INTRODUCTION: Flywheel (FW) devices are becoming an increasingly popular tool for improving muscle power, strength and functional abilities, particularly in older adults. Despite the proven benefits of eccentric training on these devices, it remains unclear how quickly individuals adapt to the specific demands of the exercise. Notably, our study is the first to investigate the familiarization process of performing squats on FW device in older adults. We hypothesized that the group completing the 5-weeks familiarization protocol would demonstrate significantly greater squat velocity and force during the eccentric phase compared to the group that did not undergo the familiarization protocol.

METHODS: Thirty-nine participants were randomly assigned to two groups. Group S1 performed a squat assessment on a flywheel (FW) machine during weeks 1 and 2, followed by a 2-week familiarization protocol focused on performing the squat movement with controlled concentric and eccentric phases, with an emphasis on tempo. Group S2 performed assessments only during weeks 1 and 2. Both groups underwent a follow-up assessment during week 5 to assess changes in squat performance. Measurements included 2 initial squat repetitions followed by 6 maximal intensity work repetitions and 2 final squat repetitions designed for safe stopping.

RESULTS: The results showed increased F, v P mechanical outputs over visits 1, 2, and 3. The F, v, P variables increased significantly more for the F group between visits 2 and 3. Moreover, CV decreased from visits 1-2 to 2-3 where F groups showed significantly decreased within-set, between-sets and between-visits variability in comparison to control groups (CV: 15% vs. 10%).

CONCLUSION: Individuals familiar with the FW device are likely to achieve superior performance outcomes compared to those without prior familiarization. The familiarization process enhances technical execution, increases eccentric overload, and improves movement velocity, ultimately optimizing training adaptations. These findings underscore the importance of structured familiarization when implementing FW-based resistance training in older adults to maximize safety, efficiency, and effectiveness. Future research should investigate the long-term impact of familiarization on neuromuscular adaptations and functional performance, as well as its potential applications in rehabilitation and fall prevention strategies for aging populations.

**IDENTIFYING HEMODYNAMIC DIFFERENCES DURING VASCULAR OCCLUSION TEST BY TIME-DOMAIN NEAR INFRARED SPECTROSCOPY IN OLD TRAINED AND UNTRAINED POPULATION**

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INTRODUCTION: In this work, we assess the capability of time domain (TD) near infrared spectroscopy (NIRS), to detect differences between sedentary and trained old subjects by means of vascular occlusion test (VOT). The acquisitions were performed in the framework of the Trajector-AGE project.

METHODS: 15 healthy old trained (OT; 71.0±4.3 y) and 15 old sedentary (OS; 78.0±4.3 y) subjects took part to this study. VOT consisted in 2 min of rest, maximum 5 min of prolonged ischemia and 3 min of recovery. TD-NIRS sensor was placed on the distal vastus lateralis (VL) of the right leg during the whole acquisition. Absolute values for the time courses of oxy- (O2Hb), deoxy- (HHb), total- hemoglobin and tissue oxygen saturation (StO2) were obtained by using the solution of the photon diffusion equation for homogeneous media, since the average adipose tissue (ATT) thickness was 3.2±1.0 mm and 3.1±1.7, respectively. A diffuse correlation spectroscopy (DCS) sensor providing the blood flow index (BFI) was used to verify the validity of the VOT (BFI ~0). Specific parameters were calculated from all the hemodynamic parameters time courses: 1) average baseline in the last 10 s before the VOT (BAS); 2) desaturation slope during the first 60 s of the VOT by means of a linear fit (DS60); 3) re-saturation slope after the VOT in the first 10 s, as calculated by a linear fit (RS10); 4) same as point 3 but in the first 30 s (RS30). Since the two populations were not normally distributed, as revealed by a Two-sample Kolmogorov-Smirnov test, statistically significance differences were tested with Mann-Whitney method (threshold $p<0.05$).

RESULTS: For the O2HB concentration during baseline for OS was 63.0±12.7 μM, while for OT was 86.7±17.9 μM, showing a significance difference ($p=9.6\cdot10\text{-}4$). Same situation for basal StO2 which was 60.8±7.0 % for OS and 67.3±3.9 % for OT ($p=7.0\cdot10\text{-}3$).

For the DS60 the only significant difference was found for StO2, which was -0.109±0.077 for OS and -0.080±0.058 for OT ($p= 5.6\cdot10\text{-}2$). The desaturation slope is negative, so a higher value means a slower response. No significant differences were found for RS10 and RS30 parameters.

CONCLUSION: The main differences ($p<0.05$) between trained and untrained OLD population were observed for the baseline values of O2Hb and StO2 and for the desaturation slope for StO2, higher for trained OLD. We do not expect that these differences are due to the effect of the ATT on NIRS data. The ATT for OS and OT are equal, and TD NIRS do not suffer of contamination from the surface signal for these ATT values. Differences in SO2 baselines could indicate a greater physio-

logical reserve at rest while differences in desaturation slope a more efficient O2 utilization in the trained old population compared to their untrained counterparts.

**REMOTE PILATES TRAINING IS EFFECTIVE IN IMPROVING PHYSICAL FITNESS IN HEALTHY WOMEN: A RANDOMIZED CONTROLLED STUDY**

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INTRODUCTION: Despite its positive impact on physical and mental well-being, adults may refrain from per-forming regular physical activity, due to inadequate time, accessibility, or funds. Yet remote platforms could overcome such obstacles and increase participation. This study evaluated the effectiveness of remote-synchronous group-Pilates classes compared to in-studio classes in healthy sedentary women.

METHODS: In a randomized controlled design, 40 women, aged 20–45, were assigned to a Zoom or studio group-Pilates training. The intervention included twice-weekly 45 min sessions over an eight-week period. Attendance (adherence) was recorded, and the participants completed physical motor tests (plank, curl-up, stork, push-up, and V-sit and reach), Profile of Mood State Surveys, and Nordic Musculoskeletal Pain Questionnaires. Evaluations were performed at baseline, mid-intervention (4 weeks), and post intervention (8 weeks).

RESULTS: Adherence to training was high in the Zoom and studio groups (80% and 74%, respectively). Improvements in physical motor tests were seen in both groups following the Pilates interventions, thereby indicating the effectiveness of group-Pilates Zoom training.

CONCLUSION: In conclusion, remote online physical activity such as Pilates offers a good alternative to in-studio trainings, as a means for improving physical fitness and promoting a healthy lifestyle in adults, by offering a more accessible and less timely alternative to in-studio physical activity programs.

Keywords: Zoom; physical

## Oral Presentations

### OP-PN32 Hypoxia and Environment

**HIGH ALTITUDE AND PHYSICAL EFFORT: IMPACT ON THE DEVELOPMENT OF SUBCLINICAL INTERSTITIAL PULMONARY OEDEMA IN SUBJECTS WITH DIFFERENT LEVELS OF ACCLIMATIZATION. THE HIGH ALTITUDE PROJECT CAMP**

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INTRODUCTION: Subclinical interstitial pulmonary oedema is characterized by the accumulation of fluid in the pulmonary interstitial space. Lung ultrasound (LUS) detects this condition through an increase in lung B-lines. This study aims to evaluate the effect of exercise and high-altitude hypobaric hypoxia exposure on increasing lung B-lines in subjects with different levels of acclimatization.

METHODS: This observational study, conducted in collaboration with the Italian Army, enrolled 36 subjects divided into three groups (A, B, C) based on their level of acclimatization and previous mountaineering experience. Group A (n=12) consisted of young officers from the school of Applied military science assigned to the Alpine Troops, with limited mountaineering experience. Group B (n=12) included highly specialized military alpines from the Alpini brigade "Taurinense" and the 4th Alpini Paratroopers Regiment Group C (n=12) comprised Military Alpine Guides from the Alpine training center, with extensive high-altitude experience. The study lasted four days, with one day at Pollein, Aosta, (551 m) and three at Rifugio Torino, Monte Bianco, 3.375 m. LUS was performed at both locations, before and after exercise, following a standardized 16-zone thoracic ultrasound scanning protocol.

RESULTS: B-lines Score increased after exercise in both sea level (T0) and high altitude (T1, T2). Hypobaric hypoxia further intensified this effect, with a further increase after each standardized exercise activity that simulated military action. At T0, the mean rest score was 3.28 ± 2.65 (T0 Rest), significantly increasing to 11.19 ± 3.12 after exercise (T0 Exe) ($p < 0.01$), showing that physical effort alone contributes to subclinical interstitial pulmonary oedema. Following high-altitude exposure, the mean score was 9.69 ± 2.99 on the first day (T1 Rest) ($p < 0.01$), increasing further to 15.14 ± 3.80 after exercise (T1 Exe) ($p < 0.01$). On the second day, the baseline score reached 14.08 ± 5.20 (T2 Rest) ($p < 0.01$), rising post-exercise to 18.08 ± 3.16 (T2 Exe) ($p < 0.01$). By the third day, the baseline value stabilized at 12.75 ± 4.23 (T3 Rest) ($p > 0.05$). Group A consistently exhibited a higher mean LUS B-Lines Score than the other two groups at all time points, except for T3 Rest, where levels were similar to those of Group B but remained higher than those of Group C.

CONCLUSION: Exercise and hypobaric hypoxia are cumulative key factors in the development of interstitial pulmonary oedema. Prior experience in mountain activity appears to mitigate the impact of these factors, potentially influencing performance both at sea level and at high altitude. Further studies are needed to determine whether development of LUS B-lines could serve as a predictive marker for high altitude acclimatization and for high-altitude pulmonary oedema (HAPE) in athletes, mountaineers, high-altitude workers, and military personnel.

**EFFECTS OF ACUTE HYPOBARIC HYPOXIA ON OXY-INFLAMMATION AND SYSTEMIC RESPONSE IN ITALIAN ALPINE SOLDIERS**

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INTRODUCTION: The progressive reduction of atmospheric pressure and therefore of the partial pressure of O2, triggers a series of compensatory mechanisms implemented by the body to adapt to the resulting tissue hypoxia. Rapid exposure (via mechanical means: cable car and/or helicopter) to altitude induces rapid functional molecular changes, such as the generation of reactive oxygen species (ROS), with consequent oxidative and systemic damage. The military activities are characterized by a rigorous and challenging lifestyle, demanding to military personnel a constant commitment and a remarkable capacity for adaptation to hypoxia and cold. Aim of the study was the assessment of biological markers, indicators of oxidative stress, inflammation, systemic stress, and appetite hormones.

METHODS: Italian Alpine soldiers (n=18; males) were studied during 72h "Campo Alta Quota 2023"in the magnificent scenario of the glacier Mont Blanc at 3500m sl. Saliva and urine samples and psychometric scale were collected at 7:00 am pre (baseline at Aosta), every day during camp (Rifugio Torino) and 15 days post (Aosta). By biofluids we assayed: ROS, Total Antioxidant Capacity (TAC), Lipid Peroxidation (8-isoprostane), DNA oxidation (8OH-dG), Interleuchin-6 (IL-6); Cortisol, Leptin and Ghrelin concentration.

RESULTS: Observed at rest modifications of the parameters of oxy-inflammation, and changes in the hormonal response: both of the stress and appetite hormones, in the 3 days spent at high altitude, compared to the baseline values were recorded. The peak of the modifications of the parameters investigated was observed 72 hours after the ascent to altitude: ROS significantly increased during sojourn (T0: 0.31±0.06; T1 0.34±0.07; T2 0.39±0.07; T3 0.47±0.07; T4 0.30±0.06umol.min-1); with consequent increase in lipid peroxidation (T0: 0.52±0.13; T1 0.66±0.17; T2 1.09±0.11; T3 1.44±0.32; T4 0.52±0.11ug-g-1creatinine), DNA damage (T0: 3.04±0.83; T1 4.57±1.51; T2 5.09±2.79; T3 7.78±2.42; T4 4.37±2.05ng.mL-1), inflammatory status (T0: 4.68±1.07; T1 4.65±0.97; T2 6.26±1.8

CONCLUSION: The findings of this study highlight the bio-physiological adaptability of Alpine soldiers in response to the extreme environmental conditions of high-altitude and cold exposure. Their ability to endure hypoxia and cold is a testament to their resilience, discipline, and physical preparedness. The observed increase in oxidative stress markers, inflammation, and hormonal shifts underscores the bodys complex response to such challenges, necessitating precise physiological adjustments. The rise in cortisol and leptin levels further reflects the metabolic and endocrine demands imposed by altitude.

These preliminary results contribute to a deeper understanding of the biological responses to extreme conditions and reinforce the importance of targeted training and acclimatization strategies. Ultimately, this research not only advances scientific knowledge but also honors the exceptional adaptability of military personnel in extreme environments.

**PHYSICAL FATIGUE INDUCED BY MILITARY OPERATIONS IN HYPOXIC AND COLD ENVIRONMENT**

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INTRODUCTION: The Arctic environment is a strategic area in the military context. However, it also features different extreme environmental stressors, such as cold and hypoxia, which combined could affect soldiers' physical performance, especially when considering prolonged military tasks. The purpose of this study was to explore the effects of operating in a hypoxic and cold environment (HCE) on the physical fatigability of three different groups of alpine soldiers.

METHODS: Thirty-four soldiers specialized in mountain warfare (Alpine Corp) were tested before, during and after 3 days of military training (1-2-3/12 2024), on the Mont Blanc (3375m). Additional tests were conducted at 551m, four days before and 14 days after training. Soldiers were divided in 3 different groups, based on their experience and operational role: A (alpine lieutenant), B (alpine special forces), C (alpine specialized guides). Each day, soldiers were tested before and after the military operation session consisting of trekking and survival skills. Pre-operation measures included the Groningen Sleep Quality and the Fatigue scales, a 5-min psychomotor vigilance task (PVT), and a 5-min Astrand-Rhyming step test. After operating, soldiers repeated PVT and the step test. In addition, they rated the effort (session RPE), the workload (NASA-TLX) experienced during the operating session and the subjective fatigue changes compared to pre-military operation (Fatigability scale). Mixed ANOVAs were used to test the effects of Group, Day and, when relevant, Time. Significance was set at $p<0.05$.

RESULTS: All the NASA-TLX variables were significantly higher in HCE compared to low altitude, confirming that military operation was perceived significantly more effortful and more physically demanding in HCE ($p <0.05$). All the step test variables deteriorated in HCE (main effects of Day $p <0.001$) and further increased after the military operation sessions in this environment. There were no significant difference between groups in these responses.

CONCLUSION: These results show that even soldiers specifically trained for mountain warfare suffer from negative effects of HCE which include higher physical demands during military operation and greater fatigability. Furthermore, we demonstrated that hypoxia has increased heart rate, blood lactate, perceived leg effort and dyspnea. Operating in this hypoxic,

cold and challenging environment has further exacerbated those negative effects. Countermeasures are warranted for the negative effects of hypoxia and of operating in HCE on soldiers' physical performance.

**TEMPORAL EFFECTS OF ACUTE EXPOSURE TO A SUB-PLATEAU REGION ON THE AEROBIC CAPACITY OF ELITE MALE COLLEGIATE ATHLETES IN CHINA**

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INTRODUCTION: Upon acute entry into altitude regions, particularly sub-plateau areas, an athlete's aerobic capacity does not exhibit a linear change. This study aims to investigate the time-sequenced effects of acute entry into sub-plateau regions on the aerobic capacity of elite collegiate athletes.

METHODS: Ten male collegiate athletes, aged 19–23 years, who are native to lowland areas and hold national first-class or higher sports qualifications, were recruited for this study. Their specialized events included middle- and long-distance running and race walking. None of the participants had a history of high-altitude training in the past six months. Before traveling to the training base at an altitude of 1,300 meters, baseline tests were conducted in Beijing (altitude: 50 meters). After 48 hours of rest, the participants traveled by plane together and arrived at the sub-plateau base in the evening. Participants were instructed to avoid strenuous exercise the day before each test, refrain from consuming alcohol or other stimulants, and not take any medications that could influence test results. They were also required to maintain adequate sleep and a regular diet. To simulate the preparation process for marathon races held in sub-plateau regions, a longitudinal tracking study was conducted. Testing time points were as follows:T0: Baseline test in a lowland region (altitude: 50 meters),T1: Morning of the second day post-arrival,T2: Morning of the fourth day post-arrival,T3: Morning of the sixth day post-arrival. The ambient temperature was maintained at 23–25°C, and the wind speed remained at a gentle breeze level. Maximal oxygen uptake ($VO_2$ max) was measured using a progressive incremental load field test. After a 15-minute jogging warm-up, participants rested for 20 minutes before undergoing an incremental load test while wearing a cardiopulmonary exercise testing device (Cortex, MetaMax3B R2, Germany). The testing protocol consisted of running one lap each at speeds of 6 km/h and 8 km/h, followed by two laps at 10 km/h. Thereafter, the speed was increased by 2 km/h every two laps.

RESULTS: The $VO_2$ max at T1 decreased compared to T0, but without statistical significance. The $VO_2$ max at T2 was significantly lower than at both T0 and T1($p<0.05$), while at T3, it decreased compared to T0, but without statistical significance. The maximal running speed at T2 was significantly lower than at T0, whereas no significant differences were observed across other test sessions. No significant differences were found in maximal heart rate among all test sessions. At speed of 14 km/h, running economy at T2 was significantly lower than at T0 and T1, and the blood lactate concentration at T2 was significantly higher than at T1 and T3.

CONCLUSION: The negative impact on aerobic capacity was most pronounced on the fourth day after arrival at the sub-plateau region. It is recommended that marathon participation be scheduled on the second or sixth day post-arrival, while avoiding competition on the fourth day.

**NO INCREASE IN TOTAL HEMOGLOBIN MASS FOLLOWING 21 DAYS OF LIVE HIGH TRAIN HIGH ALTITUDE TRAINING IN ELITE TRIATHLETES**

FAUCHER, C., CARIN, R., MARTIN, M., DUCRAY, M., LAGARDE, H., CONNES, P., TRESSIÈRES, B., ESCOFFIER, C., LIBICZ, S., LALIRE, P., BIRAT, A., GASTON, A.-F., LACROIX, J., DOUCENDE, G., STAUFFER, E., BRUGNIAUX, J., VERGES, S., BROCHERIE, F., NADER, E., ROBACH, P., PICHON, A.
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INTRODUCTION: Live High Train High (LHTH) altitude training can increase total hemoglobin mass (Hbmass). However, this response is not systematically observed. Several factors such as training load, prior environmental exposure (heat, hypoxia), season period or iron supplementation, may influence this response. This study aims to assess the hematological effects of an altitude training camp in elite athletes.

METHODS: Elite triathletes (n=9, 2 women) completed a three-weeks altitude training camp (1850m ) with additional nocturnal exposure in a hypoxic chamber (2299±204m). Blood samples were collected before (Pre) and after (Post) altitude training to assess reticulocyte percentage (%Ret), CD71 positive red blood cells (CD71, %), hematocrit (Hct, %) and hemoglobin concentration ([Hb], g/dL). Plasma volume (PV) and Hbmass (g) were measured using the CO-rebreathing method. Training load (TL, Foster method) and hypoxic dose (HD, km.h) were monitored. Paired t-tests or Wilcoxon tests were used to compare Pre and Post values.

RESULTS: After altitude training, PV significantly decreased (-734.9 mL; $p < 0.05$), while Hct (+5.0%) and [Hb] (+1.5 g/dL) significantly increased ($p < 0.05$). However, Hbmass remained unchanged (Pre = 1028±168g; Post = 1029±173g; $p = 0.944$). %Ret showed a trend toward an increase (+0.22%; $p = 0.062$), indicating ongoing erythropoietic activity, further supported by an increase in CD71 (Pre = 0.18±0.13%; Post = 0.71±0.40%; $p < 0.05$). Finally, training load was not significantly different between the 3 weeks preceding altitude training (13293±4200) and the altitude period (15672±2839) ($p = 0.965$).

CONCLUSION: Despite a substantial hypoxic stimulus (HD=1043±39km.h), no increase in Hbmass was observed following altitude training. This altitude training camp was planned between two competition periods and athletes already had a high baseline Hbmass values, which may have limited the potential gains. This unexpected result occurred despite ongo-

ing erythropoietic activity and could be also explained by prior plasma volume expansion due to heat acclimation during the weeks preceding altitude exposure. Indeed, in the 3 weeks before altitude exposure, temperatures were significantly higher (26.3 ± 2.4°C vs. 20.5 ± 0.0°C during altitude camp; $p < 0.05$). The contraction of PV in altitude may have limited any additional increase in Hbmass.

Despite a typical hypoxic stimulus, no significant improvement in Hbmass was observed in elite triathletes following altitude training. Prior heat exposure and seasonal context may have influenced the hematological response and should be considered when designing altitude training protocols.

## Oral Presentations

### OP-MH26 Physical Activity and Body Composition in Children

**LEAN MASS TRAJECTORIES IN CHILDREN AND ADOLESCENTS AND THEIR IMPACT ON BONE HEALTH: IOWA BONE DEVELOPMENT STUDY**

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INTRODUCTION: The development of lean and fat mass during childhood and adolescence plays a crucial role in lifelong musculoskeletal health. Lean mass contributes to bone loading and remodelling, while fat mass affects hormonal and inflammatory pathways that can influence bone density. However, the specific effects of various lean mass trajectories on bone health remain unclear. This study aimed to examine the trajectories of lean mass development in children and adolescents and their effects on bone health in young adulthood. Utilising the appendicular lean body mass index (aLBMI) and the ratio of aLBM to trunk fat mass (aLBM/TrFM), the objective was to identify risk profiles for sarcopenia during growth, with bone mineral density (BMD) in adulthood measured for the whole body less head (WBLH), femoral neck, and trochanter; additionally, the BMD ratio of arms to legs and body height were included as outcomes.

METHODS: The sample consisted of 323 participants (both sexes) aged 8 to 23 years from the Iowa Bone Development Study (IBDS), assessed at ages 8, 11, 13, 15, 17, and 23. Lean mass indices (aLBMI, aLBM/trFBM) and bone mineral densities (BMDs) were measured using whole-body and proximal femur DXA scans. Z-scores for lean mass indices were calculated based on published values (aLBMI) or derived data (aLBM/trunkFBM). Participants who consistently followed the same trajectory throughout the follow-up were included in the analysis (116 for aLBMI and 67 for aLBM/TrunkFBM trajectories) and were categorised into sarcopenia risk (Z score ≤ -1), average (Z score between -1 and 1), and robustness (Z score > 1) trajectories.

RESULTS: Compared to the average trajectory, linear regression analyses adjusted for sex and height indicated that the aLBMI risk trajectory was associated with decreased BMD: 9% in the WBLH (p=0.001), 12% in the femoral neck (p=0.001), and 12% in the trochanter (p=0.002). Conversely, the robustness trajectory was linked to increased BMD: 4% in WBLH ($p \leq 0.001$), 7% in the femoral neck ($p \leq 0.001$), and 6% in the trochanter (p=0.002). For aLBM/TrFM, the robustness trajectory showed a 9% increase in WBLH BMD (p=0.031). No other differences were observed.

CONCLUSION: A low aLBMI trajectory is a significant risk factor for bone mineralisation in the whole body and femoral regions. Conversely, a low lean mass to fat mass ratio appears to have no risk to bone health. These findings underscore the importance of early identification and monitoring of lean mass trajectories to support optimal bone health during growth.

**ANALYSIS OF THE CHANGES IN THE OVERWEIGHT AND OBESITY STATUS AND INFLUENCING FACTORS AMONG CHILDREN AND ADOLESCENTS IN MACAU FROM 2005 TO 2020**

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INTRODUCTION: To analyze the prevalence trends and influencing factors of overweight and obesity among children and adolescents in Macau from 2005 to 2020, and to provide a basis for formulating targeted intervention strategies.

METHODS: Based on the physical fitness monitoring database of Macau residents, a stratified random sampling method was used to select 21,031 children and adolescents aged 6 to 22 years old. Through frequency analysis, chi-square test and multiple logistic regression, the changing trends of the detection rates of overweight and obesity and their influencing factors were explored.

RESULTS: From 2005 to 2020, the total detection rate of overweight and obesity among children and adolescents in Macau increased from 17.2% to 26.9% ($\chi^2$=182.3, p<0.001). The growth rate of males was significantly higher than that of females, and females showed a downward inflection point for the first time in 2020. The age distribution showed that the prevalence rates of overweight and obesity were higher in the groups aged 6 to 11 years and 18 to 22 years, while it showed a downward trend in the group aged 12 to 18 years. Multiple regression analysis showed that poor performance in physical education classes (OR = 2.337 - 2.390), and parental obesity (father: (OR = 2.070), mother: (OR = 1.771)) were risk factors for overweight and obesity; doing warm-up exercises before sports (OR = 0.373), participating in non-sports interest classes (OR = 0.459) and moderate physical exercise (OR = 0.524 - 0.597) were protective factors. In addition, using electronic

products for ≥ 4 hours on weekends (p = 0.003) and not participating in interest classes (p = 0.016) were significantly associated with an increased risk of obesity.

CONCLUSION: These findings highlight that adolescence is a crucial transitional period for weight management intervention. Gender-specific prevention strategies should prioritize the male population while maintaining the positive trend among the female population. Family-school collaborative interventions targeting the reduction of screen time, cultivation of an active lifestyle, and parental health models show particular promise. Policy recommendations suggest integrating a mandatory physical activity monitoring system and establishing community-based family health programs to counteract the environmental factors contributing to obesity.

**EVALUATION OF A CO-CONSTRUCTED MULTI-LEVEL INTERVENTION TO REDUCE SEDENTARY BEHAVIOUR IN PRIMARY SCHOOL CHILDREN: A CLUSTER-RANDOMIZED CONTROLLED TRIAL.**

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INTRODUCTION: Sedentary behaviour is linked to negative health outcomes, including unfavourable body composition and chronic diseases like cancer, diabetes, and obesity. A large proportion of French children do not meet WHO activity guidelines (66% of 11-17 and 37% of 6-10 year-olds). Therefore, interventions reducing sedentary time (ST) in children are a major public health priority. This study evaluates the CIPRES multi-level intervention, grounded in socio-ecological and trans-contextual models, using a cluster-randomised controlled trial.

METHODS: This study involved 1042 children in Years 4 and 5 (aged 8-10) from 13 primary schools across four French municipalities randomly assigned to the CIPRES or Control group. The intervention lasted for 6 weeks and consisted of activities grounded in the trans-contextual model. The activities were designed for children and implemented by teachers, educators and parents. The primary outcome was ST, assessed by GT3X+ accelerometers, across weekly (7:00 am-10:00 pm), school days (4:30-10:00 pm), and non-school days (7:00 am-10:00 pm) periods. Secondary outcomes included moderate to vigorous physical activity (MVPA), Quality of Life, and body mass index. Data were collected at baseline and 6 weeks follow-up.

RESULTS: For the entire week (7:00 am-10:00 pm), significant group-by-time interactions were evident for both ST (p=0.029) and MVPA percentage (p=0.015). For weekly ST, no significant change was observed in the CIPRES group compared to a significant increase in the control group (0.1 Pp, p=0.820 and 1.4 Pp, p=0.001, respectively). Weekly MVPA showed a trend towards increase in the CIPRES group and a trend towards decrease in the control group (0.4 Pp, p=0.099 and -0.4 Pp, p=0.073, respectively). During school days (4:30-10:00 pm), a significant group-by-time interaction was found for both ST (p=0.005) and MVPA percentage (p=0.004). The CIPRES group demonstrated a significant reduction in ST (-1.5 percentage points [Pp], p=0.026) and a significant increase in MVPA (0.8 Pp, p=0.025), whereas the control group showed a trend towards increased ST (1.2 Pp, p=0.078) and decreased MVPA (-0.7 Pp, p=0.058). However, during non-school days, no significant group-by-time interactions were found. In addition, body mass index or quality of life were not significantly changed.

CONCLUSION: CIPRES intervention effectively reduced ST and increased MVPA during school days (4:30-10:00 pm), with these benefits extending across the entire week (7:00 am-10:00 pm). Significant changes, however, were not observed on non-school days. CIPRES intervention, anchored on both the trans-contextual and the socio-ecological model, therefore offers a novel framework for future school-based interventions to promote more active and less sedentary behaviour in primary school children.

**WEIGHT STATUS AND BASIC MOTOR COMPETENCIES IN ITALIAN SCHOOLCHILDREN: CROSS-SECTIONAL RESULTS FROM THE MOTION STUDY**

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INTRODUCTION: The rise in pediatric obesity is a growing concern, leading to higher healthcare costs (NCD Risk Factor Collaboration (NCD-RisC), 2024). The development of motor competence (MC) appears to influence physical activity participation, and previous studies suggest a negative relationship between MC and obesity; however, these studies are often limited to specific age groups.

Basic motor competence (BMC), a fundamental component of the broader motor competence (MC), is an essential prerequisite for engagement in physical activity and the development of more complex motor skills, especially in physical education (Herrmann et al., 2015)

The present study aims to investigate the relationship between basic motor competence (BMC) and obesity in children from preschool to class 6, examining how this relationship varies across school classes.

METHODS: The BMC of 1495 children in Northern Italy was assessed using the MOBAK test, which evaluates object control and self-movement skills. BMI z-scores were computed to determine weight status. Logistic regression was used to calculate adjusted odds ratios for obesity risk based on BMC levels. Bivariate correlation examined the relationship between BMC and BMI z-scores, while linear regression analyzed how object control, self-movement, and combined BMC scores correlated with BMI.

RESULTS: A strong inverse relationship was found between all BMC domains and obesity odds, independent of sex. Self-movement skills showed a stronger association with obesity than object movement skills. The association between BMC and BMI z-scores remained consistent across classes 3–5 after adjusting for sex.

CONCLUSION: This study highlights the inverse relationship between BMC and BMI z-scores in Italian schoolchildren, particularly in grades 3–5. The stronger association observed with self-movement skills suggests that obesity prevention strategies should prioritize the development of these competencies. Moreover, to ensure that children with higher BMI perceive themselves as capable, it is essential to adopt assessment methods that consider their body composition and functional abilities.

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**LINKING METABOLIC SYNDROME AND PHYSICAL FITNESS IN CHILDREN WITH OBESITY: A CROSS-SECTIONAL STUDY FROM THE PODIACAR PROJECT**

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INTRODUCTION: Paediatric obesity is a major public health issue, recognised by the World Health Organization. Metabolic syndrome (MetS), linked to cardiovascular (CV) morbidity and mortality, affects about 29.2% of children with obesity [1]. Physical fitness (PF) is a key indicator of long-term health, impacting CV risk and mortality; yet only few studies have examined its association with MetS. This study aims to analyse the relationship between PF and MetS in children with obesity [2].

METHODS: We performed a cross-sectional study evaluating 55 children with obesity (11.96 ± 2.35 years; 21 [38%] girls; mean BMI 29.5 ± 4.81 kg/m2 and BMI z-score 3.15 ± 0.78). Physical fitness was assessed with the 6-minute walking test (6MWT), standing broad jump (SBJ), and 4×10 m shuttle run test (SHT). MetS z-score assesses MetS, using sex-specific formulas (cut-off > 0.75). A fasting blood sample was collected and analysed for total cholesterol, HDL-C, triglycerides, fasting glucose (FG), and insulin. Insulin resistance was estimated using HOMA-IR and TyG index.

RESULTS: In both sexes, the SBJ test was inversely correlated with MetS odds independent of age (OR: 0.18, 95%, CI: 0.04–0.53). The 6MWT and SHT were not related to the odds of MetS. The SBJ showed an inverse association (BMI z-score: $\beta$=-0.528; SBP: $\beta$=-0.397; MetS z-score: $\beta$=-0.299; all $p < 0.05$) with the MetS z-score and its components, except for HDL, FG and triglycerides (respectively $\beta$=0.335, $\beta$=0.429 and $\beta$=0.354) showing a positive association. The SHT was associated with BMI z-score ($\beta$=0.419), systolic blood pressure ($\beta$=0.419), and FG ($\beta$=-0.331; all $p < 0.05$), while the 6MWT was inversely related to BMI z-score ($\beta$=0.295; $p < 0.05$).

CONCLUSION: Our findings highlight an inverse relationship between PF and MetS, showing the strongest association with lower limb strength, assessed with the SBJ. These results reveal the importance of including PF assessments into the clinical evaluation of children with obesity. Future research should explore the mechanisms underlying this relationship and assess targeted exercise programs for MetS prevention in children with obesity.

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2. Jebeile, H.; Kelly, A.S.; O'Malley, G.; Baur, L.A. Obesity in Children and Adolescents: Epidemiology, Causes, Assessment, and Management. The Lancet Diabetes & Endocrinology 2022, 10, 351–365, doi:10.1016/S2213-8587(22)00047-X.

## Oral Presentations

### OP-AP42 Statistics and Analyses I - Endurance Sports

**A NOVEL BIOENERGETIC MODEL OF SPRINT RUNNING PERFORMANCE**

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INTRODUCTION: While the short duration and high-intensity nature of sprint events hinder direct measurement of metabolic demands, a robust bioenergetic model can illuminate the interplay among aerobic, anaerobic lactic, and anaerobic alactic pathways. Although existing bioenergetic approaches indirectly capture sprinting's energy contributions, they often

underestimate the anaerobic alactic component. For instance, di Prampero et al. [1,2] noted that early acceleration phases present high metabolic power peaks, likely driven by alactic energy expenditure. Building on these insights, the aim of the present study is to propose a comprehensive bioenergetic model of sprint running, detailing the time course of aerobic, anaerobic lactic, and anaerobic alactic contributions across 100–400 m distances.

METHODS: Velocity data from the 2009 World Athletics Championships [3] were used to estimate the metabolic power of men's and women's winning 100, 200, and 400 m performances, following the approach by di Prampero et al. [1,2]. Aerobic, anaerobic lactic and alactic power contributions were each represented by distinct mathematical functions: exponentially rising (aerobic), bi-exponential (anaerobic lactic) and log-normal (anaerobic alactic) functions. From these fits, total anaerobic lactic and alactic energy expenditures were derived, enabling the calculation of maximal anaerobic capacities for male and female athletes. Model validation involved simulating each race distance and comparing the simulated performances to actual results [3].

RESULTS: The model accurately predicted metabolic power trajectories for all sprint distances, with R2 ranging between 0.94 and 0.98. Estimated anaerobic alactic capacities were 376 J/kg (men) and 259 J/kg (women), while anaerobic lactic capacities were 1314 J/kg (men) and 1194 J/kg (women), consistent with theoretical expectations [2]. Anaerobic metabolism accounted for ~95%, 88%, and 70% of total energy in the men's 100, 200, and 400 m events, and ~93%, 86%, and 69% for the women's events. Mean percentage differences between actual and simulated distances was 0.31% (men) and 1.05% (women), with higher discrepancy in the women's results potentially reflecting an underestimation of anaerobic lactic contributions.

CONCLUSION: This bioenergetic model provides a detailed account of aerobic and anaerobic energy contributions during sprinting, aligning closely with theoretical and empirical data. Its framework offers insights into sprint bioenergetics, informing future modelling efforts and performance optimization. Further investigation across a broader range of distances is warranted to refine model functions and parameter estimates.

1. di Prampero et al., 2005; 2. di Prampero & Osgnach, 2018; 3. Graubner & Nixdorf, 2011

**UNDERSTANDING PERFORMANCE VARIABILITY IN ELITE TRAIL RUNNERS ACROSS DIFFERENT COMPETITIONS**

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INTRODUCTION: Identifying the smallest worthwhile performance improvement is essential for coaches and researchers to assess the impact of training strategies and tapering in elite sports. This improvement is typically defined as 0.3 times the standard deviation of an athlete's race-to-race performance variability, which corresponds to gaining one additional medal every 10 competitions for those already competing at the highest level. However, since performance variability varies considerably across sports (ranging from 0.3% to 7.0%), sport-specific assessments are necessary to determine meaningful improvements. Therefore, this study aimed to estimate the variability between- and within- athletes, as well as the predictability of performance times across competitions in elite trail running (1)

METHODS: For the purpose of this study, we considered elite male athletes with an ITRA score of 825 or higher (n = 941). We collected race results from the main international trail running events, including the Golden Trail World Series, Skyrunning World Series, World Mountain Running Association, major championships (World and European), and key ultratrail races from the 2024 season (56 races). A MATLAB script matched each athlete with his race times, and races were classified into ITRA categories: uphill-only (UP), XS, S, M-L, and XL-XXL (based on length and elevation profile). Between-athlete variability was expressed as the standard deviation (SD) of the coefficient of variation (CV) across athletes, while within-athlete variability was assessed using CV and SD of performance times. Performance predictability was evaluated with the intraclass correlation coefficient (ICC), with uncertainty expressed as 90% confidence limits. All analyses were performed using Hopkin's spreadsheet (2)

RESULTS: Between-athlete variability ranged from 5.43% in the UP category to 8.49% in XL-XXL, with XS (5.96%), S (7.24%), and M-L (6.66%) in between. Within-athlete variability was lower, with values ranging from 3.18% in XS to 5.34% in S, and 3.98%, 4.46%, and 4.32% for XS, M-L, and XL-XXL, respectively. ICC for performance predictability were moderate for UP (0.46) and S (0.45), and very high for XS (0.71) and XL-XXL (0.73), with M-L showing a high ICC (0.55).

CONCLUSION: This study provides a detailed analysis of performance variability and predictability in elite trail running. Between-athlete variability was highest in the XL-XXL category, while within-athlete variability was relatively lower across all categories. Performance predictability was moderate to high across most categories, with the highest ICC values observed in the XS and XL-XXL groups. These findings highlight the importance of sport-specific assessments for evaluating performance improvements and understanding the variability in elite trail running. Coaches and researchers can use these insights to tailor better training and tapering strategies for athletes at the highest competitive levels.

1. Skattebo & Losnegard, 2018

2. Hopkins, 2015

**AN EMPIRICAL STUDY ON THE PACING PROFILES OF FEMALE 20KM RACE WALKERS AT THE PARIS OLYMPICS**

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INTRODUCTION: Pacing profiles play a critical role in race walking performance. This study aims to analyze the differences in pacing profiles, speed control capabilities, and the correlation between the ability to reproduce personal best performances and race results among female 20km race walkers of different competitive levels at the 2024 Paris Olympics.

METHODS: This study utilized competition data from 43 female athletes who completed the 20km race walk at the 2024 Paris Olympics. Data were sourced from the official websites of the Paris Olympics and World Athletics. A quasi-experimental design was adopted, with athletes divided into four groups based on their final rankings (Group A: 1st–11th; Group B: 12th–22nd; Group C: 23rd–32nd; Group D: 33rd–43rd). Key variables included split times for each 1km segment, average speed per 5km, starting speed (average speed over the first 2km), peak speed, and the coefficient of speed variation. When data exhibited a normal distribution, analysis of variance (ANOVA), Pearson correlation analysis, and independent samples t-tests were employed to explore differences in pacing profiles, starting speed, peak speed, and the ability to reproduce personal best performances among the groups.

RESULTS: ANOVA results for 5km split speeds across groups revealed significant differences ($p < 0.05$), with the disparities becoming more pronounced as the race progressed. Athletes in Group A exhibited significantly higher peak speeds compared to other groups ($p < 0.05$). While the starting speeds of Group A and Group B athletes showed no significant difference ($p > 0.05$), Group As starting speed was significantly higher than that of Groups C and D ($p < 0.05$). The time at which athletes fell below their starting speed varied across groups, with Group A maintaining their starting speed longer than other groups. The race results at the Paris Olympics showed a significant positive correlation with peak speed ($r = 0.805$, $p < 0.001$) and starting speed ($r = 0.880$, $p < 0.001$). Additionally, the ability to reproduce personal best performances was positively correlated with final Olympic rankings ($r = 0.518$, $p < 0.01$).

CONCLUSION: Athletes in different groups demonstrated distinct pacing profiles. Group A athletes primarily adopted a negative-split strategy, maintaining a conservative pace in the first half of the race, gradually increasing speed, and finishing with a strong sprint. In contrast, athletes in Groups B, C, and D tended to adopt a positive pacing strategy, reaching their peak speed earlier and subsequently slowing down. Higher-ranked athletes exhibited superior speed control, characterized by smaller variations in starting speed, peak speed, and split speeds, later occurrence of peak speed, and a delayed drop below starting speed, which contributed to their stronger finishing capabilities. These athletes were also more capable of delivering performances close to their personal bests in the Olympic setting.4

**ASSOCIATION BETWEEN AMBIENT TEMPERATURE AND COMPETITION PERFORMANCE OF WORLD-CLASS 20KM RACE WALKERS: DIFFERENT RESULTS ACROSS SEGMENTS**

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INTRODUCTION: Ambient temperature has a significant impact on endurance sport performance, which is why world-class elite race walkers undergo heat acclimatization training before the Olympics and World Championships, with a cooling program for each 1km during the competition [1]. But how much did the ambient temperature affect the performance of each segment in the competitions? There is still a lack of quantitative evidence. The aim of this study was to assess the association between ambient temperature and competition performance of world-class 20km race walkers on a segmental scale, to provide a more accurate reference for heat acclimatization and cooling down.

METHODS: The investigated competitions were the mens and womens 20km race walking in the 7 Olympic Games and World Championships during the years 2015-2023. The top 8 athletes of each race were included. Ambient temperature variables were pre-race and post-race temperatures, with data collected from official reports or the Weather Spark platform, and ICC was calculated to confirm their consistency. Performance variables were marks per km, with data collected from official reports or official videos. 3 analyses were conducted. 1) 2-sided Pearson correlation analysis was performed with significance set at $p<0.05$. 2) Causal path diagrams were plotted by conditional independence test. And 3) linear regression models were fitted based on the previous 2 analyses results.

RESULTS: (1) Both mens and womens overall mark had the strongest correlation with pre-race temperature ($r(56)=0.770$, $r(56)= 0.691$, $p<0.001$). Womens first half was even stronger ($r(54)=0.782$, $p<0.001$), but the second half weaker ($r(54)=0.576$, $p<0.001$). Mens first half was also stronger ($r(52)=0.756$, $p<0.001$), but the second half turned insignificant. Womens 1-2km segment was the strongest ($r(32)=0.947$, $p<0.001$), so was mens 2-3km segment ($r(32)=0.875$, $p<0.001$). Here, the analysis of 1km segments only included years 2019-2023 with an average temperature of 27.4°C.

(2) The female data showed a path from the pre-race temperature, via the first half performance, and then to the second half performance. But the male data did not.

(3) The regression model for female athletes showed that for every 1°C increase in pre-race temperature, it resulted in a decrease of about 15.5 seconds in the first half performance ($R2=0.61$); the male model showed that for every 1°C increase in pre-race temperature, it resulted in a decrease of about 13.3 seconds in the first half performance ($R2 = 0.56$).

CONCLUSION: With the trend of increasing temperatures in race walking 20km competitions, world class athletes, especially women, should pay more attention to heat acclimatization and cooling down in the first half of the race to achieve the expected performance.

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**HOW SEX AFFECTS OXYGEN MANAGEMENT IN MUSCLE AFTER HIGH-INTENSITY AEROBIC INTERVAL TRAINING: INITIAL OBSERVATIONS**

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INTRODUCTION: High-intensity interval training (HIIT) improves maximal oxygen uptake (VO2max), primarily through cardiac adaptations. However, positive adaptations should also happen in muscle oxidative capacities, which notably differ for sex. This study investigates how near-maximal HIIT affects VO2max and mitochondrial oxidative capacity in sex differences.

METHODS: A running incremental test and intrinsic mitochondrial respiration in permeabilized vastus lateralis fibers were conducted in 8 young healthy males and 5 females, one week before and 3 days after a 6-week HIIT program (3 days/week). The HIIT consisted of 4x4 min of interval running (4min of running at 90-95%HRmax followed by 3min of active resting at 70%HRmax).

RESULTS: HITT significantly increased females' (49.4±5.6 to 52.9±6.9 L/min, p=0.046) but not males' (6.2±3.2 vs. 60.9±4.1 L/min, p=0.381) VO2max. Unexpectedly, the mitochondrial net oxidative capacity decreased significantly in females by 17.3±9.7% (p=0.01) and in males by 33.0±21.8% (p=0.01). In females, the decline in mitochondrial performance was apparent as early as the Complex I-linked substrate state following ADP addition (all, p<0.022). In contrast, males exhibited significant differences only at the point of maximal coupled and uncoupled mitochondrial respiration (mitochondrial surrogate for VO2max) (all, p<0.040), where the Complex II-linked substrate state is predominant.

CONCLUSION: Near-maximal HIIT increased VO2max in females, but unexpectedly reduced mitochondrial oxidative capacity. In contrast, males maintained their $VO_2$max but experienced a more pronounced decline in muscle oxidative capacity, primarily driven by reductions in Complex II-linked respiration. These responses may reflect increased mitochondrial O2 affinity (reduced p50mito), as shown by Larsen, et al. [1]. The statistical power of the study will be further strengthened as participant recruitment remains ongoing.

1. Larsen, F. J., et al., Acta Physiologica 2020, 229 (3), e13463. DOI https://doi.org/10.1111/apha.13463.

## Oral Presentations

### OP-PN09 Nutrition VI - Mixed

**EFFECTS OF A 16-WEEK DIGITAL INTERVENTION ON SPORTS NUTRITION KNOWLEDGE AND RELATIVE ENERGY DEFICIENCY IN SPORTS (REDS) MARKERS AMONG SWISS NATIONAL TEAM CROSS-COUNTRY SKIERS AND BIATHLETES**

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INTRODUCTION: Endurance athletes with high training loads have increased risk of low energy availability (LEA) and Relative Energy Deficiency in sport (REDs). The aim of this study was to evaluate the effects of a 16-week nutritional digital intervention on sports nutrition knowledge and REDs markers among Swiss national team cross-country skiers and biathletes.

METHODS: Swiss national team cross-country skiers and biathletes (21 females, 13 males; 24 ±4 years, training 19 hours/week, VO2max 63 ±8 ml/kg/min) were evaluated of REDs severity using the International Olympic Committee Clinical Assessment Tool (CAT) 2; menstrual disturbances (MD), risk of eating disorders (Eating Disorder Examination Questionnaire (EDE-Q)), levels of testosterone (males), triiodothyronine (T3), cholesterol, bone mineral density (DXA) and bone stress injury (BSI) history. Nutrition knowledge was assessed by a validated 78-item questionnaire for endurance athletes. The Food and nUtrition for Endurance athletes—a Learning (FUEL) program, comprising 16 weekly online lectures and individual athlete-centered nutrition counseling every other week, was administered to athletes both with and without REDs. Data was analyzed with McNemar test, Repeated Measures ANOVA and dependent t-tests.

RESULTS: Four males and nine females (39%) were categorized with REDs (12 mild, 1 moderate, 0 severe) PRE intervention and two males and three females (15%) (5 mild, 0 moderate, 0 severe) POST the intervention (p=0.02). Nutrition knowledge improved from PRE to POST for athletes with REDs (p=0.002, d=1.4 95% CI [0.50, 2.2]) and without REDs (n=9 males and 12 females), (p=0.007, d=1.2 95% CI [0.6, 1.8]). Athletes with REDs decreased their (EDE-Q) total global score (1.0±0.9 versus 0.5±0.6; p =0.03, d = -0.8 95% CI [-1.3, -0.08]) while no changes were seen among the athletes without REDs. Male athletes with REDs increased their testosterone levels (free 280 ± 94 vs. 418±37pmol/l; p=0.01, d=1.9) 95% CI [0.1, 3.5], and total 14±6 vs 20±4 nmol/L; p =0.003, d = 2.9 95% CI [0.50, 5.3]), from PRE to POST while no changes were seen among male athletes without REDs. The number of female athletes with MD (24 %, n=5) PRE decreased to 10 % n=2 POST intervention. No changes in T3, BSI, body weight, body composition estimates, or cholesterol levels were found in either group.

CONCLUSION: Athletes with REDs improved their sport nutrition knowledge and decreased their eating disorder pathology after participating in the FUEL program. Furthermore, male and female athletes with REDs improved testosterone levels

and menstrual status, respectively, indicating a decreased risk of clinical markers of REDs after participation in the FUEL program. However, further research with a larger sample is needed to confirm these findings.

**PHASE ANGLE IN THE CONTEXT OF LOW ENERGY AVAILABILITY – IS IT A GOOD PREDICTOR OF FEMALE CROSSFIT® ATHLETES' HORMONE LEVELS?**

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INTRODUCTION: The assessment of phase angle (PhA) is significant in the context of sports, as it plays a crucial role in potentially identifying functional impairments, such as overtraining syndrome (OTS), muscle injury, and related changes in fluid distribution. OTV and Relative Energy Deficiency in Sport (REDs) share symptom similarities initiating from a hypothalamic-pituitary origin, that can be influenced by low energy availability (LEA). Thus, the aim of the study is to verify if the PhA may be used as T3, leptin, and IGF-1 predictor in the scenario of LEA.

METHODS: This is a cross-sectional study with nonprobability sampling. Inclusion criteria: healthy female CrossFit® (CF) practitioners aged 18-39 years, training experience ≥1 year; 5-7 training sessions (5-7 hours) per week for ≥6 months for the recreational practitioners' group (RG); ≥12 hours of practice per week for ≥6 months for the elite group (EG). Subjects visited the laboratory once. They answered health, sociodemographic, and the Low Energy Availability in Females (LEAF-Q) questionnaires. Resting energy expenditure (REE) via indirect calorimetry and body composition (bioelectrical impedance analysis) were assessed in a fasting state, followed by blood test. Data were analyzed using Jamovi® 2.3.21 version.

RESULTS: Data of 43 subjects are presented as mean (SD). Students t-test showed no differences regarding age (33.1 (5.2) and 30.3 (6.2) years), body mass index (24.0 (1.8) and 25.9 (1.5) kg/m2), and REE (1618.8 (168.9) and 1647.8 (173.2) kcal/day) between RG (n=30) and EG (n=13), respectively. Body fat percentage (BF%: 23.3 (3.4) and 19.1 (2.7); $p < 0.001$), T3 levels (1.0 (0.3) and 0.8 (0.1) ng/mL; $p < 0.05$), and leptin levels (10.4 (7.5) and 2.4 (1.3) ng/mL; $p < 0.001$) were significantly lower in the EG. Fat free mass (FFM: 48.5 (4.2) and 55.2 (3.8) kg; $p < 0.001$) and IGF-1 levels (168.8 (48.6) and 207.2 (42.4) ng/mL; $p = 0.018$) were significantly higher in the EG. Energy availability was 22.0 (9.8) for RG and 21.4 (12.9) kcal/kg of FFM for EG. PhA was significantly different between EG and RG (t=4.94; p<0.001; MD: 1.20; d=1.66). PhA was positively correlated to FFM (r=0.56; p=0.005), FFM% ($p < 0.001$), and LEAF-Q score (r=0.341; p=0.029), and IGF-1 levels (r=0.318; p=0.045), but negatively correlated to T3 (r=-0.342; p=0.029) and leptin (r=-0.372; p=0.017) levels. After controlling for group, the linear regression model showed that group (EG) was positively associated with PhA, independently of FFM (B: 0.87; 95% CI: 0.31-3.16; 0.003). However, when controlling for variables of adjustment, PhA was not associated to T3 (B=-0.04; p=0.400), leptin (B=0.778; p=0.571), and IGF-1 (B=8.2; p=0.435) levels.

CONCLUSION: PhA was positively correlated to female CF athletes' FFM, the LEAF-Q score, and levels of T3, leptin, and IGF-1 and positively associated to the EG, but no association to hormone levels was found. More studies are necessary to verify the usefulness of PhA as a predictor of hormone levels in the LEA scenario.

**QUALITY OF LIFE IN FEMALE ENDURANCE ATHLETES AT RISK OF RELATIVE ENERGY DEFICIENCY IN SPORT: THE FUEL STUDY**

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INTRODUCTION: Quality of life (QOL) is an important research outcome measuring an individual's perception of their position in life. However, evidence concerning QOL in female endurance sports is lacking. Female endurance athletes are at high risk of Relative Energy Deficiency in Sport (REDs), a syndrome of impaired physiological and/or psychological functioning caused by problematic low energy availability (LEA). Thus. the aim of this study was to assess QOL in female endurance athletes with symptoms of REDs and investigate whether the Food and nUtrition for Endurance athletes – a Learning (FUEL) program affected QOL in this group of athletes.

METHODS: Female endurance athletes from Norway (n=60), Sweden (n=84), Ireland (n=17), and Germany (n=47) were recruited to the FUEL intervention consisting of 16 weekly online lectures combined with sports nutrition counseling every-other-week. Fifty athletes with symptoms of REDs [LEA in Females Questionnaire (LEAF-Q) score ≥ 8] and with low risk of eating disorders, no use of hormonal contraceptives, and no chronic diseases, were allocated to either the intervention (FUEL) condition (n=32) or the control (CON) condition (n=18). All but one completed the FUEL intervention, while three participants dropped out of the CON condition. Athletes completed the WHOQOL-BREF pre- and post-intervention and data were analyzed using a Bayesian mixed factor analysis of variance.

RESULTS: Self-rated QOL were 4.3 ± 0.5 for CON and 4.3 ± 0.8 for FUEL at pretest, which did not change after the intervention period (CON: 4.2 ± 0.7, FUEL: 4.4 ± 0.9). Likewise, satisfaction with one's health were 4.2 ± 0.8 for CON and 4.0 ± 0.7 for FUEL at pretest and did not change after the intervention period (CON: 4.1 ± 0.5, FUEL: 4.2 ± 0.9). Comparing CON and FUEL, no evidence for differences in change were found for Physical domain (CON pre: 79.6 ± 7.0, CON post: 82.7 ± 6.9; FUEL pre: 76.8 ± 13.5, FUEL post: 82.4 ± 13.0), Psychological domain (CON pre: 71.5 ± 10.6, CON post: 74.3 ± 12.2; FUEL pre: 73.6 ± 10.3, FUEL post: 75.9 ± 15.7), Social domain (CON pre: 68.1 ± 17.3, CON post: 65.4 ± 18.4; FUEL pre: 72.5 ± 15.7, FUEL post: 76.4 ± 16.1), or Environmental domain (CON pre: 80.7 ± 8.6, CON post: 84.6 ± 10.4; FUEL pre: 81.7 ± 10.9, FUEL post: 85.3 ± 12.8).

CONCLUSION: When comparing the FUEL and CON conditions, the results revealed that QOL did not change after the intervention period. This finding might be attributed to the context-specific nature of the FUEL intervention. The intervention content focused exclusively on information related to health and performance outcomes in endurance sport. Another explanation might be attributed to the complexity between various psychological reactions to problematic LEA exposure as they interact with other factors, such as the social environment and level of competition. Nevertheless, future studies need to focus on investigating prospective variability of QOL among female endurance athletes at risk of REDs.

**THE IMPACT OF A FIVE-WEEK RESISTANCE TRAINING PROGRAM WITH TIMED NUTRIENT INTAKE ON BODY COMPOSITION AND EXTRACELLULAR VESICLE-ASSOCIATED MIRNA PROFILES.**

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INTRODUCTION: The anabolic window hypothesis suggests that there is a limited time frame following exercise for optimized nutrient uptake and utilization. Prior research indicates that microRNAs (miRNAs) transported in extracellular vesicles (EVs) may play a crucial role in post-exercise adaptation, since small nucleic acids finely regulate protein synthesis. The aim of the present study was to examine the impact of physical exertion on conventional physiological parameters and expression profiles of miRNAs transported in EVs.

METHODS: Twenty male participants (age: 22±2 years) voluntarily engaged in a five-week hypertrophy-specific resistance training program with timed nutrient intake (maltodextrin, whey protein). Participants were assigned to one of three groups based on the timing of nutrient consumption relative to exercise: immediately post-exercise (AE), three hours post-exercise (AE3), or no nutrient intake (CTRL). We assessed body composition and quadriceps femoris muscle strength. Additionally, following the isolation of platelet-free plasma, we extracted small extracellular vesicles. Subsequently, total RNA was isolated from pooled vesicular samples, followed by miRNA profiling.

RESULTS: Compared to baseline measurements, skeletal muscle mass significantly increased in the AE (p=0.001) and AE3 (p=0.028) groups, while quadriceps femoris strength improved significantly in the AE group (p=0.032). Additionally, body fat percentage was significantly reduced in all three groups: AE (p=0.005), AE3 (p=0.024), and CTRL (p=0.005). The isolation of EVs was validated using transmission electron microscopy, exosome antibody array, and nanoparticle tracking analysis. Between-group comparisons revealed distinct expression profiles of EV-associated miRNAs. Specifically, 39 miRNAs exhibited differential expression in AE, whereas 13 miRNAs were differentially expressed in both AE3 and CTRL relative to baseline. Notably, let-7d-5p, hsa-miR-181b-5p, hsa-miR-222-3p, and hsa-miR-324-5p were differentially expressed between the AE and CTRL groups.

CONCLUSION: The observed increases in skeletal muscle mass in AE and AE3 groups suggest that both the resistance training program and macronutrient intake contributed to alterations in body composition. Findings further indicate that the timing of nutrient intake is closely associated with the efficacy of exercise in modulating body composition and quadriceps femoris strength. Additionally, the miR-181 family appears to be a key regulator of angiogenesis, while miR-222-3p and miR-324-5p may be involved in the mTOR pathway, a critical regulator of hypertrophy. These data suggest that EV-associated miRNAs may provide insight into the molecular mechanisms underlying the observed differences between groups.

**ENERGY EXPENDITURE OF MALE SOCCER PLAYERS FROM THE ENGLISH PREMIER LEAGUE DOES NOT DIFFER BETWEEN ONE-GAME AND TWO-GAME PER WEEK MICROCYCLES: A DOUBLY LABELLED WATER INVESTIGATION**

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INTRODUCTION: Determining energy requirements is vital for developing nutritional guidelines for elite soccer players (1). Research on total daily energy expenditure (TDEE) of English Premier League (EPL) players is limited, with one study reporting a mean TDEE of 3566 ± 585 kcal·day$^{-1}$ (2). Since then, the physical match demands (e.g. high-speed running (HSR) and sprint distances) of match play have increased significantly (3). Additionally, two-game per week (2GW) microcycles impose greater physical demands than one-game per week (1GW) microcycles (4). However, no studies have directly compared TDEE between these microcyles. Therefore, this study aimed to assess TDEE, dietary intake and external physical load in male EPL players during 1GW and 2GW microcycles.

METHODS: Nine male players from an EPL club were assessed over a 15-day in-season period, including a 1GW followed by a 2GW. TDEE was measured using the doubly labelled water (DLW) method and external physical loading was monitored via global positioning system. Self-reported energy intake was assessed using weighed food inventory and the remote food photographic method (RFPM) (5). Energy intake (EI) derived from DLW method was calculated through the adjustment of TDEE for changes in energy stores (6).

RESULTS: No differences were observed in accumulative total (25552 ± 3502 m vs 26360 ± 5462 m), HSR (1744 ± 536 m vs 1705 ± 752 m), or sprint distances (372 ± 150 m vs 324 ± 252 m) between 1GW and 2GW (all $p < 0.05$). Mean TDEE was 3551 ± 507 kcal·day-1, with no difference between 1GW (3554 ± 963 kcal·day-1) and 2GW (3467 ± 821 kcal·day-1, $p = 0.781$). Self-reported EI using RFPM (2975 ± 292 kcal·day-1) underestimated DLW derived EI estimates (3663 ± 665 kcal·day-1) by 724 ± 722 kcal·day-1 (18% error, $p = 0.026$). Carbohydrate (CHO) intake was significantly higher on match day (MD) (5.0 ± 1.1 g·kg BM-1·day-1) compared to the day before the match (MD-1) (3.5 ± 1.3 g·kg BM-1·day-1), the day after the match (MD+1) (3.0 ± 1.0 g·kg BM-1·day-1) and training day (3.0 ± 1.1 g·kg BM-1·day-1) (all $p < 0.05$).

CONCLUSION: TDEE in male EPL soccer players does not differ between 1GW and 2GW microcycles, likely due to similar weekly accumulative external load metrics, including total distance, HSR and sprint distances. Players practiced CHO periodization, with higher intake on MD, but intakes were below the recommended levels on MD-1, MD, MD+ 1 and training days. Practically, the lack of significant differences in TDEE between microcycles suggest that the current CHO guidelines (4-6 g·kg $BM^{-1}$·$day^{-1}$ on rest and training days and 6-8 g·kg $BM^{-1}$·$day^{-1}$ for MD-1, MD and MD+1) may adequately support the demands of elite soccer players during both microcycles.

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## Oral Presentations

### OP-SH16 Mentoring / Coaching

**EFFECTIVE COACHING PRACTICES AND BEHAVIOURS OF EXPERT PROFESSIONAL TENNIS COACHES**

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Introduction: Tennis ranks among the most widely followed sports globally, with a fanbase exceeding one billion and media revenues approaching $700 million. In light of its popularity and global success, it is not entirely surprising that professional tennis players and coaches face challenges inherent to the sport, including extensive travel, social isolation, and an income structure heavily reliant on performance outcomes. Although there is a large body of literature dedicated to effective coaching across different contexts (i.e., sport type, geography), little research has specifically explored coaching within the professional tennis environment.

Methods: The purpose of this study was to explore professional tennis coaches' perspectives of their unique coaching context, including how this context influenced their coaching practices. We conducted individual semi-structured interviews with five professional tennis coaches, each of whom was coaching a top 20 ranked player at the time of the study. On average, these coaches had over 15 years of tour coaching experience and had collectively guided male and female players to win four singles grand slam titles and one grand slam doubles title. Furthermore, this group of coaches had achieved more than 15 ATP titles with their current players. Using a reflexive thematic analysis, interviews were transcribed verbatim and arranged into codes, themes, and overarching themes (Braun et al., 2016).

Results: Our reflexive thematic analysis highlighted coaches' perceptions of a unique power-dynamic in which their player was their employer, potentially affecting the style and content of their coaching feedback. Coaches also emphasized the demanding nature of the tour on players, highlighting the importance of providing social support while also recognizing the importance of taking time apart to avoid relationship burnout. Furthermore, participants underlined the challenges incoming coaches face in learning to navigate this unique context, noting that the sport's competitive nature often made established coaches hesitant to provide mentorship.

Conclusions: Overall, this study is among the first to present qualitative data from an elite sample of professional tennis coaches who shared their perceptions of coaching within this distinctive coaching context. The findings provide valuable information to current and prospective professional individual-sport coaches by highlighting how some of the world's best tennis coaches navigate their environment, offering coaching strategies to enhance their coaching effectiveness and success.

**THE ROLE OF WOMENS FOOTBALL ACADEMIES IN SPORT DEVELOPMENT AND EDUCATION**

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Research on youth and talent development has increased significantly; however, women remain substantially underrepresented (Williams et al., 2020). The rapid global expansion of women's soccer is evident in its growing geographical reach, the number of registered players, and the establishment of soccer academies. In Hungary, a new talent development system was introduced in 2021 with the launch of six sports academies. This study focuses on the experiences of selection processes and expectations of players, coaches, and parents regarding the female academy system.

Data were collected from all six sports academies in Hungary. The sample comprised 262 female players, 37 coaches, and 218 parents (78%, 100% & 65% of the total population). A structured questionnaire using a 4-point Likert scale, along

with a document analysis of the academies pedagogical programs, was utilized. Data analysis included descriptive statistics, ANOVA, and qualitative content analysis.

Results revealed that both female players and parents rated "hope of success" (M=3.23±0.804) and "sense of talent" (M=3.16±0.789) as the most significant factors motivating their entry into the academy system. Factors such as the accessibility of soccer (M=2.03±1.078), its relative rarity among girls (M=2.01±1.089), and media influence (M=1.89±1.003) were considered less important. Moreover, parents placed significantly greater emphasis on expectations related to a sense of talent, a healthy lifestyle, and the hope of popularity compared to players ($p<0.05$), whereas players more strongly valued role modeling in soccer ($p<0.05$).

Regarding recruitment, 38% of players were automatically recruited from collaborating clubs, 31% were self-recruited, and a scout or coach selected 31%. Both players and parents expressed high expectations for high-level development opportunities provided by the academy (M=3.51±0.770). Additionally, coaches identified the professional support team (M=3.43±0.728) as their primary motivation for working within the academy system. The preparedness of coaches (M=3.63±0.740) and the effectiveness of the professional support team (M=3.57±0.784) were highlighted as key contributors to the academies' high level of functioning. Notably, 20.5% of respondents underscored the need for ensuring equal treatment and conditions between men and women in academies.

The academies' educational programs not only aim to develop successful soccer players but also prepare athletes for civil professions and promote further education. In addition to a dual career focus, these programs emphasize team spirit, mutual respect, and cooperation. The findings suggest that while the academies are considered important in all-around development by all parties, they also reveal important areas for future development.

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**OFF THE BEATEN TRACK: HOW COACHES AND ATHLETES NAVIGATE FEMALE-SPECIFIC TOPICS**

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INTRODUCTION: Communication between coaches and female athletes is essential when addressing six key topics: puberty, menstruation, injuries, body composition, coach-athlete relationships, and within-group communication. However, some coaches may experience challenges in communicating these topics due to limited knowledge or confidence. Effective communication on these issues can strengthen coach-athlete relationships, foster trust, and contribute to athlete well-being. This study examines (1) how female athletes and coaches perceive the importance of feeling safe communicating about these topics, (2) how coaches evaluate their own comfort and ability to address these topics, and (3) how coaches perceive their athletes' comfort in communicating personal thoughts.

METHODS: Two digital surveys were conducted: one with 779 coaches of female athletes (306 female coaches, mean age = 44 years, SD = 11.5years) and one with 1,323 female athletes aged 16 to 24 years (mean age = 19 years, SD = 2 years) in Norway and Sweden. Coaches rated the importance of feeling safe communicating about these six topics (rated from 1 = unimportant to 7 = very important). Athletes answered three questions: (1) how important they thought these conversations are, (2) how comfortable they felt engaging in the conversations, and (3) how comfortable they believed their athletes felt when communicating with them about the six topics. Latent profile analyses were conducted using Mplus.

RESULTS: Athletes rated communication on all six topics as highly important (M = 5.87-6.27, SD = .82-1.23). Coaches recognized this (M = 5.86-6.21, SD = 0.86-1.13) but reported lower comfort levels in communicating about these topics (M = 4.76-5.96, SD = 1.10-1.75). Individual sport coaches felt generally more comfortable than team sport coaches. The largest gaps were found in menstruation and body composition, where coaches felt significantly less comfortable. Coaches also rated their athletes' comfort in sharing as lower than their own, with female coaches perceiving their athletes as less comfortable than male coaches.

Discussion: Findings revealed a gap between the perceived importance of communication and coaches' comfort in addressing these topics. While athletes highly value these conversations, coaches—especially in team sports—often feel unprepared. Coaches also perceived their athletes as less comfortable sharing than they are in engaging, suggesting a misalignment in communication expectations. These findings highlight the need for fostering environments where athletes feel safer expressing personal concerns and where coaches are better prepared to respond effectively.

**EFFECTS OF 12-WEEK MINDFULNESS-BASED INTERVENTION ON EXECUTIVE FUNCTIONING SKILLS, BRAIN OXYGENATION, AND BIOMARKERS OF COGNITIVE FUNCTION IN BASEBALL PLAYERS: A RANDOMIZED CONTROLLED TRIAL**

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Purpose: While mindfulness has demonstrated efficacy in enhancing executive function in non-athletes through improved present-moment awareness and acceptance of current experiences, particularly regarding attention regulation and cognitive control, its neurocognitive mechanisms and the effects and underlying mechanisms of mindfulness-based intervention (MBI) on different executive functioning skills in athletic populations remain poorly understood. The purpose of this

randomized controlled trial tackles a novel and important topic by investigating the beneficial effects of 12-week MBI on executive functioning skills in baseball players—a population that faces unique cognitive and physical demands, and the associated neurophysiological and biochemical regulation mechanisms.

Methods: Thirty-four baseball players were randomly divided into the MBI group (11M/6F) and the control group (11M/6F). Executive functioning skills (N-back task for working memory, Stroop task for inhibitory control, and Switching task for cognitive flexibility) were tested before and after the intervention. Functional near-infrared spectroscopy (fNIRS) was used to record quantified hemodynamic responses in the prefrontal cortex through oxygenated hemoglobin concentration (Oxy-Hb) monitoring during the performance of executive function tasks. Biomarkers of cognitive function, including BDNF, IL-6, TNF-, and cortisol, were measured using enzyme-linked immunosorbent assays (ELISA).

Results: MBI improved all three executive function skills, with increased Oxy-Hb level in L-FPA during the task of working memory, increased Oxy-Hb level in R-VLPFC during the task of inhibitory control, and decreased Oxy-Hb level in R-FPA, M-FPA, and L-DLPFC during the task of cognitive flexibility. Furthermore, MBI increased circulating BDNF level and decreased IL-6 and cortisol levels. In addition, our correlation analyses showed that improvement in executive function (improved behavioral performances and changes in Oxy-Hb levels) were associated with changes in cortisol and inflammatory cytokines (TNF-α and IL-6).

Conclusion: A 12-week MBI improved three components of executive function in baseball players. This enhancement may be attributed to the MBI-induced reductions in cortisol and inflammatory cytokines (such as TNF-α and IL-6), which altered blood oxygen contents in specific brain regions, thereby promoting executive function.

**TALENTED ATHLETES' PERSPECTIVES ON TALENT DEVELOPMENT PROGRAMS: A COMPARATIVE ANALYSIS ACROSS SPORTS**

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INTRODUCTION: While traditional talent development models predominantly emphasize physical and technical aspects of athlete development (1, 2) less attention has been given to the broader developmental context, including environmental and policy-related influences (3, 4) Understanding how these external factors shape an athlete's experience and long-term success is crucial for optimizing talent pathways. Therefore, this study investigated talented athletes perceptions on national sport federations' talent development programs, focusing on aspects such as training infrastructure, coaching quality, athlete health, and safe sport environments.

METHODS: A total of 1149 athletes (565 male, 581 female) from various sports completed a questionnaire about their federation's program, wellbeing and their sports environment.

RESULTS: Talented athletes rated their elite sport environment with an average of 7.8 (scale 0-10) , with handball and field hockey receiving the highest scores. The quality of trainers and coaches received the highest ratings in gymnastics, hockey and handball. Athletes in athletics, cycling, and gymnastics most often report insufficient physical health, while those in athletics, skiing, and swimming most often express concerns about mental health. Further analysis is ongoing to examine associations between training environment and wellbeing, and sport-specific trends in greater detail.

CONCLUSION: This study showed that there are large differences between sports in athletes experiences and perceptions regarding training environment and wellbeing. The results indicate that some sports have structured a large part of their trainings programs effectively, whereas others still fall short on multiple areas. These findings will contribute to the optimization of talent development programs by identifying their strengths and areas requiring improvement. Additionally, these insights will serve as foundation for further exploration into how federations implement talent development models in practice and how these align with athletes' experiences.

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Oral Presentations

OP-MH13 Sports Cardiology

**IMPROVING ADULT CPR EFFICIENCY AND EFFICACY: A SYSTEMATIC REVIEW OF RESCUER POSTURE AND MECHANICAL AND PHYSIOLOGICAL FATIGUE**

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INTRODUCTION: The posture and position of rescuers, as well as the height at which a patient is positioned during chest compressions, significantly influence the efficacy and efficiency of cardiopulmonary resuscitation (CPR). Despite this, there are no established guidelines regarding optimal rescuer posture or patient height placement, highlighting the need to systematize existing knowledge and explore the potential benefits of exercise interventions on CPR performance.

This systematic review aims to evaluate the impact of rescuers posture and the height at which a patient or manikin is positioned during chest compressions. It focuses on mechanical and physiological fatigue indicators to determine how these factors affect the efficacy and efficiency of CPR.

METHODS: Adhering to PRISMA guidelines and registered with PROSPERO, the review included peer-reviewed articles that compared different rescuer postures and patient heights during chest compressions. Databases such as MEDLINE Complete, SPORTDiscus, Cochrane Reviews, and CINAHL Complete were searched. The methodological quality was assessed using the Quality Assessment Tool for Quantitative Studies.

RESULTS: The search yielded 6543 articles, with 34 meeting inclusion criteria. All studies were observational, utilized manikins, and were deemed weak in methodological quality. No studies specifically addressed exercise intervention impacts. The kneeling posture was found to enhance the efficacy and efficiency of chest compressions compared to standing, particularly when performed on the ground rather than a bed. Research on optimal patient height relative to rescuer anthropometrics remains scarce. The contact hand does not significantly impact compression quality, and chest compressions should not be performed while moving.

CONCLUSION: The review found no studies on exercise interventions effects on CPR efficiency. There are no specific rec-ommendations for rescuer posture based on patient height. Fitness levels may influence the duration of effective chest compressions, as physical function, muscle strength, mass and morphology tend to decline with age. Understanding physiological effort and recovery could optimize CPR techniques. Future research should investigate how exercise pro-grams can affect CPR efficiency and fatigue in first aiders.

**OUTCOMES OF CARDIOVASCULAR SCREENING IN THE LARGEST MANDATORY SCREENING PROGRAMME IN THE UK FOR FEMALE SOCCER PLAYERS**

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INTRODUCTION: Elite sporting organizations in the Western world advocate cardiac screening to mitigate sudden cardiac death (SCD) risks. Data relating to the diagnostic yield of such programmes in sport are dominated by male athletes. Soccer is associated with the highest prevalence of SCD among young male athletes. A previous study on 11,168 soccer

players, primarily males, revealed a 0.38% prevalence of cardiac disorders associated with SCD, and a 2% prevalence of minor cardiac disorders. The aim of this study was to investigate the prevalence of serious cardiac diseases and subsequent outcomes amongst female soccer players in the UK. We also report ECG and echocardiogram characteristics in this previously underreported population.

METHODS: From 2000 to 2024, 3,121 female soccer players underwent the English FA cardiac screening programme, which comprised a health questionnaire, physical examination, 12-lead ECG, and transthoracic echocardiogram. The FA registry was reviewed for cardiac morbidity and SCD over a 6.8-year follow-up period. ECG and echocardiogram characteristics compared.

RESULTS: Athletes had a mean age of 19.8 ± 5.4 years, with 749 (24%) aged 12–16 years, and 2,716 (87%) were white. 284 (9.1%) athletes reported one or more cardiac symptoms, and 165 (5.3%) required additional investigations. Six (0.2%) athletes were identified with significant cardiac disorders associated with SCD, and 33 (1.1%) had minor cardiac conditions. Over a follow-up of 5.0 ± 4.7 years (15,507 cumulative person-years), there were no cases of SCD, and one (0.03%) case of non-ischaemic cardiomyopathy.

Compared with age- and ethnicity-matched male soccer players, females had lower rates of sinus bradycardia (39.1 vs 45.3%; p<0.001), sinus arrhythmia (15.0 vs 38.5%; p<0.001), left ventricular hypertrophy (8.7 vs 24.8%; p<0.001), and right ventricular hypertrophy (0.4% vs 2.3%; p<0.001), but a longer PR interval (150 ± 24 vs 140 ± 14 ms; p<0.001) and QTc interval (417 ± 26 vs 398 ± 16 ms; p<0.001). T-wave inversion (TWI) was more common in females (13.4 vs 2.8%; p<0.001), with a distribution of 12.2% in anterior leads, 1.1% in inferior leads, and 0.2% in lateral leads. Echocardiography revealed smaller left ventricular diameters (47.3 ± 3.7 vs 52.4 ± 3.9 mm; p<0.001) and right ventricular diameters (34.0 ± 5.2 vs 36.6 ± 4.8 mm; p<0.001) in females compared to males.

CONCLUSION: Despite more frequent cardiac symptoms in female athletes, the occurrence of life-threatening conditions was lower compared to males. Electrical diseases were the most common significant cardiac disorders, and no cases of sudden cardiac arrest were recorded during the six-year follow-up.

**ANAMNESIS VS. ECG DATA FROM PRE-PARTICIPATION PHYSICAL EVALUATION TO IDENTIFY MEDICAL EXAMINATION FOLLOW-UP: A MACHINE LEARNING APPROACH**

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INTRODUCTION: Pre-participation physical evaluation (PPE) is critical in reducing the risk of Sudden Cardiac Death in athletes and healthy individuals (1, 2). In Italy, PPE is mandatory for sport practice, and it usually includes anamnesis, electrocardiogram (ECG), it may include spirometry, and echocardiogram. In other countries, such as the USA, PPE mainly includes medical history and physical examination, excluding ECG(2). However, it is still disputed whether adding ECG to PPE is cost-effective. Over the past two decades, significant advancements in data digitalization and availability have led to the widespread adoption of Machine Learning (ML) algorithms in various fields. Supervised ML has shown excellent results in identifying follow-up recommendations(3).

This study aimed to compare two supervised ML models, one using anamnesis data (Anamnesis_Model) and a second ECG data (ECG_Model), to evaluate their efficacy in identifying PPE medical examination follow-up need.

METHODS: We used the PPE Cardarelli Campobasso Hospital database. From a total of 1116 subjects present in the database, 630 subjects were selected based on data completeness (i.e., competitive sport certificate). Data were preprocessed using the MissForest method to imputation residual missing values. Continuous variables were centered and scaled. Recursive feature elimination was applied to select the most relevant variables in both anamnesis and ECG case separately. The data set was divided into training (70%) and test sets (30%) and modeled using a logistic regression and k-fold crossvalidation (10-fold repeated 5 times). Accuracy, sensitivity, specificity of both models were compared. Data analysis and modeling were conducted in RStudio using caret package.

RESULTS: Anamnesis_Model achieved a ROC AUC of 0.74 and setting sensitivity at 90% showed a specificity of 43% on the test set, with a balanced accuracy of 59.8%. ECG_Model outperformed Anamnesis_Model, achieving a ROC AUC of 0.79 and setting sensitivity at 90% showed a specificity of 70% with a balanced accuracy of 74.9%.

CONCLUSION: PPE's ECG information improved the prediction of medical examination follow-up need as set by the physician compared to anamnesis alone. These findings seem to be in favor of ECG inclusion in PPE. A major limitation of this study was not having access to follow-up examination's results.

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**MYOCARDIAL BRIDGING AND INDUCED ISCHEMIA: A CONTROVERSIAL ISSUE DURING THE PREPARTICIPATION SCREENING IN MASTER ATHLETES**

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INTRODUCTION: Myocardial bridging (MB) consists of the intramyocardial course of a coronary artery. The evaluation of the MB-induced ischemia, caused by the compression of the "tunneled" tract during the systolic phase, represents a debated issue during preparticipation screening. Specifically, the assessment of MB hemodynamic effects becomes a crucial factor in athlete management. Indeed, participation in competitive sports, according to ESC and Italian guidelines, should be considered only in the absence of induced ischemia. The issue becomes of relevance in master athletes (> 35 years old) in which impaired vasomotor adaptations, inflammation, myocardial remodeling and atherosclerotic phenomena can alter compensation mechanisms and trigger an ischemic condition downstream of the tunneled segment. The aim of the study was to evaluate the correlation between myocardial perfusion data and the coronary anatomy in asymptomatic master athletes.

METHODS: 25 master endurance athletes (mean age: 66+3,4; Males: 20, Females: 5) came to our attention due to the finding of stress ECG abnormalities (ST-T tract depression or premature ventricular beats) performed during the annual preparticipation screening. None of them reported symptoms, cardiovascular risk factors or previous cardiovascular diseases. In order to precisely identify the cause of these findings, they were all subjected to a myocardial Single Photon Emission Computed Tomography (SPECT) and subsequently to a coronary CT angiography (CCTA).

RESULTS: In these athletes, myocardial SPECT detected a mild perfusion defect (<5%) in absence of left ventricular dysfunction. Anatomical data obtained by CCTA showed the relationship between the ischemic area and the presence of a MB, involving the left anterior descending artery in 21 athletes. In 18 patients, the systolic phase caused the total occlusion of the tunneled segment, thus demonstrating a severe hemodynamic impact on ventricular myocardium.

CONCLUSION: The evidence of mild inducible ischemia is generally not an indication for further diagnostic investigation; however, our data showed that restricted perfusion defect could be associated with the presence of hemodynamically significant MBs. Therefore, during preparticipation screening it is crucial to perform the anatomical study of coronary arteries of master athletes, even in the presence of mild inducible ischemia to prevent cardiovascular adverse events during exercise.

## Oral Presentations

### OP-MH12 Epidemiology I

**INJURY SURVEILLANCE PRACTICES IN PRIORITISED UNIVERSITY SPORTS CODES IN SOUTH AFRICA**

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INTRODUCTION: Injury surveillance and the practice thereof is the first step in the development of injury prevention strategies. Utilising injury definitions, study designs and methods of data collection in injury surveillance studies that are not standardised can immensely affect the results of the injury surveillance data. Therefore, the aim of this study is to assess the current injury surveillance practices and data collection methods of prioritized university sport codes in South Africa.

METHODS: The study utilised a cross-sectional study design within prioritized university sport codes competing in an annual university sports tournament in South Africa. An online questionnaire was designed by using previous studies that assessed injury surveillance practices and data collection. The online questionnaire was piloted using physiotherapists and sport physicians using a previously validated critical appraisal assessment tool (CAAT). The final questionnaire consisted of nine (9) sections and 39 questions covering personal information (age, gender, sport, etc.), knowledge and attitudes on injury surveillance, sports injury incidence data, definitions of sports injury, barriers and facilitators of injury surveillance, and experiences of medical staff when collecting and reporting injury surveillance data. The questionnaire was distributed online to the medical personnel/staff responsible for injury surveillance.

RESULTS: Forty medical staff from 16 universities across 5 prioritized university sport codes responded (response rate = 40/56 = 71%) to the questionnaire. Eighty percent of respondents (32/40 = 80%) indicated that their institutions collected information on sports injuries during matches (32/40 = 80%) and training (30/40 = 75%). The majority (29/40 = 72.5%) of respondents reported that their institutions have no intention of collecting sport injury information in future. Injury prevention and management (30/40 = 75%) was the main reason for institutions collecting injury data. Time, and introducing a standardized sports injury recording form, as well as appointing designated medical staff were the main barriers to injury surveillance. The most common facilitators to injury surveillance were training of staff, introducing a standardized sports injury recording form, and appointing designated medical staff on injury surveillance. Thirty-point eight percent of the respondents indicated both training in injury surveillance and funding (12/40 = 38%) as important factors when collecting and reporting injury surveillance data

CONCLUSION: Medical staff reported that collecting, recording and reporting of injury information was important. Providing adequate resources to medical staff and using a standardised injury recording form, with clearly defined injury defini-

tions and data collection methods, would enhance injury surveillance in the future. Continuous training of medical staff would also improve injury surveillance and help to develop effective injury prevention initiatives.

**A LONGITUDINAL STUDY OF INJURY EPIDEMIOLOGY AND ATHLETIC TRAINING SERVICES AT THE INTERCOLLEGIATE TENNIS ASSOCIATION DIVISION I REGIONAL CHAMPIONSHIPS**

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INTRODUCTION: The role of athletic trainers and sports medicine teams in supporting athlete safety, injury prevention, emergency care, clinical diagnosis and treatment during sports events should never be overlooked. There are over 1,700 collegiate tennis programs the Intercollegiate Tennis Association (ITA), including over 300 womens programs and 240 mens programs in Division I, and more than 8,000 players participated in ITA tournaments in 2023. The purpose of this study was to investigate athletic training (AT) services provided at ITA Division I womens tennis tournaments over the past 6 years, and to analyze tennis injuries and physical discomforts that occurred during the tournament.

METHODS: The data used in this study included the past 5 years of ITA Regional Championships in Division 1 womens tennis held annually from 2018 to 2023, excluding the 2020 tournament which was canceled due to COVID-19. Participants were from 19 colleges in the Northwestern United States. The number of singles and doubles players who participated in the tournaments and the number of players who withdrew and/or retired from play due to injury or illness were collected based on ITA tournament records.

RESULTS: A total of 637 players participated in the singles (632 matches), there were 7 walkovers (4-injury and 3-illness: 1.11%) and 8 retirements (7-injury and 1-illness: 1.27%). In doubles (309 matches), there were 6 workovers and no retirements (4-injury; 2-illness: 1.94%). AT services were primarily injury assessment and athletic tapings of joints and/or areas complaining of pain/discomfort. The top 3 AT services for the lower extremities were ankle inversion sprains, toe blisters, and foot blisters; for the upper extremities wrist compression, lower abdominal muscle strains, and finger blisters and elbow hyperextension; other services included hot packs, lower back stretching, and hamstring stretching. A total of 31 medical timeouts (6.2 medical timeouts per tournament) were requested during the 5-year tournament, the most common being the ankle-related complains (7 medical timeouts), with 6 conditions requested 2 or more medical timeouts, and 1 timeout for a finger, shoulder, and head. Unusually, 1 case of anxiety related dyspnea was included.

CONCLUSION: This study found that higher performing ITA D1 women's tennis players had lower injury rates, which allowed them to perform better in singles and doubles. In the 5 years of tournament, there has never been a walkover or retirement after players advanced to the quarterfinals in singles and the round of 16 in doubles. As medical support in other sport events, the role of on-site athletic trainers is essential at tennis tournaments, and most AT services provided to players consist of assessment injuries or physical discomfort and providing necessary treatments such as athletic tapings/wrappings and injury treatment.

**REALLOCATING SEDENTARY TIME TO PHYSICAL ACTIVITY, AND GENETIC SUSCEPTIBILITY: PROSPECTIVE ASSOCIATIONS WITH MAJOR ADVERSE CARDIOVASCULAR EVENTS IN INDIVIDUALS WITH DIABETES OR PREDIABETES**

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INTRODUCTION: Individuals with diabetes or prediabetes face a substantially elevated risk of major adverse cardiovascular events (MACE). Modifiable lifestyle factors, such as sedentary behavior (ST) and physical activity (PA), hold potential to mitigate this risk. However, little evidence exists on how reallocating ST to PA of varying intensities is associated with incident MACE in these at-risk populations. This study investigates the prospective association between time reallocation of movement behaviors and MACE risk among individuals with diabetes or prediabetes across strata of genetic susceptibility.

METHODS: This study is based on data from 15,229 adults with prediabetes or diabetes from the UK Biobank, free of baseline cardiovascular disease and with valid accelerometer-derived movement data. A cross-ancestry coronary heart disease (CHD) polygenic risk score (PRS) was computed using 144 genome-wide significant genetic markers ($r^2 < 0.001$) identified through a multi-ancestry genome-wide association study. Isotemporal substitution models with Cox regression were performed to estimate hazard ratios (HRs) of MACE when replacing ST with equivalent durations of light PA (LPA) or moderate-to-vigorous PA (MVPA).

RESULTS: Over a median follow-up of 8.1 years, 1,280 incident MACE cases were identified. MVPA, relative to other behaviors, was associated with a 12% reduction in MACE risk (HR 0.88, 95% confidence interval [CI] 0.82–0.95). ST, relative to other behaviors, was associated with a 31% higher risk of MACE (HR 1.31, 95% CI 1.11–1.54). Additional adjustment for PRS made no material change to the associations. LPA had no evidence of associations. Isotemporal substitution analysis revealed that reallocating ST to equivalent durations of MVPA was associated with a lower risk of MACE, with longer durations of reallocation corresponding to a greater risk reduction, across strata of genetic risk.

CONCLUSION: Reallocation of ST into an equivalent amount of MVPA is associated with lower risk of MACE in individuals with diabetes or prediabetes, irrespective of their genetic risk of coronary heart disease. The consistent associations across genetic risk strata suggest that ST replaced by MVPA could benefit MACE prevention not only in all individuals with diabetes or prediabetes but in those at high genetic risk. Clinical trials of individuals with diabetes or prediabetes including those at high genetic risk should focus on increasing PA in exchange for ST for primary prevention of MACE.

**INTERMENSTRUAL PAIN AND ITS IMPACT ON SPORT AND EXERCISE IN PREMENOPAUSAL FEMALES: A MIXED-METHODS STUDY**

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INTRODUCTION: The knowledge of intermenstrual pelvic pain (IPP) is limited despite being experienced by 20-70% of premenopausal women (1). This study aimed to determine whether IPP influenced sport and exercise practice in premenopausal females.

METHODS: 1576 naturally menstruating (NM) females and 210 hormonal and non-hormonal contraceptive (HC/NHC) users of >16 years of age, experiencing menstrual bleed at the time of study participation, volunteered to complete an online survey that consisted of 20 questions. The survey was created on Qualtrics software and hosted by Massey University. A 10-point numerical rating scale was used to determine the self-reported severity of the participants IPP. The self-reported perceived impact of IPP on sport and exercise was obtained through close-ended and open-ended questions. Mann-Whitney U tests were used to analyse quantitative data in SPSS software for Macintosh, version 25. Qualitative data (i.e., free-text answers) were analyzed through thematic analysis, allowing for the identification and subsequent coding and grouping of meaningful information into themes.

RESULTS: Results from our participants indicated that 88.4% (n=1393) of NM and 89.7% (n=122) of HC/NHC experienced IPP. There were no differences in IPP pain ratings (5.52 ± 2.03 and 5.78 ± 1.89, respectively) between groups. In the HC/NHC group, 81.1% who reported IPP were currently using or had used an IUD Mirena. The self-reported negative impact of IPP on sport and exercise for NM and HC/NHC groups was 56% and 62.2% respectively. Thematic analysis noted that over 60% of participants perceived a negative impact of IPP on their sport and exercise performance, which was managed through complete avoidance of exercise practice or adaptation of training schedules, intensity, volume or types of exercises. However, not all participants were negatively impacted by IPP. Some participants reported that they exercise normally and experienced relief from bothersome IPP symptoms with regular exercise practice.

CONCLUSION: In this mixed-methods study, a high percentage of active women both NM and users of HC/NHC, especially of IUD Mirena, experienced IPP. Pain severity was rated ~5 out of 10 and seemed to negatively impact their sports and exercise practice. Although this research sheds light on the occurrence, intensity, and effects of IPP, additional studies are essential to achieve a more comprehensive understanding of this phenomenon and its impact not only on exercise and sport engagement, but also on activities of daily life.

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**EPIDEMIOLOGY OF INJURIES IN ELITE MALE VOLLEYBALL PLAYERS: A 39-WEEK LONGITUDINAL STUDY**

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INTRODUCTION: Volleyball is a limited-contact sport; however, it involves repetitive jumping, overhead motions, and rapid directional changes [1]. These characteristics contribute to both traumatic and overuse injuries. Although several studies have examined volleyball-related injuries, most have relied on the narrowest definition—time-loss injury—focusing only on injuries that prevent players from participating in sport [2]. However, this approach may underestimate the true burden of injuries. This study aimed to investigate both traumatic and overuse injuries in elite male volleyball players using the broadest injury definition to provide a more comprehensive understanding of injury prevalence and patterns.

METHODS: This descriptive epidemiological study monitored traumatic and overuse injuries among 47 elite Japanese male volleyball players over 39 weeks. Each Sunday, injuries were assessed using the Japanese version of the Oslo Sports Trauma Research Center (OSTRC) Questionnaire on Health Problems (OSTRC-H2.JP) [3]. An injury was defined as any injury sustained by a player during a match or training, regardless of whether it received medical attention or necessitated time loss from sports activities (any complaint definition). The weekly response rate of the OSTRC-H2.JP was presented as a percentage with a 95% confidence interval (95% CI). The prevalence of all injuries and substantial injuries was calculated weekly based on OSTRC-H2.JP responses. This was determined by dividing the number of players reporting any type of injury or substantial injury by the number of questionnaire respondents.

RESULTS: The average OSTRC-H2.JP response rate was 52.8% [95% CI; 50.4–55.2%] throughout all weeks. A total of 100 injuries were recorded, comprising 43 traumatic and 57 overuse injuries. The average weekly prevalence of all injuries was 23.8% [95% CI; 21.4–26.3%], with 9.3% [95% CI; 7.6–11.0%] classified as substantial. The average weekly prevalence of traumatic injuries was 10.7% [95% CI; 8.6–12.8%], with 3.4% [95% CI; 2.2–4.5%] considered substantial. The prevalence of overuse injuries was 16.0% [95% CI; 14.0–18.0%], with 6.2% [95% CI; 4.8–7.7%] classified as substantial. The most affected body regions were the knee (n = 33, 33.0%) and the lumbar-sacral spine/buttock (n = 19, 19.0%). Overuse injuries accounted for 87.9% (n = 29) of knee injuries and 57.9% (n = 11) of lumbar-sacral spine/buttock injuries.

CONCLUSION: This study found that over 20% of elite male volleyball players experienced symptoms of injury each week, demonstrating the high injury burden in this population. Moreover, the prevalence of all and substantial overuse injuries exceeded that of traumatic injuries, highlighting the importance of using the broadest injury definition in volleyball injury surveillance. Injury prevention efforts should prioritise the knee and lumbar-sacral spine/buttock.

Oral Presentations

OP-SH05 Physical Education III

**IMPACT OF THE QUALITY OF BASIC PHYSICAL EDUCATION CURRICULUM ON MOTIVATION TOWARDS PHYSICAL ACTIVITY PARTICIPATION**

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Introduction

Physical Education (PE) and Sport is one of the major contributors to improving the quality of health required by all citizens across the world. PE forms the basis of learning sports skills that one can apply throughout their life and motivate participants towards lifestyle choices in terms of career and recreation choices, which impacts their lifelong engagements. This study analyzed the motivational impact of PE towards participation in Physical Activity (PA) among university students.

Methodology

This quantitative study employs a survey method. Questionnaires were used to collect data from 106 university students (35 female; 71 male) from Kenya. Behavioural Regulation in Exercise Questionnaire -3 (Markland & Tobin, 2004) was used to measure motivation in PA participation, while the Global Physical Activity Questionnaire (WHO, 2021) was used to measure the amount of PA participation. The Physical Education Quality Assessment Questionnaire was used to measure the quality of PE curriculum undertaken by the respondents. Data was analyzed using SPSS version 23.0. Pearson and Spearman's rho were used to determine correlations, while Crammer's V was used to determine the degree of association.

Results

Male respondents had higher PA levels in MET minutes (M= 10,832) compared to females (M=9,677). Male students also recorded a higher intrinsic regulation (M=42.20; SD=7.61) compared to their female counterparts (M=41.62; SD=9.65). Female students showed a higher external regulation (M=-2.29; SD=4.06) against the males (M=-4.76; SD=6.86). Quality of basic physical education curriculum showed significant impact on intrinsic regulation among male students, with Crammer's V association value of (V=0.72) while among the female students, external regulation was significantly affected by the quality of PE (V=0.655). Generally, quality of PE showed significant impact on introjected regulation across the sample ($X2(N=106) = 695.63$, $p<0.001$, V=0.66).

Discussion and CONCLUSION: The results indicated that quality PE has an effect on three aspects of motivation: intrinsic regulation, external regulation, and introjected regulation. Among the female students, the need for physical activity participation is driven mainly by external pressures and external rewards and punishments. Male students are more likely to express genuine interest in physical activity and integrate it in their daily lives, as indicated by intrinsic regulation results.

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**THE IMPACT OF PHYSICAL EDUCATION TEACHERS HEALTH EDUCATION LITERACY ON STUDENTS HEALTH LITERACY: MEDIATING ROLE OF CURRICULUM QUALITY**

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Background:

Physical education teachers play an indispensable role in the process of school health education. Although previous studies have focused on the impact of physical education teachers health education literacy on students health literacy in China, few have explored the role of health education curriculum implementation quality in this process.

Method:

To investigate the impact relationship and mechanism between physical education teachers health education literacy and students health literacy in China, this study utilized the Health Education Literacy Assessment Scale for Physical Education Teachers, the Health Education Curriculum Implementation Quality Assessment Scale, and the Student Health Literacy Assessment Scale. Measurements were conducted on 614 middle school students from three schools designated as the first batch of national health school construction units by the Chinese Ministry of Education. The collected data were analyzed using structural equation modeling and the bias-corrected Bootstrap method.

RESULTS: The results indicated that physical education teachers health education literacy had a significant positive effect on both students health literacy ($\beta = 0.18$, $p < 0.01$) and the quality of health education curriculum implementation ($\beta = 0.59$, $p < 0.01$). Furthermore, the quality of health education curriculum implementation had a significant positive effect on

students health literacy (β = 0.67, p < 0.01). The quality of health education curriculum implementation partially mediated the relationship between physical education teachers health education literacy and students health literacy (indirect effect = 0.39, p < 0.01).

Discussion:

As the primary implementers of school health education, physical education teachers need to enhance their health education literacy by improving both pre-service and in-service training systems. Health education courses, as key carriers of school health education, should include teaching methodology courses to strengthen physical education teachers health education teaching knowledge while integrating the relationship between physical education and health education to ensure the quality of health education curriculum implementation. As the beneficiaries of school health education, students urgently require the establishment of scientific, objective, and actionable evaluation standards and supervision mechanisms for health education curricula, in order to promote the development of students health literacy.

**LEVELS OF PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR DURING PHYSICAL EDUCATION LESSONS AMONG CHILDREN 10-14 YEARS –OLD.**

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INTRODUCTION: Low levels of physical activity (PA) are negatively associated with general health. However, one of the most important settings that can enhance PA levels in children and adolescents is physical education (PE) by enhancing the time that children spend in moderate and vigorous physical activity (MVPA).

METHODS: Consequently, this cross-sectional study aimed to objectively measure PA levels and sedentary (SED) time during physical education classes in Turkey. Accelerometers have been used to measure PA of 274 children and adolescents aged 10-14 (49.6% girls). To determine time spent in PA and sedentary, accelerometer counts per minute were used (SED < 25; light physical activity (LPA): 26 - 574; and MVPA > 574).

RESULTS: The percentage of time spent in SED, LPA, and MVPA during PE lessons was 44.5%, 12.3%, and 43.2%, respectively. The percentage of participants who met the recommended 50% of PE time in MVPA was 45.6% (44.2% were male and 47.1% were female). The results showed that sedentary time was higher among overweight participants and time spent in LPA and MVPA was higher among non-overweight participants (all P < 0.05). The percentage of LPA time was higher in female compared to male participants (P = 0.003).

CONCLUSION: It is concluded that increasing the time of MVPA and replacing sedentary time with PA during PE time is important, especially among overweight students.

**THERE IS EDUCATION, THERE IS PHYSICAL EDUCATION: RECAPITULATE THE MARGINALISATION OF PHYSICAL EDUCATION**

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Physical education (PE) finds itself trapped in a paradox in the contemporary education system and society: recognised as essential yet persistently marginalised. This precarious position is not merely practical or policy-driven but reflects deeper philosophical and cultural tensions embedded within education itself. Dominant dualistic paradigms exemplified by Western frameworks such as the Peters-Hirst and Chinese traditional cultural hierarchies like Zhong Wen Qing Wu (重文轻武, valuing the literary over the martial, physical), relegating bodily activity below propositional knowledge pursuits. These biases are further amplified by the pervasive instrumental logic of neoliberalism, which reduces education to a utilitarian enterprise geared towards economic productivity. In this vein, PE is narrowly framed as a tool for improving health outcomes and developing workforce development, neglecting its potential for embodied understanding, moral development, and social cohesion. Health-centric policies, while well-intentioned, risk reinforcing this narrow focus, transforming PE into a mechanistic and outcome-driven subject disconnected from its cultural and philosophical roots.

Reclaiming PE requires a paradigm shift, in particular, ancient Chinese thought offers a counter-narrative to the dominant neoliberal and dualistic paradigms. The Confucian principle of Shen Xin Yi Zhi (身心合一, unity of body and mind) and Daoist notions of harmony between humans and nature present a holistic understanding of the body, not as an isolated instrument but as a relational entity deeply embedded in social and ecological systems. These philosophies challenge late capitalism's disembodied logic, positioning PE as a site for embodied, relational, and transformative learning. By fostering harmony between body, society, and nature through traditional Chinese thought, PE can transcend its reductive framing, addressing existential and ecological challenges. This reconceptualisation is urgent as neoliberal reforms increasingly marginalise economically undervalued disciplines.

Further, situated in the global neoliberal context, aligning PE with roader market dynamics, such as emerging opportunities in the sports industry, may provide strategic pathways for elevating its societal status. However, these efforts must remain grounded in a philosophical commitment to preserving its intrinsic educational value. Navigating this delicate balance involves leveraging market forces to enhance PE's visibility and institutional recognition without succumbing to the commodification of its core principles. This paper advocates for reimagining PE as a discipline that integrates physical and intellectual development while promoting ecological and social awareness. By embracing its potential to cultivate embodied subjectivities and holistic well-being, PE can evolve from a marginalised subject into a vital foundation for fostering harmony in a fragmented world.

**QUALITATIVE ANALYSIS OF FUNDAMENTAL MOTOR SKILL PATTERNS IN 7-YEAR-OLD CHILDREN BY SEX**

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INTRODUCTION

There are sex differences in total fundamental motor skill (FMS) proficiency in children. Boys tend to be more skilled than girls overall. However, while girls generally excel in locomotor skills (LS), boys outperform them in object control skills (OCS). Furthermore, these differences gradually increase with age (1). To explain this trend, this study aimed to qualitatively analyze the fundamental motor skills patterns in 7-year-old children by sex.

METHODS: A total of 183 participants were eligible for analysis (84 boys and 87 girls; mean age: 7.41±0.32 years). The CAMSA test was used to assess FMS in a dynamic environment, taking into account completion time. (2). The test evaluates: LS patterns (2-foot jumping - horizontal force, force precision; Sliding - right direction, left direction, change of direction; Skipping - hop-step pattern, alternation-swing arm; 1-foot hopping - lateral force, lateral balance), and OCS skill patterns catching; throwing - overhand precision, transfer-rotation tunk, kicking - approach and precision, elongated last stride (2). The CAMSA test was video recorded as previously described (3) to perform a qualitative analysis. The unadjusted effect of sex on the 14 binary categorical dependent variables (1 = correct, 0 = incorrect) was analysed using a comparison of two proportions via the Wald z-test for independent groups. The p-value for the two-tailed test and the effect size were measured by Cramér's V (4).

RESULTS: Regarding skill outcomes, girls performed significantly better than boys in 2-foot jumping-force precision (p=0.030, ES=0.12), and skipping-hop-step pattern (p=0.024, ES=0.12), albeit with a weak effect size. Conversely, boys performed significantly better than girls in catching (p=-<0.001, ES=-0.24), throwing - transfer-rotation tunk (p= <0.001, d=-0.31), kicking - approach and precision (p=-<0.001, ES=-0.24), and kicking - elongated last stride (p=-<0.001, ES=-0.37) with moderate effect size, except for throwing - overhand precision (p=-0.005, ES=-0.37), which exhibited a weak effect size. Among children in general, the skill outcomes with 50% or more correct performance were, in descending order of performance: 2-foot jumping - horizontal force, 2-foot jumping - force precision, kicking - approach and precision, skipping - hop-step pattern, 1-foot hopping - lateral force, catching, and kicking - elongated last stride.

CONCLUSION: The findings suggest that boys perform moderately better in the FMS patterns related to catching, throwing, and kicking. In contrast, girls perform slightly better in FMS patterns associated with jumping and running techniques. These results highlight the importance of tailored physical education programs and early sports training that focus on improving specific FMS patterns by sex.

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## Oral Presentations

### OP-SH23 Sociology III

**THE CAUSES AND GOVERNANCE OF EXTREME CHINESE TABLE TENNIS FAN CULTURE**

SONG, Y., JIN, Y., WU, F.

*PEKING UNIVERSITY*

Table tennis, esteemed as the national sport of China, has long been a symbol of numerous glories and a focal point of extensive public attention. Nevertheless, the problem of abnormal fan culture within the table - tennis fan community has been growing more severe. During the Paris Olympics, extreme manifestations of "fandom culture" emerged. The aftereffects of these incidents still persist, triggering extensive discussions and widespread aversion in society.

The concept of the "table - tennis fandom" can be defined and classified into four distinct categories. Firstly, there are "fandom - oriented fans" who show a high level of concern for the appearance and daily lives of table - tennis athletes. Secondly, "competition - centered fans" concentrate on the technical and tactical aspects of the sport and athletes performances in competitions. Thirdly, "comprehensive fans" possess characteristics of both types. Fourthly, "bandwagon fans" are influenced by popular trends or the content on social media. The object of this study is specifically the "fandom culture" formed by "fandom - oriented fans".

Regarding the chaos in the Chinese table - tennis fandom, it is mainly characterized by several prominent issues. These include hyperbolic idolization of athletes, the "singles - supremacy" concept, the binary opposition of "exclusive love", intense data - driven rivalries, invasions of athletes privacy, and disorderly behavior during matches. By taking the interaction ritual chain as a theoretical model, this paper explores the causes of the "table - tennis fandom" phenomenon from

four essential components: group assembly, boundary - setting for outsiders, the focus of mutual attention, and shared emotions. It also examines how these factors influence the behaviors of fans and the dynamics within the fan community.

The internet serves as the primary medium for expressing social public opinion. Social network analysis can identify the crucial nodes in the information - dissemination process. These nodes are characterized by high connectivity and significant influence, and they have the ability to facilitate cross - circle communication and homogeneous information diffusion. Given the large user base of Weibo, public opinion regarding unexpected events spreads rapidly on this platform. By writing a Python - based program to crawl relevant texts for topic extraction and emotional analysis, an early - warning mechanism can be established. For negative information, different intervention measures are implemented based on its degree of deviation from the facts.

Finally, to address the chaos in the table - tennis fandom, a multi - faceted approach is proposed. This includes strengthening the construction of relevant regulations, leveraging the guiding role of opinion leaders, promoting the collaborative efforts of multiple parties, and returning to the essence of sportsmanship.

**POLITICS, SPORT AND GLOBALISATION: CHINESE STRATEGY AND POLICY FOR SPORT TALENTS CROSS-BOUNDARY MOVEMENTS**

LIANG, Y.

*HEBEI SPORT UNOVERSITY*

INTRODUCTION: The relationship between sport and politics plays a significant role in shaping and reflecting society. A comprehensive long-term sport development strategy is essential for a state seeking to realise its political objectives. This article examines how China has implemented various strategies and policies to attain sport success. Notably, it highlights the countrys efforts to attract global sports talent and foster international collaboration since the establishment of the Peoples Republic in 1949.

Methods:

To explore China's sport migrates cross-border movements the research employs Ravenstein's Push-pull Migration Law with the world-system theory of sport diffusion to combine a theoretical framework, Additionally, it also examines sport talents' self-identification over migration naturalisation issue through the lens of social identification theory in the process. The article collects premier data from a total 10 semi-structured interviews (consisting of five senior Chinese sport administrators - from the State Sport General Administration and five from relevant athletes and coaches); interview questions were designed to answer - how the sport migration trends have been shaped by state strategies and policies? Secondary data (focused on state mainstream media platforms, such as China Central Television, China Daily, State Council, etc.) to unveil the impact of state strategies and policies on its sport talents international movements.

RESULTS: International exchanges and the movement of talent encompass various dimensions that evolve and are influenced by different development strategies and policies. This evolution has shifted from a predominantly one-way flow to a more reciprocal exchange. Sports strategies and policies can be understood through push-pull factors that align with governmental interests and overarching goals. Notably, Chinas naturalization practices have transitioned from the 'jus talenti' model, which emphasizes athletes talent, to the 'jus sanguinis' model, which is based on bloodlines and heritage. This trend is expected to persist in the foreseeable future.

Discussion:

The findings highlight the practices of Chinese state governance, the strategy, and policy changes for sports development under the communist regime. Although the government has made substantial efforts to attract global sports talent, its historical perspectives and attitudes throughout this evolutionary process are overlooked. This research not only enriches the existing literature on sports migration but also sheds light on established sport migration theories as they apply to the Chinese context, enhancing the understanding of Chinas overall sports strategy. These elements are two sides of the same coin; the recent controversy illustrates the governments desire to attract global sports talents as part of its ambitious China Dream project, while simultaneously disregarding its own Nationality Law to benefit a selected elite few.

**DRUG BAN INCIDENT IN CHINESE SPORTS DURING THE NEW CORONAVIRUS OUTBREAK:MEDIA REPRESENTATION OF SUN YANG'S SUSPENSION AND PATRIOTISM OF CHINA**

LEI, Y.

*HUAZHONG UNIVERSITY OF SCIENCE AND TECHNOLOGY*

Introduction: On September 4, 2018, staff from the IDTM representing the WADA went to Sun Yangs residence for an out-of-competition doping test. Due to issues with the testing personnels qualifications, Sun Yang and his team had a disagreement with the testers. WADA believed that Sun Yangs behavior constituted "violent resistance to testing" and appealed to the CAS. On June 22, 2021, the final ruling of CAS was made, reducing Sun Yangs eight-year ban to four years and three months, which also confirmed that Sun Yang would be unable to participate in the Tokyo Olympics and the 2022 Asian Games in Hangzhou.

Methods: Based on six Chinese print medias and six western print medias from the United States, the United Kingdom, and Australia relatively from February to June, 2020 for text analysis, using the Critical Discourse Analysis (CDA) proposed by van Dijk as the research method.

Results: Chinese and Western media presented completely different ideology and positive/negative evaluation on the "Sun Yang ban incident". Western media denigrated and satirized Sun Yangs performance and personal image, emphasizing that the justice of the swimming pool had been served: (1) Position binding: FINAs "protection" of Sun Yang; (2) Historical connections: The manipulation of sports in Communist countries; (3) Rule understanding: the difference between Chinese and Western interpretation. On the contrary, Chinese medias sympathy and support for Sun Yang is determined to shape a positive image of Sun Yang as a "sunshine boy": (1) United Report: Sun Yang's suspension ruling and Sun Yang's appeal; (2) Official Voice: The support of the Chinese Swimming Association and the anti-doping efforts of the Chinese sports governing body; (3) WADA's authority: CAS's contradictory ruling.

Discussion: Under the guidance of different political backgrounds, ideologies and public opinion orientation between China and the West, the occurrence of "Sun Yangs Suspension" has reinterpreted the cognition and interpretation of Chinese competitive sports and patriotism, and arouse peoples reflection and reconstruction of the relationship between competitive sports and patriotism. In China, the increasing control of the ruling party in the political, cultural, ideological, social and other fields make people more often stand in the perspective of patriotism subjective cognition issues. Chinese people generally believe that the Western medias smearing of Sun Yang is ultimately due to the prejudices and stereotypes of Westerners based on their hearts and minds. Ironically, however, this ideological perception seems to be the bias that Chinese people hold when they look at the negative coverage of Sun Yangs ban in the Western media. When the Chinese official media with the ideology of patriarchy patriotism "reproduce" Sun Yangs ban incident, the Chinese peoples understanding and cognition of the incident will inevitably be marked by a profound brand of patriotism.

**RUNNING CULTURE, INSCRIPTION DEVICES AND TRANSLATION: A STUDY OF "SERIOUS RUNNERS" BASED ON ACTOR-NETWORK THEORY**

BI, X., HUANG, L., CHAI, J.

*BEIJING SPORT UNIVERSITY*

INTRODUCTION: Using smart watches and apps while running,especially in long-distance, has become a common practice among amateur runners. This practice of using technological devices for self-monitoring is conceptualized as self-tracking or the quantified self (Lupton, 2014; 2016; 2020). Bale (2004) believes that it is impossible to understand running without considering the cultural context in which running occurs, and that running needs to be studied as a body/cultural phenomenon. Based on the actor-network theory(ANT) from the perspective of sociomateriality, this study explores: (1) How are inscription devices produced and what is the circulation of inscription? (2) How is a heterogeneous actor-network of serious runners formed through the four stages of translation?

METHODS: To answer the research questions, this study conducted semi-structured interviews of approximately 60 minutes with each of 15 runners in a running club and conducted participatory observation of the club (online and offline) for more than 3 months.

RESULTS: The study firstly found that when runners use devices, they call themselves "serious runners", indicating that hardware (such as smart watches), software (such as apps) and data (monitored indicators and social media contents) are inscribed in running culture and become inscription devices, which are then circulate to runners. Inscriptions are identified as: success and victory, body aesthetics, pain/injury and health, the relationship between the body and nature, etc., and develop into "athlete identity". Secondly, through the four stages of translation (Callon, 1986), namely, problematization (the inscription devices as initiators), interessement (the desire to obtain the identity of a serious runner), enrollment (the participation of human and non-human actors) and mobilization (becoming spokespersons), various actors negotiate and eventually form a network of serious runners with the inscription of running culture as the order. This combined effect is that the running culture is maintained and inherited through the acquisition of runners social identity.

DISCUSSION: The actor network is an alliance of human and non-human actors with common interests. After four stages of inscription and translation, an immutable serious runner actor-network is formed. Digital technology and devices, as non-human actors, are the carriers of runner inscriptions and the "necessary point of passage" (Callon, 1986) of the actor-network. Actors who take inscription as the starting point build the network. This brings a new understanding of the relationship between emerging technologies and running culture.

**THE IMPACT OF THE GIG ECONOMY ON THE PROFESSIONAL DEVELOPMENT OF ATHLETES: AN EMPIRICAL STUDY BASED ON A QUESTIONNAIRE ON PERCEIVED CAREER STABILITY**

MU, Y., NAZARUDIN, M.N., MA, T., JIANG, S., ZHANG, G., SUI, X., YU, M.

*UNIVERSITI KEBANGSAAN MALAYSIA*

INTRODUCTION: With the rapid rise of the gig economy, more and more professional athletes are trying to increase their economic flexibility through diversified income channels. This trend provides athletes with financial support and the possibility of career transformation. However, the short-term flexibility brought by the gig economy is often accompanied by income fluctuations and challenges in professional identity, especially in Asia. In this context, the impact of the gig economy on athletes perception of career stability and how athletes can find a balance between gig work and traditional professional development have become topics worthy of research. This study aims to reveal the specific impact path of the gig economy on professional athletes perception of career stability and analyze the main motivations for athletes to participate in the gig economy and the opportunities and challenges.

METHODS: The study focuses on how athletes view the dual impact of the gig economy on their income sources, professional time allocation, and professional identity, and explores how to optimize strategies for participating in the gig economy. Through questionnaire empirical analysis, the study strives to quantify the effects of the gig economy on athletes career development and put forward suggestions for improving career stability and security. The study collected quantitative data through questionnaires, covering multiple dimensions. The questionnaire was distributed through athlete social media groups and local sports associations, and a total of 457 valid samples were collected, covering a variety of sports and age groups.

RESULTS: The results of the data analysis revealed the complex impact of the gig economy on the career development of athletes. The higher the proportion of gig income, the lower the perceived career stability of athletes. At the same time, some advantages of the gig economy have been verified, including the role of alleviating economic pressure and expanding career transformation opportunities. Among the main types of gig tasks, the flexibility of private lessons and online live broadcasts makes them more popular among athletes, but it has a certain negative impact on career stability due to time conflicts.

CONCLUSION: The study also found that the degree of athletes adaptation to the gig economy is closely related to their time management ability. Athletes who can reasonably allocate their main career and gig tasks have relatively higher career satisfaction. Based on the research findings, this study puts forward serval optimization suggestions. This study systematically reveals the multi-dimensional impact of the gig economy on professional athletes and expands the scope of research on the gig economy for special occupational groups. In addition the study provides a new perspective for understanding the relationship between the gig economy and career stability and a clear direction for athletes to participate in the gig economy and related policy formulation.

## 15:15 - 16:30

## Invited Symposium

### IS-MH05 Effort and its perception: current knowledge and perspectives

**AN EFFORTFUL TASK: DEFINING AND MEASURING PERCEPTION OF EFFORT DEFINING AND MEASURING PERCEPTION OF EFFORT**

HALPERIN, I.

*TEL AVIV UNIVERSITY*

Rating of perceived effort (RPE) scales are widely used in exercise science as simple and practical tools for monitoring and prescribing exercise intensity. However, there are certain methodological challenges when using these scales due to the multiple definitions of perceived effort, and insufficient standardization in current measurement practices. In this presentation, I will address these challenges by discussing common definitions of perceived effort, highlighting their circular nature and the insufficient differentiation between perceived effort and other perceptual experiences. I will also address the varied and often conflicting instructions associated with using RPE scales, specifically focusing on two key issues: First, the lack of uniformity in instructions regarding the time domain for RPE reporting. That is, are subjects expected to rate their effort instantaneously or as a summary of the experience during the task? Second, I will cover the significant variability induced by inconsistent application of the scale's upper anchor (i.e., what 10 on a 0-10 scale signifies). I propose distinguishing between imposed and self-selected anchors, noting that inconsistent use of these could influence the ratings. To overcome these limitations, I propose two strategies: first, adopting a clear, consistent, and narrowly focused definition of perceived effort to avoid the pitfalls of existing definitions and to facilitate collaborative research across disciplines and the transferability of results beyond sports science; second, defining and standardizing the reporting of the time domain and the meaning of upper anchors when collecting and reporting RPE data. Implementing these strategies will enhance the validity of RPE measurements in exercise science and broaden their applicability in other fields.

**EFFORT COST AND EFFORT AVERSION: TWO DIFFERENT PERCEPTIONS OF EFFORT**

ANDRÉ, N.

*UNIVERSITÉ DE POITIERS*

Effort is an important part of daily life for nearly everyone. Managing effort is often a key to health and well-being, as well as to reaching goals, achieving successes, and sustaining good interpersonal relationships. In sport settings, effort is an important component of perseverance in sports training and competitive performance. Understanding the nature of effort is therefore crucial. A large part of the literature on effort claims that effort is perceived as aversive, and this would lead people to systematically avoid exerting effort or to choose the less effortful means of reaching the same goal. Yet, this principle of least effort (Hull, 1943) or principle of minimization of effort does not entail aversion: cost is enough. A parallel "principle of least money" would be that people often prefer the lower price for exactly the same item—and money is clearly a cost, not an aversion. Same with effort. Effort aversion occurs only when costs outweigh benefits. People may choose to exert effort when doing so avoids other kinds of costs such as pain or obtain meaningful reward. If effort is

perceived as a cost (rather than an aversion), it follows, however, that people do not avoid effort itself just as they do not always avoid spending money. Rather, they try to avoid the waste of effort, akin to overpaying. Positing that people avoid the waste of effort rather than effort itself can improve the understanding of how, when, and why people exert effort, indeed including even very high effort as in elite athletes. Understanding the factors influencing effort commitment can help athletes engage more efficiently. Focusing on avoidance of wasting effort removes the seeming paradox that people sometimes willingly exert high, even extreme effort. Hull, C. (1943). Principles of behavior. Appleton-Century.

**THE NEUROPHYSIOLOGY OF PERCEPTION OF EFFORT AND ITS LINK WITH PERFORMANCE**

PAGEAUX, B.

*UNIVERSITÉ DE MONTRÉAL*

Effort is a common experience in our voluntary behaviour, whether we are walking or running, drinking a cup of tea, imagining a movement, or engaging in cognitively demanding tasks like solving a complex puzzle. The experience of effort can be described as "the sensation of expending energy" (1), and "is accompanied by a sensation of labour, a sensation that intensifies as we increase our investment in the task" (1). The perception of effort provides information about the intensity and difficulty of the task being performed. The perception of effort is involved in the regulation of behaviour and influences how the nervous system selects a precise movement from a multitude of possibilities. Thus, the perception of effort is intrinsically linked to performance. In this presentation, I will provide an overview of the current knowledge on the neurophysiology of perceived effort and how this perception is a key determinant of physical performance. The integration of knowledge from different disciplines highlights the importance of studying effort as a perception dissociated from other perceptions we experience during physical exercise, such as pain or fatigue (2). The literature highlights the role of motor command in the perception of effort (2), particularly its corollary discharge. This corollary discharge, also named efference copy, can be defined as a copy of the central commands sent to the working muscles. The origin of the motor command also directs us to the anterior cingulate cortex (3), a key brain area at the interface of cognition, emotions, motor control, and decision-making (4). To illustrate the key role of effort and its perception in the regulation of physical performance, I will use the motivational intensity theory (5), a theoretical framework from the psychology literature used for ~ 15 years in sport science. The motivational intensity theory predicts that we maintain optimal performance in cognitive and motor tasks by increasing effort when task difficulty increases, and that performance decreases when we are no longer able or willing to invest additional effort – when task difficulty increases beyond our perceived capacity or when the value of outcomes/goals diminishes. As the physiological and psychological determinants of performance are task-specific, I will conclude by discussing how the motivational intensity theory could contribute to a better understanding of the regulation of maximal force-power-speed performance (e.g., sprint), endurance performance (e.g., time to exhaustion) and psychomotor performance (e.g., motor skills execution). REFERENCES 1. Preston & Wegner (2009). Oxford handbook of human action, 569-586. 2. Bergevin et al. (2023). Sports Medicine, 53(2), 415-435. 3. Gillies et al. (2019). Autonomic Neuroscience, 216, 51-58. 4. Caruana et al. (2018). Brain, 141(10), 3035-3051. 5. Richter et al. (2016). Advances in motivation science, 3, 149-186.

## Oral Presentations

### OP-PN35 Energy Metabolism

**MITOCHONDRIAL SUBSTRATE SENSITIVITY FOLLOWING ACUTE EXERCISE AND POST-EXERCISE RECOVERY: IMPLICATIONS TO GLYCOGEN CONTENT IN HUMAN SKELETAL MUSCLE**

PETRICK, H., FUCHS, C.J.1, HERMANS, W.J.H.1, HENDRIKS, F.K.1, BELS, J.L.M.1, SENDEN, J.M.1, HOLLOWAY, G.P.2, VAN LOON, L.J.C.1

*1. MAASTRICHT UNIVERSITY, MAASTRICHT, THE NETHERLANDS; 2. UNIVERSITY OF GUELPH, GUELPH, CANADA*

INTRODUCTION: Muscle glycogen is an important substrate during moderate to high intensity exercise, while repletion of muscle glycogen after exercise is often prioritized during recovery. The enzymatic regulation of glycogen breakdown and resynthesis is directly impacted by cytosolic ADP and glycolytic flux. This raises the possibility that the sensitivity of mitochondria to oxidative substrates may represent an important control point in glycogen breakdown and resynthesis. We therefore examined muscle glycogen content and the sensitivity of mitochondria to ADP, pyruvate, and ketone bodies (KB) in human skeletal muscle following exercise and during prolonged post-exercise recovery with or without carbohydrate intake.

METHODS: 12 endurance-trained male cyclists (25 ± 5 y, VO2peak: 67 ± 5 mL/kg/min) performed two test-days in a randomized cross-over design. On both test-days, a standardized glycogen depletion protocol was performed on a cycle ergometer in a fasted state. The protocol lasted 125 ± 13 min and 124 ± 14 min, consisting of 2 min blocks alternating between high and low intensity cycling. During the subsequent 12 h of post-exercise recovery, participants either remained fasted or consumed 10 g/kg body mass carbohydrate (CHO). Muscle biopsies were obtained from the vastus lateralis before and after exercise, and following 6 and 12 h of post-exercise recovery. Mitochondrial respiration and substrate sensitivity were measured in permeabilized muscle fibres using an Oroboros O2k Oxygraph. Muscle glycogen content was determined in freeze-dried whole muscle homogenate. Data were analyzed using a one-way repeated-

measures ANOVA with Tukey's post-hoc tests. Statistical significance was set at P<0.05. All data are expressed as mean ± SD.

RESULTS: Following exercise, mitochondrial ADP sensitivity decreased ~15% on both trials (P<0.008), correlating (r=-0.587, P=0.045 fasted day; r=-0.568, P=0.054 CHO day) with the extent of glycogen depletion during exercise. On the post-exercise fasted trial, mitochondrial ADP sensitivity returned to baseline after 6 h of recovery, but decreased once again after 12 h of post-exercise fasting (~15% decrease, P=0.037). Pyruvate sensitivity increased following exercise and declined with post-exercise fasting. However, neither pyruvate nor ADP sensitivity were altered during post-exercise recovery when consuming CHO. Furthermore, there were no relationships between changes in mitochondrial substrate sensitivity and muscle glycogen repletion during post-exercise recovery with CHO ingestion. Regardless of exercise, fasting, or CHO ingestion, KBs contributed minimally to respiration at all time-points (~2-6% of maximal complex I+II-linked respiration).

CONCLUSION: Combined, the exercise-induced decrease in mitochondrial ADP sensitivity may be a mechanism promoting glycogen utilization during exercise. However, changes in mitochondrial substrate sensitivity do not appear to relate to glycogen resynthesis during post-exercise recovery when carbohydrates are ingested.

**CHANGES IN NITRATE AND NITRITE CONCENTRATION IN SALIVA, BLOOD AND SKELETAL MUSCLE AFTER STEP REDUCTION AND RETRAINING**

PORCELLI, S., MARCIANO, A.1, BLACK, M.I.2, GIUSTI, L.1, BUZZACHERA, C.F.3, VANHATALO, A.2, JONES, A.M.2
*UNIVERSITY OF PAVIA*

INTRODUCTION: Physical deconditioning has been shown to impact main conduit arteries and decrease post-occlusion hyperemic leg blood flow response, although findings vary depending on the duration and model of disuse (1,2). Endothelial nitric oxide (NO) release following a shear stress stimulus is a key mediator of vasodilatation, facilitated by the sequential conversion of nitrate (NO3-) to nitrite (NO2-) to NO (3). This study aimed to evaluate the effects of 14 days of step count reduction and subsequent retraining on nitrate and nitrite in different body compartments and skeletal muscle microvascular responsiveness.

METHODS: We recruited 16 (n=8 women) young, healthy, normally active participants. After baseline (BDC) data collection, they underwent 14 days of step reduction (SR; 1500 steps/day) followed by a retraining (RT) period incorporating endurance and strength exercises. Measurements were performed at BDC, post-SR, and post-RT. Resting diastolic (DBP) and systolic (SBP) blood pressure were assessed at each time point. Microvascular post-occlusive reactive hyperemia in the vastus lateralis muscle was assessed by near-infrared spectroscopy. During the 30 s post-ischemia, the rate of change in tissue oxygenation index (Slope 2) was calculated. Saliva, blood, and vastus lateralis muscle samples were collected and NO3- and NO2- concentrations were determined by chemiluminescence. One-way repeated measures ANOVA and post-hoc tests were used to determine differences in the investigated variables.

RESULTS: Daily step count was reduced by 82% during SR and increased with RT, but did not returnto baseline (8429±1659, all p<0.001). At BDC, DBP and SBP were 79±5 mmHg and 122±9 mmHg, respectively, and they did not change at any time points (p=0.12). Slope2 decreasd from BDC to SR (1.40±0.69%*s-1 vs. 1.00±0.29%*s-1; p<0.01) and partially recovered in RT (1.03±0.51%*s-1; p=0.04). At BDC, saliva [NO3-] and [NO2-] were 608±253 μM and 102±50 μM, respectively, with no changes across time (p=0.29). Plasma [NO3-] was not affected by the interventions. Plasma and muscle [NO2-] significantly increased from BDC (115±42 nM and 1.2±0.3 nmol*g-1) to SR (160±74 nM and 1.6±0.8 nmol*g-1, all p<0.03), and they partially recovered after RT. Muscle [NO3-] decreased (-37±3%) at SR.

CONCLUSION: Fourteen days of SR impaired hypoxic vasodilation at the microvascular level without affecting resting blood pressure. While salivary nitrate-nitrite metabolism did not change, plasma and muscle nitrite concentrations increased during SR, and muscle nitrate content decreased, possibly reflecting a compensatory mechanism related to impaired endothelial NO production. Retraining partially restored NO metabolite distribution across body compartments.

REFERENCES

1 Bleeker et al, 2005

2 de Groot et al, 2006

3 Cosby et al, 2003

**ACUTE EFFECTS OF EXERCISE ON TOTAL CREATINE CONCENTRATIONS IN MULTIPLE HUMAN BRAIN REGIONS**

PRATT, J., MUNDELL, O., HENTHORN, L., KENNERLEY, A., SALE, C.
*MANCHESTER METROPOLITAN UNIVERSITY*

INTRODUCTION: Creatine is well-known for supporting skeletal muscle function during periods of high-intensity exercise, through the rapid provision of high-energy phosphates. Despite growing interest in the role of creatine in supporting brain health, evidence of the response of creatine concentrations in the brain, to exercise, is limited. We aimed to determine the response of total creatine concentrations (tCr) in multiple brain regions to an acute bout of vigorous exercise in humans.

METHODS: Nine healthy adults aged between 23 and 30 years [6 female, age (mean ± SD) = 26.3 ± 2.8 years; body mass index = 22.7 ± 2.5 kg/m2] completed a graded cycle ergometry test lasting ~15 minutes and reaching ~85% of predicted heart rate maximum. Single-voxel proton magnetic resonance spectroscopy (1H-MRS; 20mm3 voxel) was acquired at 3T on a Siemens MAGNETOM VIDA from the visual cortex and frontal cortex before (PRE), 15- (POST15) and 30-minutes (POST30) after exercise. Multi-voxel 2D proton chemical shift imaging (1H-CSI; 80mm2 grid, 15mm slice thickness) was also

acquired across the midbrain PRE and 25-minutes after exercise (POST25, taken between repeated 1H-MRS measurements). OSPREY was used to determine tCr concentrations from 1H-MRS data and TARQUIN was used to examine tCr resonance signals from 1H-CSI data. Voxel tissue fractions and relocalisation accuracy were assessed. One-way repeated measures ANOVAs and paired t-tests were used to test for exercise-induced changes in tCr.

RESULTS: Following an acute bout of exercise, tCr concentrations decreased by 9.8% in the frontal cortex by POST15 (6.27 vs 6.95 mmol/L, $p < 0.001$), and remained significantly lower (by 5.2%) than PRE levels at POST30 (6.59 vs 6.95 mmol/L, $p < 0.001$), although there were signs of a gradual return to baseline concentrations. Multi-voxel 1H-CSI revealed that, overall, tCr resonance signals were significantly lower (by 8.7%) across the midbrain at POST20 compared with PRE levels (area under curve = 808.01 vs 737.80 a.u., $p = 0.044$), although region specific responses were shown. No significant responses to exercise were shown in the visual cortex at any timepoint (tCr concentrations = 7.84 vs 7.67 vs 7.81 mmol/L at PRE, POST15 and POST30; all $p > 0.05$).

CONCLUSION: tCr concentrations in certain regions of the young adult brain are dynamic and respond acutely to exercise, demonstrating the reliance of the brain, on creatine, for energy provision during high-intensity activity. From a broader, methodological perspective, our data highlight the importance of considering external factors, such as prior exercise, in standardisation protocols for repeated MRS studies of creatine concentrations in the human brain. Determining the response of creatine concentrations in brain to other types of exercise and, indeed, other stimuli, could provide additional insight into the dependence of the brain on creatine during periods of increased metabolic demand, supporting the development of therapeutic strategies to support brain function.

**CHANGES IN LACTATE CONCENTRATION DO NOT PREDICT CHANGES IN FAT OXIDATION THROUGHOUT A TRAINING SEASON**

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INTRODUCTION: Capillary lactate concentration [La-] presents a strong inverse correlation with fat oxidation (FatOx) across individuals with different metabolic characteristics (1). This has led to the suggestion that [La-] alone could be an effective way to assess changes in FatOx at different points through a training season. Hence, the aim of the present work was to determine whether changes in [La-] at two different points during a training season would allow to predict changes in FatOx.

METHODS: Fifteen males (76±6.7 kg, 180.7±8.3 cm, 60±6.1 ml/kg/min) and eleven females (62.2±4.6 kg, 164.8±5.7 cm, 49.5±3.9 ml/kg/min) performed a step incremental exercise test on a cycle ergometer at two points of the training season (spring and autumn). The test began at 50 W, followed by increments of 30 W for males and 25 W for females every 2 minutes until task failure. [La-] was measured during the final 30 s of each step and immediately after task failure, while mean FatOx during the last minute of each stage was estimated using indirect calorimetry. For each individual, Pearson's correlation was used to determine the relationship between [La-] and FatOx during the step incremental exercise test at each time of the training season. Subsequently, the difference in [La-] (Δ[La-]) and FatOx (ΔFatOx) between the two points of the training season at each power output during the step incremental test was calculated. Pearson's correlation was also used to determine the relationship between the changes in Δ[La-] and ΔFatOx.

RESULTS: [La-] was strongly and inversely associated with FatOx at both points of the training season in males (-0.812±0.12, range: -0.973, -0.534) and females (-0.887±0.101, range: -0.968, -0.521). Conversely, widely variable correlations were determined for the relationship between Δ[La-] and ΔFatOx in males (-0.236±0.524, range: -0.751, 0.973) and females (-0.397±0.478, range: -0.866, 0.65).

CONCLUSION: Assessing [La-] alone might be considered as an effective way to indirectly assess FatOx at specific points throughout the training season due to the strong agreement between these two variables. However, changes in [La-] do not predict changes in FatOx as the training season progresses. Thus, caution should be taken when trying to use [La-] as predictors of FatOx.

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**THE PREVALENCE OF REDS INDICATORS IN MALE ATHLETES**

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INTRODUCTION: There is a significant gap in evidence-based knowledge and attention to problematic LEA and REDs in male athletes although it has been recognized that male athletes experience hormonal, body composition, sexual and psychological changes when they are underfuelled.1 Given the need for further research, we investigated primary REDs indicators in male athletes competing in weight-sensitive and non-weight-sensitive sports and examined their relationship with sex drive.

METHODS: Seventy-nine national- and international-level male athletes (23.6±3.9 years) participated during the preparatory season. Athletes were categorized into weight-sensitive (WS, n=61) and non-weight-sensitive (S, n=18) groups. The REDs indicators used in this study included low testosterone concentration, low blood free triiodothyronine concentration,

history of bone stress injury, low bone mineral density (Z-score <-1) at the lumbar spine analysed by Dual-energy X-ray absorptiometry (Lunar Prodigy Advance), and an elevated score for the EDE-Qs (eating disorder examination questionnaire short). The participants were divided into groups based on risk of REDs: no-risk (0 indicator), risk (≥1 indicators). Sex drive was assessed using the Low Energy Availability in Males Questionnaire. The differences of the points between groups were analysed with Mann-Whitney U Test and the differences of prevalence were tested Chi-Square Tests (SPSS 28.0.0).

RESULTS: REDs indicators were observed in 31% of participants. The prevalence of the indicators of REDs was significantly higher in WS compared to S ($p<0.01$; 34% vs. 22%), driven by lower testosterone and higher bone stress injury rates in WS athletes. However, sex drive scores did not differ between no-risk and at-risk groups.

CONCLUSION: These findings highlight the need for increased research and support for male athletes at risk for REDs across all sports. While libido and morning erections may not be reliable indicators of REDs in a single measurement, their potential usefulness in longitudinal monitoring warrants further investigation.

1. Mountjoy M, et al. 2023 International Olympic Committees (IOC) consensus statement on Relative Energy Deficiency in Sport (REDs). Br J Sports Med. 2023; 57(17): 1073-1097.

## Invited Symposium

### IS-PN05 Effects of environmental heat stress on human performance and health across the lifecourse

**ARE CHILDREN AT A THERMOREGULATORY DISADVANTAGE WHEN EXERCISING IN THE HEAT?**

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Global surface temperature is projected to increase by 3 to 5°C by 2100, along with the frequency, severity, and duration of life-threatening heatwaves. These changes in climate will present a significant challenge to human thermoregulation, especially in those with greater vulnerability to extreme heat. Historically, children have been suggested to have an underdeveloped sweating response (i.e. lower maximal sweat rate) and different regional sweat patterns to adults, increasing their vulnerability to hyperthermia during exercise under heat stress, wherein sweat evaporation is the primary avenue for heat loss. Biological sex and maturation have also been suggested to affect sweating during exercise in response to physiological changes that occur during puberty in males (i.e. elevated testosterone), as well as a greater sweat gland output in adult males relative to females and prepubertal boys. However, isolating the independent effect of sex and/or maturation on the sudomotor response to exercise is complex due to differences in physical and physiological characteristics between individuals. Indeed, previous research that has reported differences in thermoregulation between sexes or with maturation is often confounded by body size, aerobic fitness and body composition differences between participants. Few studies have addressed these confounding factors when comparing the sweating response and change in core temperature between boys and girls, and children and adults, to determine if children are truly at greater risk of exertional heat illness. This presentation will therefore: 1) contextualise the current understanding of age and biological sex-related differences in the sudomotor response and change in core temperature (i.e. risk of hyperthermia) during exercise in the heat, 2) highlight the importance of biophysical factors when comparing independent groups, and 3) present recent research findings demonstrating that children did not have a lower sweating capacity and greater vulnerability to heat stress than adults. Following the presentation, the audience (e.g. sports scientists, sports medicine physicians, allied health professionals) will have a better appreciation of the confounding effects of morphological differences and metabolic heat production on thermoregulatory sweating in compensable and uncompensable conditions; understand how to investigate the change in core temperature, whole-body sweat rate and local sweat rate when comparing independent groups; learn that active adolescents demonstrate thermal and cardiovascular heat adaptations following summer that are commensurate to those of adults; and that children are not at a thermoregulatory disadvantage. Ultimately, the content of the presentation will allow for the audience to better discern the impact environmental heat stress on performance and health in young athletes.

**BLOWING HOT AIR – IMPACT OF ENVIRONMENTAL HEAT STRESS ON RESPIRATORY HEALTH AND PERFORMANCE**

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Changes in pulmonary function and ventilatory responses to exercise do occur when humans are exposed to environmental heat, yet airflow and ventilatory variables are under-reported in the literature and sport scientists often underappreciate the consequences of heat-related respiratory changes. Further, coaches, support staff and athletes themselves often neglect the risk of bronchoconstriction associated with exercise in the heat (despite asthma/exercise-induced bronchoconstriction being the number one chronic medical condition in children and elite athletes). The aim of this presentation is to raise awareness within the sporting community of the significant changes happening to human lungs during prolonged exposure to environmental heat. In this presentation, we will first consider the influence of ambient temperature and humidity on the air conditioning process and exercise-induced bronchoconstriction. One of the primary functions of the lungs is to bring inhaled air to 37°C and 100% humidity before it reaches the alveoli. Exposure to hot environmental

conditions minimises conditioning requirements, thereby limiting thermal and osmotic stress within the airways. In children and young adults (incl. athletes) with asthma, breathing hot humid air (up to 37°C) during exercise has therefore been shown to be beneficial, i.e. reducing risk and severity of osmotic/inflammatory-driven bronchoconstriction. However, when outdoor temperature rises above 39°C, negative consequences may arise – i.e., those suffering from asthma are likely to develop (cholinergic-mediated) reflex bronchoconstriction. Beside bronchoconstriction, humans face another respiratory challenge during uncompensable heat stress – i.e. when core temperature rises, humans start spontaneously to hyperventilate. Through excess removal of carbon dioxide, hyperventilation disturbs acid-base balances and reduces cerebral perfusion and oxygenation. Whether hyperthermic-hyperventilation limits exercise performance remains however a matter of debate. Finally, during prolonged heat exposure, humans often get dehydrated. Under controlled laboratory conditions, we previously demonstrated that acute dehydration causes small airway impairment, and that rehydration reverses this impairment. We will therefore reflect on the biological plausibility of heat-induced dehydration to contribute to the high burden of morbidity and mortality from respiratory illnesses (particularly apparent in older adults) during heatwaves. Following this presentation, the audience will be able to: differentiate between hot and cold air-induced bronchoconstriction; consider implications of environmental conditions for exercise-induced bronchoconstriction treatment; recognise the multiple physiological consequences of heat-related respiratory changes; and better account for respiratory changes in the design of temperature-controlled laboratory-based experiments.

**ELEVATED HEAT RISK IN OLDER HUMANS – WHAT CAN BE DONE ABOUT IT?**

CRANDALL, C.
*UNIVERSITY OF TEXAS SOUTHWESTERN MEDICAL CENTER*

Cutaneous vasodilation and sweating are the primary mechanisms by which humans maintain body temperature within a relatively narrow range. However, should heat gain (e.g., exercise and/or environmental heat exposure) exceed the capacity of these heat loss mechanisms to dissipate the heat, body temperature will progressively rise, culminating in a heat-related injury or death. In parallel with the elevations in global temperatures, the number of individuals 65+ years is escalating. Thus, a greater number of older individuals will be exposed to progressively higher environmental temperatures, including more frequent and intense heatwaves, over the ensuing decades. Notably, older individuals are at a greater risk for heat-related injuries and death, likely due (in part) to age-related reductions in the aforementioned heat dissipating capabilities coupled with cardiovascular limitations. Given that background, the objectives of this presentation are to: 1) provide a comprehensive review on the effects of aging (65+ years) on thermoregulatory function and associated cardiovascular stress during extreme heat exposure, 2) provide insight on the mechanisms responsible for the greater heat-related risk in older individuals, and 3) present research findings on possible low-energy demand heat mitigation strategies to reduce the risk of heat-related injuries/death in older individuals exposed to extreme heat conditions. Upon the conclusion of the presentation the audience will have a greater understanding of how humans regulate body temperature during extreme heat conditions; will understand that in older adults impaired cutaneous vasodilation and sweating, coupled with cardiovascular limitations, are the primary mechanisms responsible for their greater risk for heat related injuries/death; and will learn about low-energy cooling approaches that can reduce excessive rises in core and skin temperatures for older adults facing extreme heat conditions. The provided information will be directed to an audience having a limited understanding of human thermoregulation and cardiovascular function.

## Oral Presentations

### OP-AP26 Cycling II

**IMPROVING ENDURANCE PERFORMANCE ASSESSMENT. CAN PEAK OXYGEN UPTAKE BE ASSESSED IN TIME TRIALS AND CRITICAL POWER TESTS?**

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INTRODUCTION: Work efficiency, critical power, and cardiorespiratory fitness are the key determinants in assessing endurance performance. Cardiorespiratory fitness is commonly measured as the highest oxygen uptake (VO2peak) during an incremental ramp test (RT). However, such protocols provide limited insight into sport-specific performance parameters. In contrast, Time Trials (TT) provide insight into pacing and aerobic capacity while critical power or short-duration All Out Tests (AOT) provide data on anaerobic work capacity, peak power, and fatigue index. Protocols that capture such performance parameters as well as VO2peak would thus improve endurance performance assessment and increase testing efficiency. Previous studies have thus compared VO2peak achieved during RT with TT and/or AOT. However, most studies used group mean comparisons using t-test or correlation analyses which are clearly not suitable to evaluate validity of a method. Those few studies correctly using Bland-Altman analyses, however, did not pre-specify an acceptable range which is essential for subsequent interpretation.

METHODS: Two studies were conducted. First, 18 males and 13 females well-trained endurance athletes performed two RT and two 4-minute TT on four different days, while measuring gas exchange parameters with a metabolic cart. In the second study, 23 males and 17 females semi-professional and professional athletes performed one RT followed by a 3-

minute AOT with an intervening 20-min recovery. The a priori defined tolerance limits for delta-VO2peak between the exercise tests was set to ±0.13 L/min (approximately ±3.3%). This value derived from the day-to-day variation in VO2peak measured in a previous study [1].

RESULTS: Participants' mean (standard deviation) age (years) was 23 (4) years in the first and 30 (4) years in the second study. The mean differences when comparing the first RT with the first TT and comparing the second RT with the second TT were 0.02 L/min (p=0.93) and 0.03 L/min (p=0.87), respectively, which indicates no significant differences as presented in previous studies. However, the respective tolerance limit for these comparisons were -0.35 to 0.31 L/min and -0.36 to 0.42 L/min and thus outside of the a priori defined limit. Likewise, for the comparison of RT and AOT the mean difference was 0.08 L/min (p=0.64), but the tolerance limit was -0.42 to 0.58 L/min. The respective Lin's concordance correlation coefficient for RT VO2peak was 0.98 (95% CI: 0.96 to 0.99) for TT, and 0.95 (95% CI: 0.92 to 0.97) for AOT.

CONCLUSION: The TT and AOT show limited agreement with RT VO2peak. However, considering the lack of systematic deviations in VO2peak and the determination of further performance parameters emphasize the potential value of incorporating VO2peak measurements during TT and/or AOT for investigating aspects of performance.

References: Knaier R, et al. Frontiers in Physiology 10 (2019): 219.

**EFFECTS OF CORE STRENGTH TRAINING ON MAXIMAL TRUNK MUSCLE STRENGTH AND CYCLING ECONOMY IN FEMALE MOUNTAIN BIKERS**

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*UNIVERSITY OF FREIBURG*

INTRODUCTION: Performance in cross-country mountain biking (MTB) is primarily determined by athletes' aerobic capacity. However, with the reduction of race duration to 80 minutes, anaerobic capacity, along with muscle strength and power gained importance as key performance determinants. Adequate trunk muscle strength (TMS) is needed in MTB to facilitate force transfer between the lower and upper extremities, particularly during the start, inclines and finish sprints. There is preliminary evidence indicating that TMS training of the global, large and superficial trunk muscles can improve cycling economy (CE). Here, we examined the effects of global TMS training on TMS and CE in MTB athletes.

METHODS: Twenty-four female trained (Tier 2-3) mountain bikers aged 14-22 years participated in this study. They were paired by age and randomly assigned to a TMS training or an active control (CON) group. The training took place during the off-season, lasted for eight weeks with three weekly sessions. While TMS performed 30 minutes of TMS training targeting the global trunk muscles, CON did their regular upper- and lower-body strength training excluding trunk muscle exercises. Both groups had similar training volumes. Pre- and post-training, maximal isometric TMS and TMS endurance for ventral, dorsal and lateral trunk muscles were tested. Physiological CE (i.e., O2/CO2 per min/kg) and mechanical CE (e.g., lateral oscillations of the bike frame, torque effectiveness during pedalling) were assessed while performing a MTB racecourse simulation for twelve minutes on a 3x5-m treadmill.

RESULTS: Group-by-time interactions were found for maximal isometric flexor ($p<0.0001$, $d=1.1$) and extensor ($p<0.0001$, $d=1.7$) TMS. Post-hoc tests revealed greater improvements for flexors ($p<0.001$, $d=2.2$, +32.2%) and extensors ($p<0.001$, $d=2.0$, +28.4%) following TMS training. Interaction effects were also observed for lateral TMS endurance ($p=0.03$, $d=0.47$), with post-hoc tests indicating greater progress in the TMS group ($p=0.03$, $d=0.74$, +18.2%). For mechanical CE, an interaction effect was found for bike oscillation ($p<0.001$, $d=0.8$) in favour of the TMS group ($p=0.01$, $d=0.9$, -24.4%).

CONCLUSION: TMS training improved maximal isometric flexor and extensor TMS, lateral TMS endurance and mechanical CE. Off-season global TMS training is a suitable recommendation for female MTB athletes.

**PHYSIOLOGICAL ADAPTATIONS FOLLOWING REPEATED SPRINT TRAINING WITH VOLUNTARY HYPOVENTILATION: COMPARISON WITH THE TRAINING IN HYPOXIA**

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INTRODUCTION: Repeated sprint training in hypoxic conditions has been shown to improve repeated sprint ability (RSA). Moreover, repeated sprint training with voluntary hypoventilation at low lung volume (VHL) is gaining attention as an alternative method for establishing a hypoxic environment in the body. Training with VHL has previously demonstrated a further increase in RSA compared to the same training with normal breathing [1]. However, a direct comparison between "repeated sprint training in hypoxia" and "repeated sprint training with VHL" has not yet been conducted. The purpose of the present study was to compare the training adaptations between "repeated sprint training with VHL" and "repeated sprint training in hypoxia".

METHODS: Twenty-four healthy, physically active males (age, 21.9 ± 0.4 years; height, 172.9 ± 1.2 cm; weight, 71.0 ± 21.9 kg) performed repeated cycling sprints (two sets of 6-8 × 6-s maximal sprints with 24-s rest periods between sprints) twice per week for three weeks (six sessions in total). Subjects were randomly assigned to one of three different groups: (1) training in normoxia with normal breathing (NOR group; 23°C, FiO2 = 20.9%), (2) training in hypoxia with normal breathing (HYP group; 23°C, FiO2 = 16.4%), or (3) training in normoxia with breath holding (VHL group; 23°C, FiO2 = 20.9%). Before and after the training periods, subjects performed RSA test (12 × 6-s maximal sprints with 24-s rest periods between sprints) and maximal oxygen uptake (VO2max) test. Power output, systemic oxygen uptake, and cardiac function were monitored during the training and performance tests. Muscle oxygenation variables in vastus lateralis and respiratory muscles were also evaluated using near-infrared spectroscopy.

RESULTS: Over six training sessions, the minimum arterial oxygen saturation was significantly lower in the VHL and HYP than in the NOR (VHL; 84.8±1.6%, HYP: 82.8±1.0%, NOR: 92.1±0.7%, $P < 0.05$). Peak power output and mean power output did not differ significantly among the groups ($P > 0.05$). In the VHL, cardiac output (including the 24-s recovery between sprints) was significantly increased in session 6 compared with session 1 ($P < 0.05$), but not in the HYP and NOR ($P > 0.05$). Power output during RSA test was significantly increased in the VHL and HYP (VHL, 575±21 W vs. 659±30 W, $P < 0.05$; HYP, 604±26 W vs. 671±35 W, $P < 0.05$), whereas the NOR did not show significant changes after the training period (592±32 W vs. 623±30 W, $P > 0.05$). Additionally, VO2max during the incremental pedaling test was significantly increased in the VHL ($P < 0.05$), but not in the HYP and NOR ($P > 0.05$).

CONCLUSION: Three weeks of repeated sprint training with VHL and repeated sprint training in hypoxia caused comparable decreases in arterial oxygen saturation during the training session and enhanced RSA performance. Furthermore, the increase in VO2max observed after the training with VHL suggests that the physiological mechanisms for enhancing RSA may differ from those of hypoxic training.

**PHYSIOLOGICAL RESPONSES TO DIFFERENT CYCLING CADENCES**

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INTRODUCTION: Since the 21st century, professional cyclists comprehensively increase their pedaling cadence from 80 rpm to 90-100 rpm or higher. The physiological impacts caused by different pedaling cadences have not been well investigated.

This study aims to investigate how different pedaling cadences during cycling influence various physiological indices, including excess post-exercise oxygen consumption (EPOC), oxygen debt during cycling, gross efficiency, respiratory exchange ratio (RER) and power output.

METHODS: Amateur road cyclists (n=20 for men female) aged from 20 to 65 were recruited. Each participant completed two cycling tests, which were a standard functional threshold power test and a multiple-cadence test. Three days after the FTP test, all participants were required to ride a protocol consisting of continual trials with different gear ratios but consistently at an intensity of 95% personal FTP. Based on the personal selected gear ratio, seven different gear ratios were set, which would lead to different pedaling cadences (ranging from 65 to 115 rpm). Each trial consisted of a 3-minute ride followed by a standardized 3-minute rest period with low power output pedaling. Throughout the multiple-cadence test, various physiological indices of respiration, power output, and cadence were measured. Repeated measure of one-way ANOVA was used for data analyses ($\alpha = .05$).

RESULTS: For maintaining consistently power output at 95% personal FTP, pedaling at lighter gear ratios (lower pedaling torques) were associated with increased cadence the self-selected gear ratio was associated with a lower oxygen debt as well as lower EPOC. In contrast, pedaling at gear ratios with higher cadence demonstrated a higher oxygen debt and higher EPOC. In addition, with the increase of pedaling cadence, RER showed similar trends suggesting a shifting of macro-nutrients resources for energy metabolism. Gross efficiency showed a downward trend while the pedaling cadence increased.

CONCLUSION: For a 3-minute cycling pedal, relative lower pedaling torque accompanied by higher cadence might lead to a higher energy expenditure. However, lower pedaling cadence associated muscular loading might be a concern for long term cycling. Investigation regarding a balance between pedaling cadence and torque would be interesting for the practical applications in recreational as well as professional cycling.

**COMPARISON OF DYNAMIC STABILITY BASED ON RIDING TIME AND SADDLE HEIGHT DURING CYCLING**

YOON, S., KIM, D.1, KANG, J.1, PARK, S.1, RYU, S.1, LIM, H.S.2
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INTRODUCTION: Research on finding the optimal saddle height for cycling has been continuously conducted since Hamley & Thomass inseam method (1) in 1967. The optimal saddle height is a crucial factor in preventing knee injuries and enhancing athletic performance during prolonged pedaling (2). Since cycle pedaling requires continuous coordination between lower extremity joints, it has been reported that consistent movement of lower extremity joints is essential(3). However, previous studies on cycling dynamic stability has focused on evaluating heart rate variability, pedaling time, and force, whereas studies comparing the variability of lower extremity movements based on optimized saddle height remail insufficient. Therefore, the purpose of this study was to analyze the effect of differences in saddle height and riding time on the dynamic stability of lower limb joints during pedaling.

METHODS: Total of 11 elite university cyclists (height: 174.2±6.9 cm, weight: 67.4±8.7 kg) participated in this study. The experiment was conducted over three days, with each day participant cycling for 60 minutes at randomly selected one of three different saddle heights. The cycling intensity was set at 3 watts/kg in this study. A three-dimensional motion analysis with eight infrared cameras (sampling rate: 200 Hz) was performed. A two-way RM ANOVAs between saddle heights and riding time were peformed.

RESULTS: As cycling duration increased, the variability of knee joint angles also increased ($p < .05$). Post hoc analysis revealed that saddle heights of 106% and 108% showed the greater variability compared to 110%. Among the saddle heights, the 108% exhibited greater variability than both 106% and 110%. A significant interaction effect between cycling

duration and saddle height was observed ($p < .05$). Over time, the 110% saddle height showed less variability compared to the 106% and 108% saddle heights.

CONCLUSION: The results of this study indicate that, even as cycling duration increased, the 110% saddle height maintained a consistent lower limb joint movement pattern. Therefore, in competitive elite cyclists, a saddle height of 110% of inseam length may contribute to consistent pedaling and more efficient cycling performance.

## Oral Presentations

### OP-BM06 Rate of Force Development

**ARTIFICIALLY-INDUCED SILENT PERIOD BY TMS INCREASES RATE OF TORQUE DEVELOPMENT IN SUBSEQUENT BALLISTIC CONTRACTIONS OF THE ANKLE DORSIFLEXORS.**

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INTRODUCTION: Explosive strength is a key neuromuscular capability, measured as the rate of torque development (RTD) from a muscle group (1). In ballistic contractions, faster motor units recruitment and higher discharge rates are associated with higher RTD (2). The presence of a pre-contraction silent period, defined as the absence of muscle activity and motor units firing prior to contraction onset, leads to higher discharge rates and increased RTD (3). However, the role of the synchronisation of descending drive after the silent period in improving RTD remains debated, with lacking experimental evidence. In this study, we artificially silenced descending neural drive to motor units and thereafter synchronised it by using transcranial magnetic stimulation (TMS) before the onset of ballistic contractions. We hypothesized that explosive efforts preceded by TMS would exhibit higher RTD, muscle activity, and motor units discharge rate, compared to control contractions.

METHODS: Nine participants performed 6 sets of 2 isometric ballistic ankle dorsiflexions (2 min rest between sets), separated by 20 s. Muscle activity of the tibialis anterior was recorded with high-density electromyography (EMG). Participants were instructed to contract as fast as possible when hearing the TMS discharge after a countdown. In the first contraction (w/SP), TMS was used (at rest) to induce a corticospinal silent period overlapping with the reaction time of the ballistic effort. For this reason, the TMS output was set up to induce a silent period recorded from tibialis anterior of ~180 ms during isometric contractions at 20% maximal voluntary contraction (MVC) torque. In the second condition (w/oSP), the TMS discharge sound was triggered, but no silent period was elicited. The order of w/SP and w/oSP was alternated between sets.

RESULTS: Reaction time (TMS trigger to EMG onset) was longer w/SP (172 ± 31 ms) than w/oSP (112 ± 29 ms; $P < 0.01$). Root-mean-square of the EMG 0-50, 0-100, and 0-150 ms from onset was higher w/SP (129 ± 74, 94 ± 43, and 63 ± 33 %, respectively; $P < 0.01$). Peak RTD (in a 30 ms-window, divided by MVC torque) was 22 ± 9 % higher w/SP than w/oSP (8.5 ± 2.0 vs. 7.0 ± 1.9 MVC torque/s; $P < 0.01$). The discharge rate of motor units (average from the first four discharges) was higher w/SP than w/oSP (62 ± 15 vs. 56 ± 11 Hz; $P < 0.01$).

CONCLUSION: By silencing corticospinal excitatory neurons in the primary motor cortex before ballistic efforts, and by delaying and synchronising descending neural drive, higher discharge rate of motor units and RTD was achieved. These findings highlight the simultaneous role of the silent period and following synchronised neural drive to motoneurons for muscle rapid force production.

**MOTOR UNIT ACTIVITY AND MUSCLE CONTRACTILE PROPERTIES DURING RAPID CONTRACTIONS IN LONG-TERM RESISTANCE-TRAINED, ENDURANCE-TRAINED AND UNTRAINED INDIVIDUALS**

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INTRODUCTION: Maximal rate of force development (RFD) is determined by neural (motor unit [MU] recruitment speed and discharge rate) and contractile properties (1,2). Chronic resistance training may confer neural adaptations including greater spinal cord output that facilitates faster RFD, whereas endurance trained (ET) individuals may have slower muscle contractile properties, resulting in limited increases in spinal cord output (3). Here, we assessed MU activity and intrinsic muscle contractile properties within RT, ET and UT individuals during maximal rapid contractions.

METHODS: Sixty-six RT, ET and UT (22 per group, 6 females) individuals produced maximal and rapid voluntary isometric dorsiflexion force to determine maximal voluntary force (MVF) and RFD, respectively. Supramaximal percutaneous nerve stimulation (300 Hz) was administered to the common peroneal nerve at rest to record maximal evoked force (MEF) and RFD. A 64-channel grid electrode was placed on the tibialis anterior muscle of the dominant leg to assess myoelectrical activity (EMG). The EMG signals were decomposed into individual MU spike trains using Convolution Kernel Compensation algorithm to calculate MU recruitment speed, and discharge rate (DR) in the initial and plateau period of rapid contractions.

RESULTS: MVF, MEF and maximal evoked RFD were significantly larger in RT (408.2 [358.0, 458.4] N, 151.3 [137.3, 165.3] N, 1998 [1776, 2220] N/s) compared to ET (346.6 [312.1, 381.0] N, 93.0 [78.2, 107.8] N, 1317 [1084, 1551] N/s, $p<0.04$) and to UT

(301.4 [267.8, 335.0] N, 110.4 [96.7, 124.0] N, 1492 [1276, 1708] N/s, p<0.005), respectively. When maximal evoked RFD was normalised to MVF, both RT (482 [434, 529]%MVF/s) and UT (494 [448, 540]%MVF/s) were greater than ET (383 [333, 433]%MVF/s, p<0.0157). Greater absolute voluntary RFD was seen in RT compared to UT (1754 [1542, 1996] N/s vs. 1219 [1007, 1431] N/s, p=0.0031) but not compared to ET (1469 [1258, 1681] N/s, p=0.1486). However, when normalised to MVF, there were no differences between RT, ET or UT (437 [410, 464], 419 [392, 446], 403 [376, 430] %MVF/s, p=0.1984). Initial DR was greatest in RT (71.7 [67.3, 76.2] pps) compared to UT (63.9 [59.4, 68.5] pps, p = 0.0454), but not compared to ET (64.8 [60.4, 69.2] pps, p = 0.0773). DR during the plateau phase was the highest in RT (33.1 [30.5, 35.6] pps) vs. ET (27.8 [25.3, 30.4] pps, p=0.0136), but not compared to UT (31.0 [28.4, 33.6] pps, p=0.4949). No differences were noted in recruitment speed between RT, ET or UT (290 [224, 355], 316 [250, 381], 259 [184, 333] MUs/ms, p=0.767), respectively.

CONCLUSION: RT individuals exhibited greater maximal strength and absolute RFD. However, despite greater initial MU discharge rate, relative RFD was similar between groups, likely due to between-group similarity in MU recruitment speed, a key determinant of RFD.

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**EFFECT OF ANODAL TDCS ON RATE OF FORCE DEVELOPMENT, MOTOR UNIT DISCHARGE RATE, AND RETICULOSPINAL ACTIVATION, IN YOUNG AND OLD ADULTS.**

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INTRODUCTION: The ability to produce maximal force in minimal time is a key function of the neuromuscular system. While training can enhance rapid force generation, factors like ageing and muscle unloading can cause significant declines. Despite rapid force generation being more important for human function than maximal strength, there is limited research on its decline and potential countermeasures.

The speed of motor neuron recruitment and maximal motor unit discharge rate are major contributors to rapid force generation. A startling cue, which activates the pontomedullary reticular formation neurons, can increase the maximal motor unit discharge rate. However, its unclear whether age-related physical decline is linked to reduced excitability of descending motor pathways, such as the reticulospinal tract, which plays a role in gross motor output.

Transcranial Direct Current Stimulation (tDCS), a non-invasive brain stimulation technique, may be able to facilitate subcortical structures. If effective, tDCS could potentially mitigate the loss of rapid force production due to aging or bed rest, allowing for faster recovery and resumption of daily activities in older adults, for example.

METHODS: Forty-four adults participated in a single-blind, two-arm crossover study. They were asked to generate isometric knee extensor forces as rapidly and forcefully as possible from rest to 75% of maximal voluntary force. This was done in response to visual (VC; LED), visual-auditory (VAC; 80 dB), or visual-startling cue (VSC; 110 dB), both before and after receiving either anodal or sham tDCS. Rate of force development and reaction time were measured using a rigid custom-built isometric leg extension dynamometer. Motoneuron activity was estimated by analyzing high-density surface electromyogram recordings over the vastus lateralis muscle. reticulospinal tract gain was calculated by comparing reaction times to each of the three cues.

RESULTS: Twelve young males (means ± SD; age: 23 ± 4 yr, stature: 1.77 ± 0.07 m, body mass: 77.0 ± 10.7 kg), twelve young females (age: 21 ± 2 yr, stature: 1.67 ± 0.08 m, body mass: 59.6 ± 8.6 kg), ten old males (age: 71 ± 3 yr, stature: 1.78 ± 0.10 m, body mass: 83.2 ± 13.9 kg), and ten old females (age: 70 ± 4 yr, stature: 1.62 ± 0.04 m, body mass: 61.3 ± 7.5 kg) completed three visits to the School of Sport, Exercise and Rehabilitation Sciences, University of Birmingham. There were two to six days (2 ± 1 days) between experimental visits which were preceded by an initial familiarization visit and two to ten days (4 ± 1 days) before the first experimental visit. Further analysis will investigate key measures such as reaction time, rate of force development and motor unit decomposition.

CONCLUSION: This study will provide valuable insights into the potential of non-invasive brain stimulation as a method to counteract age-related weakness. Additionally, it will contribute to the understanding of reticulospinal tract excitability in healthy aging research.

**DO INSTRUCTIONS MATTER? MOTOR IMAGERY TRAINING FOR RATE OF FORCE DEVELOPMENT AND MAXIMAL VOLUNTARY CONTRACTIONS IN YOUNG FEMALES**

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INTRODUCTION: Instructions before a maximal voluntary contraction (MVC) effect the output of the effort. Emphasis on the word "hard" compared to "fast" will produce a greater force, and with the prominent instruction word of "fast" the rate of force development (RFD) is quicker. Motor imagery training (MIT) is the mental rehearsal of a task with no overt movements and can improve and maintain task performance over time. Mentally rehearsing an MVC maintains strength performance but the influence of instruction type is unknown. The purpose of this study was to understand whether MIT instructions influence strength and RFD similar to verbal instructions for the production of an MVC. It was hypothesized that the MIT

instructions with emphasis on "hard" would maintain strength throughout the session and that the MIT instructions with emphasis on "fast" would maintain RFD throughout the session.

METHODS: Thirty-six females aged 19-35 years were randomly assigned to one of four groups. The MIT group "hard and fast" and MIT group "fast and hard" (emphasis on the first word) visualized the contraction. The control groups received one set of emphasized instructions of "hard and fast" or "fast and hard" and executed the MVC contractions. The four groups completed a familiarization day where voluntary activation was assessed with the twitch interpolation technique and an experimental day which followed a block order. Blocks 1,3 and 5 involved three isometric elbow flexion MVCs separated by two minutes of rest. Blocks 2 and 4 involved MIT (MIT groups) or viewing a documentary (control groups). Participants self-rated their MIT blocks with a 7-point Likert scale. Data are reported for 8 participants.

RESULTS: MIT scores did not differ across blocks. Voluntary activation did not differ across groups (98.7 + 0.7% $p>0.05$). The control groups "hard and fast" (approximately 7% decline) and "fast and hard" (approximately 10% decline) had an overall reduction in strength across blocks. The MIT groups "hard and fast" (approximately 6% decline) and "fast and hard" (approximately 4% decline) had an overall reduction in strength across blocks but less than the control groups. The RFD in the first block was approximately two-times faster for the MIT and control groups who received the "fast and hard" instruction compared to those who received "hard and fast". The MIT "fast and hard" group maintained their RFD across blocks.

CONCLUSION: The instructions given for MIT influence the performance of MVC contractions in a similar manner to physical performance. With an emphasis on "fast", the RFD is quicker compared with "hard". The use of MIT in between sets could prove beneficial for the performing rapid or strong contractions.

**GENDER DIFFERENCES IN RATE OF FORCE DEVELOPMENT UNDER FATIGUE CONDITIONS**

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INTRODUCTION: Rate of force development (RFD) is crucial for sports performance, especially in explosive lower-limb movements. Neuromuscular fatigue impairs RFD, leading to muscle imbalances, reduced joint stability and higher injury risk [1]. Knee flexion angle affects injury susceptibility, with low flexion (<30°) increasing anterior cruciate ligament stress and high flexion (>90°) raising meniscal and patellofemoral loading. Gender differences in fatigue resistance further influence these risks, emphasizing the need for tailored training [2]. However, the fatigue-induced decline in RFD across knee flexion angles remains unclear. This study aims to assess fatigue-induced changes in quadriceps and hamstring RFD at 30°, 60°, and 90° knee flexion, providing gender-specific comparisons and training implications.

METHODS: A cross-sectional study with 67 active adults was conducted (38 males: 24.3±3.7 years, BMI 24.4±2.3 kg/m²; 29 females: 23.9±3.1 years, BMI 22.4±2.2 kg/m²). Participants performed maximal voluntary isometric contractions (MVICs) at 30°, 60°, and 90° using an isokinetic dynamometer (Biodex System 4 PRO). RFD (N·ms) was recorded pre- and post-fatigue after 5×30 maximal isokinetic contractions at 180°/s. Two-way repeated-measures ANOVA (fatigue × knee angle × gender) with Bonferroni post hoc tests were applied.

RESULTS: Fatigue significantly reduced RFD across all knee angles ($F(1, 66)=28.74$, $p<.001$, $\eta^2=0.19$), with the largest declines at 90° and 60°. Men showed higher absolute RFD in both pre- and post-fatigue status ($F(1, 66)=17.63$, $p<.001$, $\eta^2=0.16$). Women showed greater quadriceps fatigue resistance ($F(1, 66)=5.84$, $p=.02$, $\eta^2=0.08$), conversely, men had lower hamstring RFD decline ($F(1, 66)=4.96$, $p=.03$, $\eta^2=0.07$).

CONCLUSION: Fatigue reduces RFD, particularly at higher knee flexion angles, with hamstrings more affected than quadriceps. Women show greater hamstring fatigue vulnerability, while men exhibit higher quadriceps fatigue susceptibility. These findings support targeted explosive strength training strategies at determined knee flexions (e.g. 60° and 90°), emphasizing hamstring-focused exercises for women (e.g., Nordic curls, Romanian deadlifts) and quadriceps-strengthening for men (e.g., front squats, Bulgarian split squats). Future research should explore long-term fatigue adaptations and their impact on injury prevention.

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**EFFECTS OF INTERMITTENT EXOGENOUS KETOSIS ON OXYGEN UPTAKE KINETICS AND TISSUE OXYGENATION DURING MODERATE-INTENSITY EXERCISE ACROSS THREE DAYS AT HIGH-ALTITUDE**

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INTRODUCTION: High altitude-related impaired oxygen delivery to working muscles leads to decelerated oxygen uptake kinetics during exercise (1). We previously demonstrated that ketone monoester (KE) ingestion enhances oxygen uptake and mitigates tissue oxygenation reductions during moderate-intensity exercise under acute simulated high-altitude conditions (2). Under this premise, we aimed to evaluate the effects of intermittent exogenous ketosis on oxygen uptake kinetics and oxygenation responses during moderate-intensity exercise across three days at terrestrial high altitude.

METHODS: Healthy, recreationally active participants were randomized into an intermittent exogenous ketosis (IEK, n = 17) and a placebo group (PLA, n = 17). They completed four moderate-intensity exercise sessions; one near sea-level (295 m), and the other three on consecutive days at terrestrial high altitude (3375 m). To establish a true baseline, no supplementation was administered at sea level. At high altitude, IEK received daily KE supplements, while PLA received placebo supplements 30 minutes prior to exercise. Each session consisted of three 6-minute cycling intervals at 80% of the gas exchange threshold, separated by 6-minute active recovery periods at 0 W. Power output during high-altitude sessions was adjusted to account for predicted altitude-induced exercise capacity reductions (3). Pulmonary oxygen uptake, systemic oxygen saturation, and muscle tissue oxygenation were continuously measured during exercise transitions and steady-state phases. Group differences over time were evaluated using mixed-model ANOVA, with statistical significance set at $p < 0.05$.

RESULTS: Pre-exercise ketosis was consistently induced in IEK (~2.5 mM) compared to PLA (~0.3 mM) ($p < 0.001$). Relative to sea level, the amplitude of the oxygen uptake response decreased upon arrival at high altitude ($p < 0.001$), and remained reduced throughout early acclimatization ($p > 0.181$), with no between-group differences ($p > 0.05$). The time constant of the primary phase of oxygen uptake kinetics was not modified by either high-altitude exposure time ($p = 0.136$) or supplementation ($p = 0.823$). Systemic oxygen saturation declined significantly upon arrival at high altitude compared to sea level ($p < 0.001$), and progressively improved throughout acclimatization, yet again independent of the supplementation ($p = 0.169$). In contrast, muscle tissue oxygenation did not significantly change across time ($p = 0.102$), and no difference was seen between groups ($p = 0.591$).

CONCLUSION: These data suggest that pre-exercise ketosis at high altitude does not influence oxygen uptake kinetics, systemic oxygen saturation, or muscle tissue oxygenation during moderate-intensity exercise across three days of high-altitude acclimatization.

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**A COMPARISON OF KETOGENIC AND CARBOHYDRATE-FED ATHLETES ON A BATTERY OF PHYSIOLOGICAL TESTS.**

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INTRODUCTION: The high-carbohydrate (HC) diet is widely adopted to enhance endurance and power output, while KD has been suggested to impair high-intensity performance. KD shifts reliance towards fat oxidation, due to glycogen depletion. This study assessed the impact of athletes following habitual (>3 months) HC and KD diets on exercise performance.

METHODS: Nineteen recreationally active individuals (mean age: 35 ± 9 y; stature: 175.5 ± 10.5 cm; body mass: 79.5 ± 12.4 kg; body fat %: 20.3 ± 6.2%; fat-free mass: 63.2 ± 11.6 kg were stratified into those who followed either a KD (<50 g/day CHO, >60% fat) or HC (225–325 g/day CHO, 45–65% CHO),diet for the preceding 3-months. Diets were verified via food frequency questionnaires and MyFitnessPal tracking during testing (KD: n = 8, HC: n = 11). A six-session battery of tests spanned three weeks under standardised conditions (≥3h fasted, no prior training). Visit 1 (V1) included anthropometric assessment, arm crank $VO_2$ max ($ACEVO_2MAX$), isokinetic dynamometry (ISODYNO) (30°–240°/s), and a 30-second Wingate anaerobic test (30sWAnT). V2 comprised an ACE one-hour endurance test (ACE1HR) and a 20-minute performance test. (ACE20Min). V3 assessed maximal oxygen uptakes on a LODE cycle ergometer ($LODEVO_2MAX$). V4 included a one-hour endurance test on the LODE cycle ergometer (LODE1HR) followed by a five-by-10-second repeat sprint Wingate test (10sWAnT). Heart rate (HR), respiratory exchange ratio (RER), $VO_2$ (ml.kg.min-1), power (PWR, W) and time to fatigue (s) were recorded, while blood glucose (BG, mg/dl), ketones (BK, mmol/L), and lactate (BL, mmol/L) were recorded at set intervals per test for group comparison. Data was analysed using SPSS 29 for normality. Independent t-tests compared between-group differences in $VO_2$ max, RER, heart rate, peak torque, average power, and fatigue factor, while a Repeated-

Measures ANOVA analysed time × diet interactions for HR, RER, $VO_2$, BG, BK and BL. Significance was set at $p < 0.05$. Data are expressed as mean ± SD.

RESULTS: No significant differences were found in V1 for ACE$VO_2$max, peak HR, or ISODYNO average power. However, KD had lower RER ($p < 0.05$) and greater PeakTQBW at 120°/s and 240°/s ($p < 0.05$). In 30sWAnT, no differences were found in peak PWR, distance, or fatigue factor, though KD showed greater variance. During V2, $VO_2$ increased over time ($p < 0.05$) and was higher in KD ($p < 0.05$), while ACE1HR and ACE20MIN distance were similar. BK was higher in KD ($p < 0.05$).In V3/V4, no differences were found in LODE$VO_2$MAX or LODE1HR, but KD had higher BL ($p < 0.05$). In 10sWAnT, HC had higher cadence and speed in sprints 1–4 ($p < 0.05$), while peak PWR and distance were unchanged.

CONCLUSION: KD increased fat oxidation and $VO_2$ uptake during endurance exercise, while HC resulted in higher cadence and sprint speed. Although both diets elicit different metabolic responses there is little consequential difference between dietary approaches and exercise performance.

**EFFECTS OF EXOGENOUS KETONE SUPPLEMENTATION ON POST-EXERCISE ERYTHROPOIETIN AND HEPCIDIN RESPONSES**

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INTRODUCTION: Hepcidin, an iron-regulating hormone, is thought to be downregulated by stimuli that promote erythropoiesis (Nemeth & Ganz, 2023). Ketosis, characterized by elevated β-hydroxybutyrate (βHB) levels, was reported to increase post-exercise serum erythropoietin (EPO) concentration following acute ketone supplementation in healthy men (Evans et al., 2023). Therefore, this study aimed to investigate the effects of βHB supplementation after exercise on EPO and hepcidin responses in active women.

METHODS: Eight women completed the experimental trials [means ± SD, age: 20 ± 1 years, height: 155.8 ± 7.9 cm, body mass (BM): 54.9 ± 6.2 kg, peak oxygen consumption (VO2peak): 45.7 ± 4.3 mL/kg/min] under two different conditions during the early-follicular phase: either consuming 25.5 g of βHB (8.5 g/h, 3 times; βHB) or an equivalent amount of placebo (CON) after high-intensity interval exercise (3-minutes warm-up, 8 sets of 3-minutes cycling at 85%VO2peak, 3-minutes cool-down). The βHB/placebo supplements (OKETOA®, Osaka Gas Co., Ltd.) were consumed immediately, 60 min and 120 min after exercise. A light meal (0.9 g/kg BM of carbohydrate, 0.1 g/kg BM of protein) was consumed with βHB/placebo supplements 60 min after exercise. Blood samples were collected before and after exercise (0, 30, 120, and 180 min); respiratory samples with a breath-by-breath method were collected before and after exercise (30, 120, and 180 min). A repeated-measures two-way ANOVA was applied, and significant interactions or main effects were followed up using Bonferroni post-hoc test. Significance was set at $p < 0.05$.

RESULTS: Significant differences were observed in serum βHB responses ($F = 43.523$, $p < 0.001$). Serum βHB concentrations were significantly higher in the βHB trial than in the CON trial (30 min: $p = 0.004$, 60 min: $p = 0.004$, 120 min: $p = 0.006$, 180 min: $p = 0.028$). The βHB trial showed a significantly lower mean blood glucose concentration than the CON trial ($F = 11.372$, $p = 0.012$). Significant differences were observed in changes in the respiratory exchange ratio (RER; $F = 3.994$, $p = 0.011$). The βHB trial exhibited a significantly lower RER 120 min after exercise than in the CON trial ($p = 0.002$). No significant differences were observed in serum hepcidin response between the trials ($F = 0.714$, $p = 0.427$). Significant differences were observed in serum EPO response between the trials ($F = 7.595$, $p = 0.020$); however, the post-hoc test did not reveal significant differences between the trials. Changes in serum EPO concentration (180 min minus pre-exercise) were significantly different between the trials (βHB: + 0.325 ± 0.974 mIU/mL, CON: -1.325 ± 1.400 mIU/mL; $p = 0.027$).

CONCLUSION: Exogenous ketosis via βHB supplementation influenced the EPO response and glucose metabolism but did not affect the hepcidin response following high-intensity interval exercise.

## Oral Presentations

### OP-MH27 Mixed Sleep / Physical Activity Performance across the Lifespan

**EFFECTS OF A TWO-WEEK SCHOOL VACATION ON PHYSICAL FITNESS, SLEEP, PHYSICAL ACTIVITY, AND SEDENTARY BEHAVIOR IN PRESCHOOL GIRLS AND BOYS**

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INTRODUCTION: Physical fitness is a key determinant of children's health, closely linked to sleep, physical activity (PA), and sedentary behavior (SB) (Ortega et al., 2008). The Structured Days Hypothesis suggests that school vacations disrupt movement behaviors, contributing to increased SB and decreased PA (McCue et al., 2013). School provides a structured environment that supports these behaviors, while vacations may lead to altered sleep, reduced PA and increased SB (Brazendale et al., 2017). The effects of vacations on physical fitness components remain less explored. Additionally, few studies have assessed movement behaviors simultaneously. This study aimed to evaluate the impact of a two-week school vacation on physical fitness, sleep, PA, and SB in preschoolers.

METHODS: Forty-three children (21 girls, 22 boys, aged 9-11 years) from two French school classes participated in a pre-post study. Fitness tests included the one-mile run (cardiorespiratory fitness), countermovement jump (explosive power),

and 30m sprint (speed). Simultaneously, sleep, PA, and SB were continuously monitored for one month using wrist-worn accelerometers (ActiGraph GT3X+), worn 24h/day, to record movement behaviors during both school and vacation periods (P1: before vacation: P2 and P3: during two-weeks vacations and P4: after vacation). Linear mixed models were used to analyze time and gender effects, and correlations tested associations between behavioral shifts and fitness changes.

RESULTS: No significant changes were observed in cardiorespiratory fitness, sprint performance, or jump power between pre- and post-vacation assessments. However, movement behaviors shifted considerably. Sleep patterns changed, with delayed bedtimes observed particularly in girls. Moderate-to-vigorous physical activity (MVPA) declined sharply, with boys experiencing the greatest decrease (57.1% meeting guidelines in P1 vs. 9.5% in P3). SB increased across both genders, with less than 10% of children maintaining SB levels below 8 hours/day during the two-week school vacation. Despite these behavioral shifts, no associations were found between changes in sleep, PA, or SB and physical fitness.

CONCLUSION: A two-week school vacation did not affect physical fitness but led to significant disruptions in movement behaviors, supporting the Structured Days Hypothesis. Boys experienced a greater decline in MVPA, while girls had more pronounced sleep disruptions. These findings highlight the importance of structured routines such as school in maintaining healthy activity behaviors. Future research should explore potential moderators such as socioeconomic factors, seasonal variations, and baseline activity levels to better understand and mitigate vacation-induced inactivity.

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**COMPARISON OF THE EFFECTIVENESS OF SLEEP HYGIENE STRATEGIES ADMINISTERED IN WRITTEN FORMAT VS INDIVIDUAL SLEEP EDUCATION SESSION IN ATHLETES: A RCT STUDY.**

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INTRODUCTION: Sleep is fundamental for athletes' performance, enabling optimal recovery. Sleep Hygiene Strategies (SHS) offer evidence-informed recommendations to enhance sleep in athletes, but no studies compared different methods for administered them in athletes. This randomized controlled trial investigated how different methods of delivering SHS affect sleep hygiene and sleep parameters in track and field athletes. Specifically, the aim was to compare the effect of ten days of SHS in a standardized, written format versus individual sleep education sessions.

METHODS: This three-arm randomized controlled trial was approved by the Ethical Committee of Università degli Studi di Milano (ref. n.: 74/23), and conducted according to the Declaration of Helsinki. Sixty-six athletes were recruited during the 2022/2023 and 2023/2024 competitive periods and randomized into three groups: Control (CON, n=22), Written format SHS (W-SHS, n=22), and individual sleep Education Session SHS (ES-SHS, n=22). Sleep monitoring (total sleep time, sleep efficiency, sleep latency, wake after sleep onset, bedtime, wake-up time, sleep regularity index), including actigraphy and sleep diaries, was conducted at baseline (T0) and during the intervention period (T1) for 10 consecutive days for each monitoring. Participants also completed training diaries (number of trainings, minutes of training, training load) and the Sleep Hygiene Index (SHI) questionnaire. Between T0 and T1, a maximum of 7 days was allowed for data analysis and scheduling individual sleep education sessions for the ES-SHS group. During T1, the W-SHS and ES-SHS groups adopted the same SHS, while the CON group did not receive any SHS intervention.

RESULTS: Based on National Sleep Foundation guidelines, at T0, 18 participants were considered short-sleepers (total sleep time < 7h. CON: n=4; W-SHS: n=8; ES-SHS: n=6) and 2 were poor-sleepers (sleep efficiency < 85%. W-SHS: n=1; ES-SHS: n=1). At T1, 16 participants were short-sleepers (CON: n = 7; W-SHS: n = 3; ES-SHS: n = 6), and 3 (W-SHS: n = 2; ES-SHS: n = 1) were poor-sleepers. No statistical differences were found in sleep variables and training parameters. However, significant differences were observed in SHI scores from T0 and T1, with improvements in sleep hygiene in the W-SHS (T0: 28.3±4.5; T1: 22.1±4.2) and ES-SHS (T0: 29.2±5.2; T1: 22.7±4.6) groups.

CONCLUSION: While no significant differences were observed in sleep parameters across groups, the administration of SHS significantly improved SHI scores among athletes. These findings highlight the importance of SHS in enhancing sleep hygiene in athletes. Future research should explore long-term impacts and additional methods to optimize SHS delivery.

**EXPLORING THE IMPACT OF HYPOPRESSIVE ABDOMINAL GYMNASTICS ON SLEEP QUALITY: INSIGHTS FROM A PILOT STUDY**

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INTRODUCTION: Hypopressive Abdominal Gymnastics (HAG) is a postural technique developed to reinforce abdominal and pelvic floor muscles. It is mainly practised by pregnant and post-partum women and subjects with rectus abdominis diastasis, prolapse, urinary incontinence, pelvic floor dysfunction, and chronic low-back pain. This technique combines expiratory apnoea with abdominal contraction manoeuvres to relax the diaphragm and reduce intra-abdominal pressure while activating the abdominal and pelvic floor muscles (1). Since no studies have evaluated sleep in relation to HAG practice, this study assesses if HAG might exert beneficial effects on sleep quality.

METHODS: Twenty-eight women (mean age 43.23 ± 7.03 yrs) with rectus abdominis diastasis were randomised into an intervention (INT, 17 women) and control (CTRL, 11 women) group. INT underwent a 2-month HAG intervention, with one supervised HAG session per week, while CTRL was recommended to practice a 2-month home HAG. Both groups filled in the Mini Sleep Questionnaire (MSQ) to assess sleep subjectively and wore an actigraph to assess sleep objectively. MSQ and actigraphic assessment were performed one week before and one week after the HAG intervention. ANCOVA analysis (adjusted by age) evaluated differences in delta values between INT and CTRL groups.

RESULTS: Delta MSQ total score (INT: -2.67 ± 1.19 a.u.; CTRL: -0.94 ± 0.24 a.u.), delta sleep MSQ component (INT: -1.7 ± 0.92 a.u.; CTRL: -0.99 ± 0.74 a.u.), and delta wake MSQ component (INT: -0.97 ± 0.46 a.u.; CTRL: 0.05 ± 0.03 a.u.) showed a slightly greater reduction, indicating a sleep improvement, in INT group compared to the CTRL group. However, the differences were not statistically significant ($p = 0.67$, $p = 0.82$, $p = 0.63$, respectively). Among the actigraphic parameters, the delta percentages of sleep and immobile time were positive in the INT group (sleep time: 0.62 ± 0.35 %; immobile time: 0.43 ± 0.14 %) and negative in the CTRL group (sleep time: -0.38 ± 0.22 %; immobile time: -0.32 ± 0.25 %), indicating a trend of sleep improvement in the INT compared to the CTRL group. Also in this case, differences were not statically significant ($p = 0.49$, $p = 0.23$). No differences were visible for the percentage of sleep efficiency (INT: 1.48 ± 1.02 %; CTRL: 2.01 ± 1.49 %)

CONCLUSION: This pilot study shows that two-month HAG seems to contribute to some encouraging effects on sleep quality, showing some positive trends, especially on subjective sleep quality. However, no marked and significant results were visible, probably due to the shortness of the intervention protocol. A longer intervention and a bigger sample size could probably lead to more evident results.

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**INTERACTION EFFECTS OF PHYSICAL ACTIVITY AND SLEEP DURATION ON MOTORIC COGNITIVE RISK SYNDROME IN CHINESE OLDER ADULTS: A POPULATION-BASED COHORT STUDY**

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INTRODUCTION: Motor Cognitive Risk Syndrome (MCR) is a preclinical marker of dementia characterised by subjective cognitive complaints and slow gait [1]. Emerging evidence suggests that modifiable lifestyle factors are potential targets for intervention, with sleep patterns receiving particular attention. A prior study in Chinese older adults revealed an inverted U-shaped association between night sleep duration and MCR [2]. However, the role of physical activity (PA) in the pathogenesis of MCR remains unexplored. We hypothesise that higher activity levels interact with healthy sleep status to reduce MCR risk, rather than their independent effects.

METHODS: We recruited 2,459 participants aged≥60 years from the China Health and Retirement Longitudinal Study (CHARLS). MCR syndrome was defined as cognitive complaints and slow gait speed without dementia or impaired mobility. PA was classified into three categories based on the IPAQ rubric: inadequate (< 600 MET-min/week), adequate (600-3000 MET-min/week), and high (> 3000 MET-min/week). Sleep was classified as inadequate (< 6 hours), adequate (6-9 hours), and excessive (> 9 hours). Multivariable logistic regression examined cross-sectional PA-sleep interactions on MCR prevalence, while Cox models assessed longitudinal associations with incident MCR over 3.5-year follow-up (2011-2015 waves), both adjusting for age, gender, education, smoking, alcohol, depression symptoms and chronic diseases.

RESULTS: In cross-sectional analyses (n=2,459), the combination of inadequate PA and short sleep duration demonstrated interaction effects, showing 2.5-fold higher odds of MCR in unadjusted models (OR: 2.53, 95% CI: 1.98–3.24, $p<0.001$), which remained significant after full adjustment (aOR: 2.18, 95% CI: 1.68–2.83, $p<0.001$). Longitudinal analysis (n=1,793, median follow-up 3.5 years) revealed that participants with both risk factors at baseline had 1.7-fold higher incidence risk in unadjusted models (HR: 1.73, 95% CI: 1.28–2.33, $p<0.001$), with risk persisting after adjustment (aHR: 1.49, 95% CI: 1.09–2.04, $p=0.013$). The multiplicative interaction term between PA and sleep duration was statistically significant ($p=0.021$).

CONCLUSION: As hypothesized, the combined optimization of physical activity and sleep duration significantly attenuates the MCR risk in older adults, with multiplicative interaction effects surpassing those of the individual factors. Community-based dual-component interventions targeting both behaviors should be implemented, while future studies need to identify subgroups benefiting most from such strategies.

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**EXPLORING THE INTERPLAY OF BODY COMPOSITION, PHYSICAL ACTIVITY, AND OPTIMISM ON SLEEP DURATION AND QUALITY IN POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Over 50% of postmenopausal women experience sleep disturbances, which negatively impact their quality of life. Poor sleep reduces physical activity (PA) and worsens body composition (BC) changes due to estrogen depletion. Maintaining a positive attitude can help manage menopause symptoms. This study analyses the relationship between BC, physical activity PA, optimism and sleep in postmenopausal women.

METHODS: The study included 20 women (59.06 ±5.96 years) and half of the participants had been in late postmenopause. Moderate-vigorous physical activity (MVPA) and sleep parameters (TST, total sleep time; SOL, sleep onset latency; SE, sleep efficiency; SFI, sleep fragmentation index) were recorded using Actigraph GT3X+ accelerometers. The recommended levels were as follows: MVPA= 150 min/week, TST= 7 hours, SE= 85% and SFI< 5 events/hour. Fat mass (FM, %), trunk skeletal muscle mass (TSMM), and appendicular skeletal muscle mass were measured with InBody120 bioimpedance. The index of appendicular skeletal muscle mass (ASMMI) was calculated as ASMM divided by height squared. Obesity was defined as FM = 35%, and muscle mass deficit was identified with ASMMI < 5.5 kg/m². Dispositional optimism was assessed using the LOT-R scale. Data were summarized using descriptive statistics and significance was accepted as p = 0.05. Partial correlation coefficient were used to assess associations between variables.

RESULTS: In the sample, 95% experienced natural menopause, 85% did not use hormone therapy, and 35% used sleep-affecting medication. Nine participants were obese, and eight had low muscle condition. All women had SE = 85% and SFI < 5 events per hour, but 25% had insufficient sleep duration. Average MVPA was 243.55 minutes per week (90% were active) and LOT-R was 15.30 points. In early postmenopause, higher adiposity correlated with better SE (r=0.75, p=0.02), and more optimism correlated with longer SOL (r=0.67, p=0.05). MVPA inversely related to SE (r=-0.76, p=0.02). Significant associations (p=0.01), in the overall sample included SOL and LOT-R (r=0.54), SE and %FM (r=0.42), and SFI and TSMM (r=0.56).

CONCLUSION: The results indicate that SE and SOL is influenced by adiposity levels and optimism in early postmenopausal women. Better trunk muscle condition is linked to a higher SFI. More active women and those with longer estrogen depletion show lower SE. A replication with a more representative sample is recommended.

## Oral Presentations

### OP-BM19 Motor Learning and Variability

**CONTEXTUAL INTERFERENCES IN MOTOR LEARNING OF CHILDREN AND OLDER ADULTS IN APPLIED SETTINGS – THE NOVELTY OF A TASK HYPOTHESIS**

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INTRODUCTION: Contextual interference (CI) (Battig, 1966) effect is claimed to enhance motor skill retention, though the general meta-analyses evinced that the beneficial effect of CI effect on retention is more conspicuous in adults and the elderly than in children (Brady, 2004; Czyż et al. 2024a, 2024b). Moreover, majority of the studies on adults and older adults were conducted in laboratory setting while studies on children in applied settings. To determine whether the presence of the CI effects in adults or lack in children is due to the age or setting issues we examined the interaction between practice schedule in childrens and older adults learning an aiming skill in applied settings.

METHODS: A total of 96 participants (48 children, mean age 11.09 ± 1.01; 48 older adults, mean age 72.9 ± 4.98) were randomly assigned to Blocked or Random practice schedules with either 18 or 24 repetitions per session. Participants threw beanbags towards the circular target (Ávila et al., 2012; Chiviacowsky et al., 2008) from 3m, 4m, and 5m. The study consisted of three phases: pretest, acquisition, and 24-hour retention test. Performance accuracy was analyzed using a 4-way mixed ANOVA.

RESULTS: Older adults consistently outperformed children ($p < 0.001$, $\eta^2 = 0.503$). Younger participants improved across acquisition and retention but showed no significant CI effect. In older adults, random practice led to better retention only at 5m ($p = 0.006$, $\eta^2 = 0.1098$), while performance at 3m and 4m remained stable. No significant interaction was found between CI and practice volume ($p = 0.238$).

CONCLUSION: Findings suggest that CI effects depend on task novelty and difficulty rather than age or settings alone. Based on these findings, we propose the Novelty of the Task Hypothesis, suggesting that the CI effect may depend on the relative novelty and challenge of a task for the learner. In applied settings, CI may be less effective when tasks are already well-practiced. Future studies should explore CI across diverse motor tasks and environments.

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**EVIDENCE OF A DOSE-RESPONSE EFFECT OF ACUTE AEROBIC EXERCISE INTENSITY ON MOTOR ADAPTATION AND LEARNING**

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INTRODUCTION: In daily life, we are required to learn new motor skills and to adapt our movements to changes in our environment. This dynamic process of adjusting to changes in our environment is known as "motor adaptation" and constitutes an important category of motor learning. Studies have shown that a single session of aerobic exercise (AE) can enhance motor adaptation compared to rest. Specifically, high intensity AE can increase motor adaptation, while moderate intensity AE has been shown to both enhance motor adaptation and to have no effect. No studies have investigated the impact of low intensity AE on motor adaptation. Hence, it is still unclear how the intensity of AE influences motor adaptation.

This study aimed to investigate the dose-response effect of AE intensity on motor adaptation while controlling for other AE exercise parameters (duration, type) in young adults. We hypothesized that moderate and high AE intensity would lead to greater motor adaptation compared to rest.

METHODS: Eighty healthy young adults (18–39 years) were divided into four groups (n=20/group): 20 min of interval AE training at high-intensity (HIIT), moderate-intensity (MIIT), low-intensity (LIIT), or Rest (control). A visit prior to the intervention was conducted to perform an incremental cycling test to assess cardiorespiratory capacity. Heart rate reserve (HRR) was used to prescribe the AE intensity for visit 2. AE consisted of four blocks of 3-min cycling on an ergometer (LIIT, 35%HRR; MIIT, 55%HRR; HIIT, 80%HRR), interspersed with 2 min of active recovery (25%HRR). Perceptual responses (effort, muscle pain and affects) were reported during AE/Rest sessions. Participants completed a visuomotor rotation task (45°) immediately (acquisition: motor adaptation) and 24-h (retention test: motor learning) after AE/Rest. Performance was assessed using spatial (e.g., angle at peak velocity) and temporal (e.g., reaction time) metrics.

RESULTS: The results revealed a dose-response effect of AE intensity on motor adaptation and learning. HIIT and MIIT increased motor learning more than LIIT and Rest (temporal and spatial metrics). HIIT showed the greatest motor adaptation (temporal and spatial metrics), followed by MIIT, then LIIT (temporal metrics). Findings showed that the lower the AE intensity, the more positive perceptual responses (e.g., less muscle pain, lower perception of effort).

CONCLUSION: This research is the first to reveal a dose-response effect of AE intensity on motor learning. Specifically, the higher the AE intensity, the larger the improvements in motor adaptation and learning. These findings suggest that exercise intensity prescription could be a key factor in tailoring training protocols for athletes to enhance motor skills and adapt to varying dynamics in sport. Since MIIT elicited more favorable perceptual responses than HIIT, clinicians may consider MIIT as a viable alternative for individuals who may be more impacted by the negative perceptual responses associated with HIIT.

**THE IMPACT OF MANIPULATING TASK CONSTRAINTS ON THE MOVEMENT VARIABILITY AND CREATIVITY IN KICKBOXING**

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INTRODUCTION: Creative actions are motor solutions that emerge within the dynamic interactions of the individual, task, and the environment (1). The emergence of creative action is associated with the sheer variety of action solutions an individual explores, that is, in the variety in coordination and control solutions (2). This study aimed to examine whether targeted manipulations of constraints during practice lead to specific changes in variability and creativity of action at the level of coordination and control.

METHODS: Thirty-four participants were randomly assigned to one of three groups to practice striking a boxing bag: control (N=10), distance (N=12), orientation (N=12). The distance group practiced hitting the bag from different distances with the aim to invite a broad search for different coordination solutions, while the orientation group practiced hitting the bag from different orientations at a fix distance to invite a relatively narrow but persistent search for control solutions. All groups completed pre-test and retention test, in which they were instructed to strike the bag in as many ways as possible. Wilcoxon signed-rank and Mann-Whitney U tests were used for within and between group comparisons.

RESULTS: Variability in coordination increased significantly in the distance group (Pre 2.81 ± 0.39, Retention: 2.95±0.29; P=0.05), while no significant change was observed in the orientation and control group (P>0.05). Manipulating orientation did not significantly alter control variability (Pre: 2.02±0.57, Retention: 2.10±0.46, P>0.05). Furthermore, the distance group showed higher creativity compared to orientation group (U (12,12) = 40, p=0.01).

CONCLUSION: These results suggest that manipulating task constraints can have specific consequences for variability and creativity. The distance manipulation did increase variability and creative in coordination solutions, but not in control solutions. Manipulating the orientation didnt affect variability and creative, perhaps because it requires a longer timescale to manifest itself.

**EFFECT OF STROKE RATE ON MOVEMENT VARIABILITY DURING ROWING ERGOMETER IN ELITE ROWERS**

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INTRODUCTION: Rowing is a highly competitive power-endurance sport requiring coordinated movements of the legs, trunk and arms to optimize technique [1]. Over the past decades, movement variability (MV) has been used to assess coordination levels in various motor actions across different populations. It serves as an indicator of motor control, evaluating movement regularity [2]. However, limited research has explored MV during rowing at different intensities. The aims of this research were (a) to investigate the influence of different stroke rate (SR) on MV and (b) to assess the relationship between MV and performance.

METHODS: Twenty-one elite male rowers (24.3±3.1 years, 192.6±5.6cm, 90.7±11.5kg) performed 90-second submaximal intensity rowing bouts at 20, 26 and 34 strokes per minute (spm) on a static rowing ergometer (Model D, Concept 2, USA). An inertial motion capture system (MVN, Xsens Technologies, Netherlands) with 17 sensors recorded the kinematic features of the head, trunk, upper and lower limbs, with an additional sensor on the handle of ergometer. Rowing performance was assessed by 2000m ergometer time. The time series from IMUs were analyzed using linear (standard deviation, SD) and non-linear (Sample entropy, SampEn) measures [3]. A one-way repeated measures ANOVA was used to assess the effects of SR on MV, with effect sizes (ES) expressed as partial eta-squared. Pearson's correlation coefficient was utilized to calculate the relationship between SampEn and performance.

RESULTS: SR significantly increased the SD of stroke power ($F_{2,60}=6.887$; $P=0.02$, $ES=0.187$) and SampEn of handle acceleration ($F_{2,60}=20.628$; $P<0.001$, $ES=0.407$), hip ($F_{2,60}=82.518$; $P<0.001$, $ES=0.733$), and knee ($F_{2,60}=124.612$; $P<0.001$, $ES=0.806$) angles. Across all SRs, hip angle had greater SampEn than knee and elbow. Greater variability in handle acceleration at 20 spm ($r=-0.626$, $p=0.002$) and 26 spm ($r=-0.581$, $P=0.006$), knee angle at 20 spm ($r=-0.531$, $P=0.013$), and elbow angle at 20 spm ($r=0.511$, $p=0.021$) correlated with better ergometer performance.

CONCLUSION: As SR increased, elite rowers exhibited reduced movement control compared to lower SR. Among rowers with better performance, greater MV led to efficiency and adaptability. Entropy measures may serve as a valuable tool for practitioners to assess the specific rowing performance.

**EFFECTS OF THE FAMILIARISATION WITH A SOFT BACK EXOSKELETON ON MUSCLE COORDINATION.**

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INTRODUCTION: Back exoskeletons are wearable structures that give an assistive torque to one or multiple joints and can prevent from low back disorders during manual handling tasks (1). But, the change in external constraints has been shown to modify the motor behaviour during familiarization to a soft back exoskeleton while performing manual handling tasks (2). However, little is known about the likely changes in central command during familiarization. Therefore, the aim of this study was to assess the modulation of muscle synergies during a familiarization to a soft back exoskeleton with manual material handling.

METHODS: Eighteen males (21.5 ± 2.3 years, 178.3 ± 3 cm, 69.6 ± 6.2 kg) were recruited to perform 6 sessions of one hour of familiarization to the CORFOR® V2 soft back exoskeleton (2). This protocol consisted in several manual handling and precision tasks involving trunk bending. During measurements carried out at baseline and at the end of each session, participants were asked to handle a box (8 kg; 15 cycles / min) using STOOP and SQUAT techniques. Surface electromyography (sEMG) signal was unilaterally recorded on 14 muscles of the lower limb, trunk, back and upper-limb. From sEMG linear envelopes, muscles synergies were extracted for each session through non-negative matrix factorization. The effect of the familiarization was assessed using a repeated measures ANOVA to identify any change in the number of synergies, their composition (motor module similarity) or their activation coefficients (center of activation, full width at half maximum and variance ratio).

RESULTS: Results showed that 2 synergies explained 91 ± 1.8 % of the variance for both STOOP and SQUAT tasks during the whole familiarization. For both STOOP and SQUAT, synergy 1 was activated during the downward phase while synergy 2 was activated during the upward phase. Over the familiarization, the motor modules remained similar, for both STOOP (0.91 ± 0.13) and SQUAT (0.86 ± 0.17) tasks. There was no statistical evidence of change in the muscle synergy activations across the sessions, whatever the metric analyzed, for both STOOP and SQUAT tasks.

CONCLUSION: Overall, it appears that the muscle synergies extracted were robust throughout the familiarization protocol, despite a known effect of this soft back exoskeleton on joint kinematics, perceived comfort and lumbar spine loads (2, 3). According to previous results (4), these results suggest that the exoskeleton used in this study did not bring sufficient perturbations to change the central command.

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# Oral Presentations

## OP-AP27 Sports Technology in Running

### METABOLIC AND PERFORMANCE RESPONSES TO TWO SIMILAR TYPES OF ADVANCED FOOTWEAR DURING PROLONGED RUNNING

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INTRODUCTION: Advanced footwear technology (AFT) improves running economy and performance compared with previous generations of running footwear, but little is known about the effects of minute differences in running economy between different AFT models during prolonged exercise. This study compared two AFT models with similar mechanical properties but with known differences in O2 cost of running during a prolonged run and its subsequent effect on performance.

METHODS: An initial study using intra-day comparisons (three 6-min runs in each shoe, at 16 km/h) determined that the Nike Vaporfly 3 shoes (VF) showed 1.3% better running economy compared with the On Cloudboom eco 3 shoes (EB). These differences occurred even though both models showed reasonably similar levels of energy return at the forefoot (VF 6.4 J, EB 6.0 J). For the main study, twenty-one trained runners completed two 10-km trials at marathon pace followed immediately by a 2km time-trial (TT), one wearing Nike Vaporfly 3 shoes (VF) and one in On Cloudboom Echo 3 (EB) shoes, with each trial separated by one week. During the constant runs, gas exchange, heart rate (HR) and perceived exertion and were assessed.

RESULTS: During the 10-km run, O2 cost for the VF was 1.6 ± 2.8 % lower compared with the EB ($p = 0.012$). No differences were detected in rate of perceived exertion between shoes (VF 5.0 ± 0.8 points, EB 5.2 ± 0.9 points, $p = 0.270$). No differences between shoes were detected for rate of change over time for O2 cost ($p = 0.627$), HR ($p = 0.657$), or perceived exertion (0.779). Runners performed the 2-km TT 1.8 ± 3.6 % faster wearing the VF ($p = 0.031$).

CONCLUSION: Subtle differences in O2 cost between different AFT shoes are sufficient to elicit performance improvements. Gains in performance were higher than those previously estimated from gains in running economy alone, suggesting that other indirect benefits might be present beyond the direct metabolic savings. Factors other than energy return might be equally or more important in determining the running economy benefits of different AFT models.

### CHANGES IN PLAYER LOAD BETWEEN VENTILATORY THRESHOLD RUNNING SPEEDS IN RECREATIONAL RUNNERS

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INTRODUCTION: Player load monitoring via inertial measurement unit (IMU) in sports has been widely studied to prevent injuries, enhance training efficiency, and optimize performance [1]. The first and second ventilatory thresholds (VT1 and VT2) are valuable indicators of exercise intensity for identifying the transition between aerobic and anaerobic energy systems [2]. It has been found that varying running speeds influence player load [3]. However, the differences in player load between running speeds at ventilatory thresholds remain unclear. Therefore, the aim of this study was to monitor the changes in player load between ventilatory threshold running speeds in recreational runners.

METHODS: Twenty-nine recreational runners (10km finish time: 48.10±5.87 min) performed maximal incremental running test with 3-minute stages on a treadmill (HP). An IMU (100Hz, Vicon) was placed on the runners' lower back (L3–L5) to collect triaxial acceleration data during the incremental test. The raw acceleration data were filtered at 20Hz using a low-pass Blackman filter (AcqKnowledge). The 1-minute root mean square (RMS) of the triaxial player load (PLT) were calculated. The 1-minute RMS of the single-axis player load in the anteroposterior (PLAP), mediolateral (PLML), and vertical (PLV) axes were also calculated. The percentage contribution of each axis was calculated by dividing the RMS of uniaxial player load by the RMS of triaxial player load. Participants' gas exchange data were continuously measured using a portable gas analyzer (Cortex). The 1-minute averaged gas exchange data were used to determine the VT1 and VT2 running speeds. The last-minute IMU and Cortex data from each stage of the incremental test were used for analysis. A paired-samples t-test was used to evaluate differences in player load between VT1 and VT2 speeds. The significant level was set at $p<.05$. The effect size was calculated using Cohens d.

RESULTS: The RMSPLV (VT1 speed: 4.25±0.86, VT2 speed: 4.87±0.88; $p<.001$, $d=-1.87$), RMSPLML (VT1 speed: 1.87±0.60, VT2 speed: 2.34±0.80; $p<.001$, $d=-1.37$), RMSPLAP (VT1 speed: 1.81±0.52, VT2 speed: 2.41±0.64; $p<.001$, $d=-1.78$), RMSPLT (VT1 speed: 5.04±0.92, VT2 speed: 6.00±0.93; $p<.001$, $d=-2.38$), RatioPLV (VT1 speed: 84.30±6.14, VT2 speed: 81.26±7.24; $p<.001$, $d=0.94$), and RatioPLAP (VT1 speed: 36.47±9.06, VT2 speed: 40.82±10.42; $p<.001$, $d=-1.04$) changed significantly

between VT1 and VT2 speeds. However, the RatioPLML (VT1 speed: 37.06±8.78, VT2 speed: 38.56±9.57; p=.11, d=-0.31) did not change significantly between VT1 and VT2 speeds.

CONCLUSION: The RMSPLV, RMSPLML, RMSPLAP, RMSPLT, RatioPLAP increased significantly at VT2 speed. Interestingly, the RatioPLV decreased significantly at VT2 speed. Additionally, the RatioPLML did not change significantly at VT2 running speed. The results of this study suggest that PL in anteroposterior direction may play a more influential role at VT2 speed in recreational runners.

**THE IMPACT OF FOOTWEAR FOAM ON RUNNING ECONOMY AND PERCEPTUAL METRICS AT DIFFERENT TREADMILL GRADIENTS**

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INTRODUCTION: Advanced Footwear Technology (AFT) encompasses multiple innovations including the increase in longitudinal bending stiffness achieved through the integration of a plate and a softer and more resilient foam within the midsole. They have been shown to improve running performance and running economy (1). While performance benefits have commonly been investigated in road running, AFT is beginning to influence footwear used in trail running. Therefore, research is needed to investigate the effect of AFT in trail running footwear. In this study, we aimed to compare the effect of traditional (TRADI) and advanced foam technologies (PROTO) on running economy and perceptual measures across flat, up and down-hill gradients.

METHODS: Fourteen well-trained athletes (78.9 ± 25.3 km/week) completed assessments on the treadmill with FLAT (0% gradient, 14 km.h−1), UP (+10%, 8 km.h−1) and DOWN (-10%, 14 km.h−1) conditions. Two shoes (TRADI v PROTO) were randomly allocated in a counterbalanced order, with a replicate in each condition. The shoes differed in their midsole foam type but were otherwise matched. PROTO included a softer and more resilient foam than TRADI (deformation: 23.63 v 19.46 mm; energy return: 9.97 v 6.86 J). Oxygen consumption, HR, RPE and affect (pleasure and arousal) were collected and averaged for each replicate. General Linear Mixed Model were used for the statistical analysis with a significance set at 0.05.

RESULTS: Across conditions, oxygen consumption was lower in PROTO than TRADI (44.9 ± 0.6 v 45.4 ± 0.6 ml.-1.kg-1.min-1 respectively) with a small effect size (p=0.008; d=0.47). This equates to a superior running economy in the PROTO across all the conditions of 1.1%. The interaction between condition and shoes was not significant (p=0.050) although the tendency that an improvement may be more pronounced in the FLAT (+2.1%) and UP (+1.0%) conditions, compared to DOWN (+0%) may inform future, larger investigations. HR was lower in PROTO compared to TRADI (p< 0.001; 145 ± 3.5 v 146 ± 3.5 bpm respectively) with a large effect size likely explained by the consistency of the change across all participants (d=1.19). RPE was lower (p=0.010) and pleasure higher (p=0.025) in PROTO compared to TRADI with a medium effect size. No effect on arousal was identified (p=0.730).

CONCLUSION: The findings of this study suggest that a softer and more resilient foam in trail running shoes can improve running economy, reduce HR and perceived exertion and increase pleasure while running at different gradient in a well-trained athlete population.

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**DETERMINING THE ACCURACY AND CONCURRENT VALIDITY OF A CAMERA-BASED COMPUTER VISION SYSTEM FOR RUNNING BIOMECHANICS ANALYSIS**

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INTRODUCTION: The assessment and monitoring of running biomechanics kinematic variables are crucial for optimising physical performance outcomes and facilitating rehabilitation processes in field-based sports athletes. It is well-established that marker-based 3D motion capture systems are the gold standard for accurately evaluating these metrics within a controlled, artificial environment. However, its feasibility and high cost make this technology inaccessible to most sporting organisations for regular on-field use. Continued advancements in biomechanical measurement via the application of deep learning and computer vision have supported the development of more accessible, non-invasive, and cost-effective motion capture useful for determining sport-specific movement patterns outside laboratory settings. VueMotion is a 2D camera-based markerless system capable of generating and analysing motion kinematics during sprints. This study aims to establish the accuracy and concurrent validity of VueMotion through comparison with a VICON 3D motion capture system for measuring ground contact time, flight time, step length and frequency, and peak velocity.

METHODS: Twenty-five elite and sub-elite athletes (16 females and 9 males; 22.9 ± 5.34 years) completed four maximal linear sprinting accelerations (flying 10-metre) for a total of 100 sprints while being assessed concurrently through a VICON 3D motion analysis system and VueMotion. Sixteen reflective spherical markers (14 mm diameter) and four four-marker clusters were placed onto participants' key landmarks of the body (i.e., hips, upper leg, lower leg, and feet) and analysed using the VICON Plug-In Gait lower body model. Kinematics metrics were collected using 38 infrared VICON cameras operating at 100 Hz, and 10 ground-embedded AMTI force plates sampling at 1000 Hz, synched via VICON Nexus soft-

ware. Simultaneously, body landmarks were video tracked in 2D by VueMotion using an iPhone 11 with the camera resolution set at 4K (3840 × 2160 pixels), 60 frames per second. The data capturing zone was demarked by two sets of cones placed at 0 m and 10 m, with a cone at the 5 m mark as per VueMotion setup requirements.

RESULTS: Root-mean-square errors (RMSE) for peak velocity, ground contact time, and flight time were 0.63 m/s, 0.01 s, and 0.01 s, respectively. Step length and frequency reported an RMSE of 0.05 s and 0.18 Hz. Mean bias with 95% level of agreement showed systemic underestimation for step length (0.02 m [- 0.11; 0.07]), flight time (- 0.01 s [- 0.02; 0.01]), and peak velocity (0.54 m/s [- 1.72; 0.10]). Ground contact time and step frequency were (0.01 s [- 0.01; 0.02]), and (0.03 Hz [- 0.31; 0.38]), respectively. Pearson's correlation coefficients for all variables ranged from 0.72 to 0.91, and the interclass correlation coefficients ranged from 0.67 to 0.90.

CONCLUSION: The accuracy and concurrent validity results from this study should be considered by any end user prior to integrating the tested system in research and practice.

**SLEEP ARCHITECTURE PATTERNS IN MARATHON RUNNERS DURING, PRE- AND POST COMPETITION PHASES CAPTURED BY 24/7 WEARABLE TECHNOLOGY**

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INTRODUCTION: The 2013 launch of the first wrist-worn optical heart rate monitor (OHRM) [1] has greatly impacted sports, wellness, and clinical applications. Alongside unobtrusive HR-based exercise workload monitoring [2], unobtrusive HR variability and body movement-based sleep and sleep architecture monitoring have reached outstanding levels of accuracy [3]. This study aimed to observe OHRM derived sleep architecture patterns in preparation and in response to a marathon.

METHODS: This study was designed to observe training and sleep patterns of 20 habitual marathon runners for 8 weeks, including pre-tapering, tapering, marathon, and post-marathon periods. Because of technical difficulties, data from 17 marathon runners (15 males, aged: 38±12 y, height: 1.81±0.09 m, weight: 70±9 kg, VO2max: 64±12 ml/kg/min) were analyzed. They visited our laboratory two times for VO2max and muscle fatiguability tests. During the 8-week free-living observation, runners wore the OHRM device [2,3] 24/7. This recorded photoplethysmography and tri-axial accelerometry signals at 32 Hz. Furthermore, runners kept pre- and post-training diaries where they logged their perceived muscle fatigue, pain, and overall stress and recovery.

RESULTS: Total Running Days (RuDs) recorded were N=206 and Resting Days (ReDs) were N = 149. Total rest time (TRT), the total time spent in bed with the intention to sleep, was longer after RuDs (466.2±90.2 min) vs. ReDs (461.8±99.1 min), t(13)=-2.28, p = 0.040. A trend towards a longer total sleep time (TST) for RuDs vs. ReD (TST: 428.8±88.4 vs. 416.7±92.3 min, t(13)=-2.13, p = 0.053) was also observed. No differences were found in either sleep efficiency (SE) nor wake after sleep onset (WASO) (SE: 91.89±6.15 vs. 89.98±8.50; t(13)=0.938, p = 0.365, WASO: 23.16± 24.89 vs. 26.46±23.09 min, t(13)=-0.328, p = 0.748).The RuD vs. ReD comparison did not show significant changes in sleep architecture either. Light non-REM sleep normalized by TST (N1/N2%: 62.55±8.04 vs. 65.88±9.34%, t(13)=-0.516, p = 0.615), slow wave sleep normalized by TST (N3%: 11.82±5.87 vs. 11.29±6.85%, t(13)=0.362, p = 0.723), and finally REM sleep normalized by TST (REM%: 25.62±5.63 vs. 22.81±5.90%, t(13)=362, p = 0.723) did not differ.

CONCLUSION: Previous studies showed that the longer the race distance the greater the importance of optimal sleep for race performance [4], and that sleep architecture seemed to be affected by high-intensity exercise. The present study shows that marathon runners spent more time in bed trying to sleep after a training day and tended to sleep longer, whereas sleep architecture did not seem to be affected. These preliminary results need to be integrated with linear mixed effect analysis looking at sleep pattern variations during tapering, marathon, and post-marathon periods. Furthermore, relations between sleep architecture fatigue and recovery will be analyzed.

1. https://www.cnet.com/reviews/mio-alpha-preview/ 2. Sartor et al. (2018) 3. Fonseca et al. (2017) 4. Nikolaidis et al. (2023)

## Oral Presentations

### OP-MH45 Physical Activity Promotion I

**PHYSICAL ACTIVITY AND FITNESS LEVEL IN A DISADVANTAGED REGION IN CENTRAL EUROPE: FOCUS ON HIGH SCHOOL STUDENTS AND THEIR TEACHERS**

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INTRODUCTION: Extensive research has documented the beneficial effects of physical activity on health and fitness at youth and adults. The relationship between teachers and students health-conscious behavior and physical activity is an important factor to consider. Besides teacher student relationship and teachers' role modelling, socio-economic status contributes to the development of sedentary lifestyles among the disadvantaged. While numerous studies have examined physical activity and fitness patterns among youth and adults, considerably fewer investigations have focused on teachers

and there is limited research available comparing students' and teachers' health behaviors. The purpose of the study is to demonstrate the characteristics physical activity of high school and technical school students and teachers in a disadvantaged region.

METHODS: State-maintained secondary and technical schools in the region were selected to participate in the study. A total of 834 individuals participated in the study, including 732 students (17.3±1.2 of age) and 102 teachers (48.2±11.4 of age). Data collection was conducted via a structured questionnaire that included socio-demographic questions, fitness self-assessment items, and the International Physical Activity Questionnaire-short form test. All data analyses were performed using IBM SPSS Statistics version 25.0 ($p<0.05$).

RESULTS: During the week preceding the study, 24.1% of students and 28.0% of teachers reported no engagement in vigorous physical activity. On a scale of 1 to 4, the students subjective fitness was rated as close to good (2.81±0.85), while teachers rated students' fitness level lower (2.06±0.71), and also, their own fitness was rated as good (2.84±0.79). Students' metabolic equivalent values (ME=2732) was significantly higher than teachers' (MET=2116). Students spent significantly more time walking and sitting ($p<0.05$) compared to teachers. Additionally, teachers employed at technical schools and students attending high schools exhibited significantly higher durations of sedentary behavior than their counterparts in high schools and technical schools, respectively ($p<0.05$). No significant correlations were found between students' socio-economic situation and their physical activity levels.

CONCLUSION: This study revealed that the activity levels in both students and teachers are insufficient to maintain optimal health in this disadvantaged region. Notably, there were a lot of differences between teachers and students. Teachers perceived the students' physical activity levels to be lower than the students' own assessments, while simultaneously rating their own fitness as higher, despite recording significantly lower metabolic equivalent values. These findings underscore the need for further research to elucidate the factors contributing to inadequate physical activity and to develop effective interventions tailored to both teachers and students.

**ASSOCIATION BETWEEN BLOOD LEAD AND ALL-CAUSE OR CARDIOVASCULAR DISEASE MORTALITY RISK: MITIGATING EFFECTS OF PHYSICAL ACTIVITY**

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INTRODUCTION: This study aimed to investigate: (1) the associations between physical activity (PA), blood lead (BL) and all-cause or cardiovascular disease (CVD) mortality risks, and (2) the combined effects of PA and BL on all-cause or CVD mortality risks.

METHODS: A total of 22821 participants were included from the National Health and Nutrition Examination Survey (NHANES) database from 2007-2018. PA levels were assessed by Global Physical Activity Questionnaire (GPAQ). BL were measured using inductively coupled plasma mass spectrometry. Mortality status was obtained from the National Death Index (NDI) database. Statistical analyses were performed using the Cox proportional hazards models and restricted cubic spline (RCS).

RESULTS: Compared with the sufficiently active PA group, the inactive PA group increased 88% all-cause mortality risk (HR = 1.88, 95% CI = 1.71 - 2.07) and 78% CVD mortality risk (HR = 1.78; 95% CI = 1.49 - 2.12). Compared with the minimal blood lead level (Min-BLL) group, the high blood lead level (H-BLL) groups increased 72% all-cause mortality risk (HR = 1.72, 95% CI = 1.41 - 2.10) , and 132% CVD mortality risk (HR = 2.32, 95% CI = 1.53 - 3.52). When compared with the Min-BLL group, H-BLL combined with inactive (HR = 2.45, 95% CI = 1.99 - 3.01) or insufficiently active PA group (HR = 1.69, 95% CI = 1.33 - 2.17) increased 145% or 69% all-cause mortality risk, and 200% (HR = 3.00, 95% CI = 1.95 - 4.62) or 135% (HR = 2.35, 95% CI = 1.44 - 3.84) CVD mortality risk. Compared with the sufficiently active PA group, inactive PA group combined with H-BLL (HR = 2.28, 95% CI = 2.04 - 2.25) or M-BLL (HR = 1.80, 95% CI = 1.57 - 2.07) increased 128% or 80% all-cause mortality risk, and 108% (HR = 2.08, 95% CI = 1.70 - 2.56) or 86% (HR = 1.86, 95% CI = 1.46 - 2.37) CVD mortality risk. RCS analyses showed BLL (ug/dL) above 0.12 (0.47), 0.83 (1.06), or 1.18 (1.18) in inactive, insufficiently active, or sufficiently active PA groups could increase all-cause (CVD) mortality risk.

CONCLUSION: Physical inactivity or H-BLL can increase all-cause and CVD mortality risks. In addition, increasing PA can mitigate the adverse effects of H-BLL on mortality risk. For inactive or insufficiently active individuals, maintaining Min-BLL is essential to minimize the impact of lead exposure on mortality risks.

**IMPACT OF RAMADAN DIURNAL INTERMITTENT FASTING ON PHYSICAL ACTIVITY AND RESTING METABOLIC RATE: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Ramadan diurnal intermittent fasting (RDIF) is associated with a number of lifestyle modifications, including changes in sleep patterns, dietary habits, and physical activity (PA) [1]. An understanding of how RDIF affects PA behaviors is crucial for promoting cardiometabolic and mental health among individuals observing the fast. This systematic review and meta-analysis aimed to examine changes in resting metabolic rate (RMR) and PA levels before and during Ramadan, with a focus on PA levels, measurement instruments, and gender differences. Additionally, we explored whether changes in PA were associated with body weight changes during RDIF

METHODS: This systematic review of observational studies was conducted following PRISMA guidelines. A comprehensive search of databases, including PubMed, Scopus, Medline, and Web of Science, was performed. Studies examining PA levels and RMR before and during Ramadan were included. Subgroup analyses were performed to examine differences in PA levels (sedentary behavior, light, moderate, vigorous), measurement instruments (objective and subjective), and by gender (male and female). Meta-regression was conducted to investigate the relationship between changes in PA and body weight outcomes. Random-effects meta-analyses were conducted using R programming software

RESULTS: revealed a significant reduction in objective PA during Ramadan compared to pre-Ramadan levels (SMD: -0.346, 95% CI: -0.575 to -0.117, p = 0.003), with high heterogeneity ($I^2$ = 83.84%). Sedentary behavior also increased significantly during RDIF (SMD: -0.261, 95% CI: -0.441 to -0.082, p = 0.004). Subgroup analyses indicated that vigorous PA (VPA) showed a significant decline (SMD: -0.445, 95% CI: -0.863 to -0.027, p = 0.036), while light PA (LPA) also decreased significantly (SMD: -0.263, 95% CI: -0.36 to -0.166, p < 0.0001). No significant changes were observed in moderate PA (MPA) (SMD: -0.022, 95% CI: -0.610 to 0.940, p = 0.94). Gender-specific analyses revealed no significant differences in PA changes between males and females (p > 0.05). Resting metabolic rate (RMR) showed a non-significant decrease during Ramadan (WMD: -38.97 kcal/day, 95% CI: -128.34 to 50.38, p = 0.392). Meta-regression analysis indicated that changes in PA were not significantly associated with changes in body weight post-RDIF (p > 0.05)

CONCLUSION: Vigorous and light-intensity activities decline significantly during Ramadan, accompanied by increased sedentary behavior. Objective measures of PA captured more pronounced reductions compared to subjective instruments. The overall decline in PA highlights the need for targeted interventions to promote active lifestyles during RDIF. These findings emphasize the importance of maintaining PA to support health outcomes during periods of fasting

References:

1- Aljaloud, K. S. (2024). The role of lifestyle changes to diet, physical activity, and sleep during Ramadan in controlling metabolic syndrome in adults: a scoping review

**THE ASSOCIATION BETWEEN THE FREQUENCY OF MODERATE PHYSICAL ACTIVITY AND PHYSICAL FITNESS AMONG AUTISTIC ADULTS AGED 40-70 YEARS**

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INTRODUCTION: Autism is a neurodevelopmental condition characterized by impaired social functioning and repetitive, restricted behaviours. While research has documented compromised physical fitness and reduced physical activity levels in autistic children, data on autistic adults remain limited. We aim to explore the association between the frequency of physical activity (PA) and physical fitness in autistic adults aged 40 to 70 years.

METHODS: Using the UK Biobank database, this study included 408 autistic individuals who had been diagnosed by professional institutions. Data from the baseline were analysed. The participants were categorised into two groups: regular moderate physical activity (PA), defined as engaging in PA three or more times per week (n=231), and irregular PA, defined as engaging in PA two or fewer times per week (n=167). One instance of moderate PA was defined as "10 minutes or more of moderate physical activities, such as carrying light loads or cycling at a normal pace, excluding walking". Physical fitness outcomes included pulse rate, blood pressure, overweight/obesity, abdominal obesity, and hand grip strength [1]. A logistic regression model was employed to explore the association between irregular PA and physical fitness outcomes, sociodemographic factors adjusted.

RESULTS: Individuals in the irregular physical activity (PA) group exhibited higher pulse rates (72.58±11.81 vs. 69.39±11.25, p=0.007), were less likely to have a pulse rate below 60 beats per minute (11% vs. 22.2%, p=0.005), and were more likely to be abdominally obese (54.8% vs. 42.6%, p=0.019). Additionally, they showed a higher incidence of weak hand grip strength in both the dominant hand (weak, normal, strong: 27.5%, 61.1%, 11.4% vs. 22.9%, 53.7%, 23.4%, p=0.009) and the non-dominant hand (weak, normal, strong: 43.7%, 49.7%, 6.6% vs. 33.3%, 52.8%, 13.9%, p=0.02). After adjusting for sociodemographic factors, irregular PA was associated with a higher pulse rate (OR=0.36, 95% CI: 0.18-0.72), abdominal obesity (OR=1.75, 95% CI: 1.13-2.71), and weaker hand grip strength in both the dominant (weak: OR=2.47, 95% CI: 1.20-6.21; normal: OR=2.13, 95% CI: 1.04-4.37) and non-dominant hands (weak: OR=2.70, 95% CI: 1.10-6.62).

CONCLUSION: Autistic adults with irregular physical activity (PA) habits exhibited reduced physical fitness, particularly in terms of abdominal obesity and hand grip strength. These findings have significant implications for the development of health promotion and educational services aimed at the autistic adult population. It is crucial to encourage more consistent participation in physical activity, as this can help mitigate the risk of chronic diseases and improve overall physical fitness.

**IDENTIFYING MOVEMENT BEHAVIOUR PHENOTYPES USING A REVERSED GRAPH EMBEDDING METHOD AND EXAMINING THEIR ASSOCIATIONS WITH CARDIOMETABOLIC HEALTH BIOMARKERS**

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INTRODUCTION: Numerous metrics have been developed to capture the complex and multidimensional nature of movement behaviours. However, it remains unclear which measures – or combination of measures – best describe these behaviours. A dimensionality reduction technique is needed to identify distinct movement behaviour phenotypes and evaluate their associations with cardiometabolic health.

METHODS: The present study included 1023 participants from a cross-sectional study in Luxembourg (2016-18), comprising residents aged 18-79 years with ≥4 valid days of accelerometry data. Movement behaviours were characterised using seven metrics: average acceleration (AA), intensity gradient (IG), minimum acceleration value for the most active 30 minutes (M0.5), interdailystability (IS), intradailyvariability (IV) and transition probabilities between inactive and active states (TP IN-to-PA, TP PA-to-IN). A discriminative dimensionality reduction tree algorithm, a reversed graph embedding method, was used to identify distinct movement behaviour phenotypes. Phenotypes located at distal branches represent extreme phenotypes, while central nodes indicate mixed phenotypes. Linear regression models tested associations between the derived tree dimensions, movement behaviours, and cardiometabolic health biomarkers, including systolic and diastolic blood pressure, fasting plasma glucose (FPG), triglycerides, high-density lipoprotein cholesterol (HDL-c), apolipoprotein B/A1 ratio, fasting insulin, and a clustered metabolic risk score (CMRS).

RESULTS: All movement behaviour metrics were significantly associated with both tree dimensions. IV and TP PA-to-IN were positively associated with tree dimension 1, while AA, IG, M0.5 and IV were positively associated with dimension 2. Conversely, AA, IG, M0.5, IS, and TP IN-to-PA as well as IV, TP IN-to-PA and TP PA-to-IN were negatively associated with dimension 1 and 2, respectively. Hence, individuals positioned in the upper right corner of the two-dimensional tree exhibited greater variability within a day, a higher probability of transitioning from active to inactive states, higher average acceleration, a broader intensity distribution and a higher minimum acceleration during their most active 30-minute period. Adjusted regression models showed that tree dimension 1 was significantly associated with FPG, triglycerides, HDL-c, the apolipoprotein B/A1 ratio, fasting insulin and CMRS. No association was found for dimension 2 after adjustment.

CONCLUSION: This study demonstrates that a reversed graph embedding method effectively identifies distinct movement behaviour phenotypes based on key accelerometry-derived metrics. The observed associations between these phenotypes and cardiometabolic health offer valuable insights into how variations in movement behaviours relate to metabolic risk. These findings provide a novel framework for phenotyping movement behaviours and emphasise the need for further research into their implications for disease prevention and health promotion.

## Oral Presentations

### OP-MH14 Disabilities and Rehabilitation

**TWENTY-FOUR WEEKS OF HIGH LOAD RESISTANCE EXERCISE DOES NOT INCREASE BONE MINERAL DENSITY IN WHEELCHAIR USERS: RESULTS OF THE BONEWHEEL STUDY**

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INTRODUCTION: Wheelchair users (WCU) are at risk of low bone mineral density (BMD, Z-score<-1.0) due to lack of skeletal stimuli. Previous interventions like electrical stimulation, vibration and standing therapy have shown minimal to no efficacy in improving BMD in populations such as those with spinal cord injury (SCI)1. In contrast, resistance exercise (RE) improves regional BMD in ambulant populations, but its effects in non-ambulant individuals who primarily engage in upper body exercises are unknown. Thus, we aimed to investigate the impact of high load RE on lumbar spine (LS) and hip BMD in WCU with non-progressive impairments.

METHODS: In this multi-centre 24-wk RCT, volunteers (WC use<50%) were stratified by sex and activity level and randomly allocated to either upper body RE 3 x/wk combined with nutrition optimisation (EX, n=24), or nutrition optimisation only (CON, n=21). At pre-, mid- and post-intervention, we measured LS, femoral neck (FN) and total hip BMD with dual-energy x-ray absorptiometry, maximal strength, serum bone turnover markers and vitamin D, and conducted 3x24-hr dietary recalls. The training programme consisted of four isometric and two dynamic upper body exercises aiming to load the LS and hip. Nutrition was optimised through supplementing whey protein (3x30 g/wk), vitamin D (40-120 ug/d) and calcium (500-1500 mg/d). Linear mixed model analysis was employed with random intercept for participants and fixed effects for group, time and interaction, and potential moderating factors. Values are frequencies or estimates (95%CI).

RESULTS: Forty-five WCU participated (SCI: 49%, cerebral palsy: 27%, other: 24%; 40% female; age: 37±9 y; mass: 67±19 kg; BMD Z-score<-1.0 LS: 41%, FN: 83%, hip: 80%), of which 33 completed the study. EX improved more than CON in maximal isometric (+2.0 [0.4-3.5] kg) and 1RM OHP (+2.9 [1.1-4.7] kg), as well as 1RM bench press: (+4.2 [1.4-7.1] kg). Nutrition optimisation increased, in both groups, serum vitamin D over time (+14 [10-18] nmol/L), reducing the prevalence of subclinical deficiency (<50 nmol/L; from 60% to 3%), and increased calcium intake (+167 [15-319] mg/d). No effects were found on LS BMD (EX n=8, CON=16; group: -.072 [-.232 - .089] g/cm2; time: +.004 [-.005 - .013] g/cm2), and similarly no effects on FN or total hip, nor the prevalence of Z-score<-1.0 (all p>.05). Lastly, the bone formation to resorption ratio P1NP/CTX-1 increased over time in both groups (+17 [6 - 28]).

CONCLUSION: High load RE over 24 weeks did not improve BMD, despite a significant increase in maximal upper body strength. Further analyses will explore if strength development influences BMD, with findings presented at the conference. The positive bone formation-to-resorption ratio shift suggests the positive role of nutrition in bone health. Lastly, a longer

intervention period and/or larger sample may be necessary to observe changes in BMD in this population and warrants further investigation.

1: Sutor et al., IJMS, 2022. https://doi.org/10.3390/ijms2302060

**DIFFERENT ISOMETRIC EXERCISE MODALITIES INDUCE DIVERGENT ACUTE EFFECTS ON MYOCARDIAL WORK IN TRAINED HYPERTENSIVE PATIENTS WITH ISCHEMIC HEART DISEASE.**

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INTRODUCTION: Isometric exercise effectively reduces blood pressure (BP) . However, the utilization of IE in the context of the rehabilitation of patients with IHD has,thus far,been prevented by the concern that it may result in an excessive increase in myocardial oxygen consumption. In this study we aimed to investigate the hemodynamic effects produced by two different isometric exercise modalities in hypertensive patients with ischemic heart disease (IHD)

METHODS: Forthy-eight stable, trained patients with hypertension and IHD were enrolled. They were randomly assigned to perform a single session of bilateral knee extension (IKE) or handgrip (IHG) or no exercise (control) with a 1:1:1 ratio. Both exercises were performed at 30% of maximal voluntary contraction and lasted three minutes. Speckle-tracking echocardiography with the assessment myocardial work and BP measurements were performed at rest, during the exercise and after ten minutes of recovery.

RESULTS: Both exercises were well tolerated, and no side effects occurred. During the exercise: systolic BP increased significantly in the IKE group compared to IHG and control (ANOVA p <0.001). LVGLS decreased significantly in IKE (-21%) compared IHG and control (ANOVA p 0.002). The global work index increased significantly in IKE (+28%) compared to HG and control (ANOVA p 0.034). Global constructive work and wasted work increased significantly in the IKE compared to IHG and control (ANOVA p 0.009 and <0.001 respectively). Global work efficiency decreased significantly in the IKE group (-8%) while remained unchanged in the IHG and controls (ANOVA p 0.002). During the recovery, systolic BP dropped significantly in the IKE group compared to IHG and control (ANOVA p 0.022).

CONCLUSION: We observed that myocardial work efficiency was impaired during isometric bilateral knee extension but not during handgrip. Handgrip evoked a very limited hemodynamic response. Our data suggests that in hypertensive patients with underlying IHD, performing isometric exercise with handgrip seems a viable choice in terms of hemodynamic tolerability. Future studies should clarify whether handgrip is also effective in lowering BP in these patients.

**THE EFFECTS OF AQUATIC REHABILITATION EXERCISE PROGRAMS ON FALL-RELATED PHYSICAL FITNESS AND COGNITIVE FUNCTION IN AGEING ADULTS WITH PHYSICAL DISABILITY**

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INTRODUCTION: As the ageing population increases, elderly individuals with physical disabilities face higher risks of falls and cognitive decline, leading to reduced independence and quality of life. Traditional rehabilitation methods often pose mobility and accessibility challenges, limiting participation. Aquatic rehabilitation exercise provides a low-impact alternative, using buoyancy and resistance to enhance physical function, balance, and cognitive health while minimizing joint strain.

METHODS: This research, guided by the Leisure Ability Model (LAM), consists of two components. A systematic review was conducted to analyze existing research on aquatic rehabilitation interventions for ageing adults with physical disabilities, identifying key findings and limitations. An experimental intervention was implemented to assess the effects of aquatic rehabilitation exercise on fall-related physical fitness and cognitive function, measuring balance, muscle strength, flexibility, reaction time, memory, attention, and executive function. The relationship between physical and cognitive improvements was examined, along with the long-term impact on fall prevention and well-being.

RESULTS: Findings from the systematic review highlighted positive effects of aquatic rehabilitation on mobility, strength, and cognitive function but indicated a lack of research on long-term outcomes. The experimental study demonstrated significant improvements in balance, muscle strength, and cognitive function among participants engaged in aquatic rehabilitation compared to non-participants. A strong correlation between physical and cognitive enhancements was observed.

CONCLUSION: Aquatic rehabilitation exercise effectively improves fall-related physical fitness and cognitive function in elderly individuals with physical disabilities. The findings support the development of accessible, evidence-based rehabilitation programs to promote healthy ageing, fall prevention, and enhanced quality of life.

**PRELIMINARY RESULTS FROM THE ADVICE PROJECT, PHASE I: THE INTERACTION BETWEEN MULTIPLE SCLEROSIS AND MENSTRUAL CYCLE PHASES ON FATIGUE, PAIN, AND STRENGTH.**

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INTRODUCTION: Fatigue and pain are common symptoms in women with multiple sclerosis (MS), yet their relationship with the menstrual cycle phases (MCP; early follicular phase, EFP; late follicular phase, LFP; mid follicular phase, MLP) remains

unclear. This study aimed to analyze how MS and MCP interact to influence fatigue, energy perception, pain, and strength [handgrip strength (HGS) and 5 repetitions sit-to-stand test (5-STS)].

METHODS: A comparative study was conducted as part of the Esclerosis Múltiple, Ciclo Menstrual y Actividad Física (AD-VICE) Project, involving women diagnosed with MS (n= 5) and women without MS (n= 8). Fatigue, energy, and pain were assessed using validated scales, while HGS and the 5-STS were used to measure functionality. Phase-specific comparisons (EFP, LFP, MLP) were analyzed separately within each group (MS vs. non-MS). The three-step method (i.e. calendar, urine LH peak, and serum hormones) was used for MCP confirmation. Two-way mixed ANOVA was used to examine the interaction between MS status and MCP. Pairwise comparisons were conducted, with Cohen's d calculated for both intra-group (phase differences) and inter-group (MS vs. non-MS) effects.

RESULTS: Fatigue perception was significantly influenced by both MS status and MCP ($p < 0.05$). Women with MS reported the highest fatigue levels during the EFP compared to LFP and MLP ($p = 0.026$, $d = -1.3$). In women without MS, fatigue remained stable across phases, with no significant variations. A significant MS × MCP interaction was found ($p < 0.05$), indicating that fluctuations in fatigue were more pronounced in the MS group. Pain perception was higher in the MS group, particularly during the MLP ($p = 0.008$, $d = -1.9$). Intra-group comparisons confirmed that pain increased significantly from EFP to MLP within the MS group ($d > 1.0$). Women without MS did not show significant changes in pain across the cycle. Energy levels did not differ significantly between groups or across MCP ($p > 0.05$). Handgrip strength and 5-STS performance remained stable across groups and MCP, with no significant effects of MS status or cycle phase ($p > 0.05$, $d < 0.3$).

CONCLUSION: These findings suggest that MS interacts with MCP, particularly affecting fatigue and pain perception. The EFP appears to be the most symptomatic period for fatigue in women with MS, while pain is exacerbated during the MLP. Despite these variations in perceived symptoms, functional performance (HGS and 5-STS) remained unaffected across phases and groups. The large effect sizes observed reinforce the clinical significance of phase-specific symptom changes, even in a small sample. Future research should further explore hormonal and inflammatory mechanisms underlying these variations and develop personalized symptom management strategies for women with MS.

**CARDIOPULMONARY EXERCISE TESTING IN ATHLETES WITH DISABILITIES: INSIGHTS FROM PERFORMANCE ANALYSIS**

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INTRODUCTION: This study examines the cardiovascular and aerobic performance of athletes with disabilities from Latvia through Cardiopulmonary Exercise Testing (CPET).

METHODS: A group of 30 athletes with various disabilities including spinal cord injury, amputations, cerebral palsy, and congenital development disorders participated in CPET using either veloergometer (n= 12) or an arm ergometer (n =18). Key performance indicators such as peak oxygen uptake (VO2peak), physical work capacity (PWCmax), and heart rate (HR), HR recovery were analysed in relation to athlete demographics, training habits, and sports. Athletes ranged in age from 18 to 68 years (mean=40.53±12.4), with BMI from 19 to 37 (mean = 26.43 ± 5.06). The athletes had an average of 13.52 (± 9.43) years of experience in their respective sports, with the majority (21 athletes) training 2 or more times per week. Athletes were divided into four age groups: 18-30 years (Group 1, N=6), 31-40 years (Group 2, N=8), 41-50 years (Group 3, N=8), and 50+ years (Group 4, N=8).

RESULTS: The greatest difference was found in maximum workload outcomes, with athletes aged 50+ years (Group 4) achieving significantly lower values compared to those aged 31-40 years (Group 2) (mean difference = 85.00 W, $p = 0.015$, CI 95% 16.98, 153.02). However, no statistically significant differences were found between athletes from other age groups ($p > .05$). The average aerobic threshold outcome for Group 4 was significantly lower than for Group 1 and Group 2 ($p = .039$, $p = .009$, respectively). The VO2peak values presented significant differences between Group 2 and Group 4 indicating reductions in both absolute and relative VO2peak for older athletes (mean difference = 981.75 mL/min, $p = 0.006$, CI95% 1704.74, 258.75 and 12.59 mL/kg/min, $p = 0.002$, CI95% respectively). Also, heart rate recovery was significantly slower for Group 4 athletes compared to Group 2 ($p < 0.05$). Furthermore, the reasons for CPET termination were analysed, with the most common being maximal effort (60%), followed by reaching the target heart rate (20%), excessive dyspnea (13.33%), and reaching maximal systolic blood pressure (6.67%).

CONCLUSION: Age related declines in both cardiovascular and aerobic performance were observed, especially in Group 4 (athletes aged 50+ years). Younger athletes demonstrated consistent performance, while VO2peak significantly decreased with age. Most common reason for CPET termination was reaching maximal effort and target heart rate. These findings suggest the need for age-appropriate training interventions to maintain athletes' performance. Further research is needed to develop strategies to minimize the effects of aging on athletes' performance especially in athletes with disabilities.

# Oral Presentations

## OP-SH17 Physical Activity Promotion II

### MEDIATING AND MODERATING EFFECTS OF A PARENT-BASED ELECTRONIC HEALTH (EHEALTH) INTERVENTION ON PRE-SCHOOLERS' PHYSICAL ACTIVITY, DIETARY BEHAVIORS, AND SLEEP

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Background: Preschool children are characterized by physical inactivity, poor diet, and disturbed sleep quality, negatively impacting long-term health. Parental involvement is crucial in reversing unhealthy trend, and eHealth interventions can help engage parents by overcoming barriers like time and travel costs. Investigating the mechanisms by which parent-base eHealth interventions work and who they work for is particularly important.

Objectives: To evaluate the mediators and moderators of a parent-based eHealth intervention on preschoolers' physical activity, diet, and sleep at 12-week posttest.

Method: The mediation and moderation analyses utilized dataset from a 24-week electronic health intervention study of Chinese preschoolers aged from 3 to 6 years (N=237 parent-child dyads), which was designed as a two-arm single-blinded randomized controlled trial to improve preschoolers' physical activity, diet, and sleep. Preschoolers' PA and sleep duration and quality were objectively examined using wGT3X ActiGraph accelerometer. Data related to parents and preschoolers' eating behaviors and sleep problems were subjectively assessed using parent-reported questionnaires. The generalized estimating equation analysed the changes in preschoolers' physical activity, diet, and sleep from base-line to 12 weeks between the two groups. Significant changes in the intervention group were assessed using PROCESS macro version 4.2 to determine potential mediators and moderators on these outcomes.

Results: After 12 weeks of intervention, significant improvements were observed in children's diet, sleep, and screen time, which were associated with an increase in corresponding parenting self-efficacy. Enhancements in childrens diet and sleep were mediated by authoritative parenting style, while improvements in diet were also influenced by the feeding practice of control overeating. The exploratory analysis of moderators indicated that the effectiveness of intervention on preschoolers' physical activity varied based on the children's age and the parents' BMI.

Conclusion: It is suggested that future parent-based eHealth intervention research could focus on parenting self-efficacy, parenting styles, and parenting feeding practices to enhance the effectiveness of interventions targeting preschoolers' lifestyle behaviors.

### COMMUTING PHYSICAL ACTIVITY-SCHOOLS OF SORIA (CPA-SOSORIA): STUDY PROTOCOL

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Introduction: Physical inactivity is currently one of the major threats to public health. Childhood and adolescence are considered essential periods for developing healthy lifestyle habits. The school environment provides an ideal context to promote physically active behaviours. The 48% of physical activity guidelines could be achieved among students with active commuting to and from school. This study aims to design a project to analyze the physical activity of students during commuting and its relationship with personal, interpersonal, organizational, community, and policy dimensions.

Methods: Participants are 480 students, 480 parents, and 8 Physical Education teachers from all high schools in Soria, Spain. According to these socio-ecological dimensions: a) personal dimension, measured by the Basic Psychological Need Satisfaction in Active Commuting scale (BPNS-ACS) (1), and by the mode, frequency, distance and time of commuting to and from school survey (2) as well as accelerometer (ActiGraph wGT3X-BT), ALPHA Fitness test, health and quality of life survey (EQ-5D-Y-SL); b) interpersonal dimension, assessing the parental barriers by the safe routes to school program questionnaire (3); c) organizational dimension, by a Google Form questionnaire for PE teachers to check the didactic use of active commuting according to Spanish educational law; d) community dimension, by assessing walkability index and some socioeconomic factors of the school community, and e) policy dimension, by a Weaknesses, Threats, Strengths and Opportunities (SWOT) framework based on data collected from local educational policymakers. The protocol has been sent to the Ethical Committee of Universidad de Valladolid for approval. This Project (EDUCYL2024_05) is funded by the Consejería de Educación de la Junta de Castilla y León through the Dirección General de Innovación y Formación del Profesorado.

Results: Physical active commuting data and their relationship to basic psychological needs, academic performance, physical fitness, self-perceived health, well-being, and quality of life status of students, and also, parents, teachers, and policymakers' information will be shown by a SWOT.

Conclusions: This project aims to design a planned strategy to promote active commuting in schools as an educational and public health strategy.

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**GENDER DISPARITIES IN SCHOOL SPORT PARTICIPATION: BARRIERS AND IMPLICATIONS FOR LONG-TERM SPORT ENGAGEMENT**

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School-based sport serves as a critical gateway to lifelong physical activity, athletic development, and future sport involvement. However, persistent disparities in participation rates and access continue to hinder engagement among girls and gender-diverse youth. This study investigates systemic barriers in schools in Ontario, Canada. This study analyzed survey data from 160 students (ages 5–18, M = 12.12, SD = 3.44 years) and 59 school leaders including school principals (21.3%) and physical education teachers (47.5%). Descriptive statistical analyses were conducted to examine gender-based differences in sport participation rates, perceived barriers, and structural limitations within school settings. Thematic analysis of qualitative responses provided insight into institutional challenges and facilitators of gender-inclusive sport environments. Based on the findings, a significant gender gap in participation was observed with 41% of girls meeting physical activity guidelines compared to 53% of boys. Moreover, just 29% of girls participated in varsity sports, despite equivalent program offerings, highlighting the existence of non-structural barriers that need to be further understood (e.g., perceived competence, social norms, and psychological deterrents). Notably, 25% of girls and 66% of gender-diverse youth reported actively avoiding physical education classes due to discomfort, anxiety, or lack of enjoyment, pointing to a misalignment between curricular physical education and students engagement needs. Structural barriers further constrain access to school-based sport as a developmental pathway. For example, 80% of school leaders reported that the school provided equal opportunities for physical activity, and less than 40% indicated active efforts to create more inclusive environments for girls. Additionally, 31% of girls cited menstruation as a direct barrier to participation, yet institutional accommodations (e.g., flexible uniform policies, period-friendly resources) remained inconsistently implemented. Limited off-hours access to gymnasiums (reported by 50% of schools) and restricted availability of sport equipment (33%) further narrowed the scope for skill development and continued participation beyond mandatory physical education. The underrepresentation of women school leaders in coaching and sport leadership roles was identified as a key barrier to program inclusivity. Furthermore, only 55% of secondary school administrators perceived gender equity in sport scheduling and resource allocation, highlighting persistent disparities shaped by institutional and cultural dynamics beyond opportunity provision. Based on these findings, recommendations for creating a more inclusive sport system will be discussed, focusing on strategies that can enhance access and engagement for all students. School sport experiences can be foundational to increased participation in physical activity across the lifespan and need to be fostered.

**PREVENTION OF STRESS-ASSOCIATED CONDITIONS IN HIGHER EDUCATION STUDENTS THROUGH HEALTH-ENHANCING RECREATIONAL PHYSICAL ACTIVITY**

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INTRODUCTION: Todays Ukrainian university students are exposed to military stressors for a long time. They experience significant psychological stress as a result of constant anxiety, fear for their lives and health, instability, and economic disruption caused by military operations. These factors lead to widespread stress-related states among students, including stress, anxiety, and the risk of developing post-traumatic stress disorder (PTSD).

METHODS: The study involved 125 university students. The study utilized questionnaires comprising blocks of questions designed to ascertain psychophysiological indicators (activity, mood, sleep, appetite, performance, and well-being) with the 5-point Likert scale; stress level by V. Y. Shcherbatykh; anxiety scores using the Spielberg-Hanin Inventory; and the risk of PTSD using the Mississippi Scale. To analyze the impact of different types of physical activity (PA) on stress-related states, logistic regression models were built. GLZ models were utilized. The statistical significance of the models was assessed using the Wald test.

RESULTS: The analysis indicated that adventure tourism is a statistically significant predictor ($p<0.05$) of stress reduction, a decrease in intrusive thoughts, and mood improvement. Mental fitness was found to be the most effective means for the restoration of mental balance. The models for predicting an increase in stress tolerance revealed dependencies on the type and amount of PA. This study contributes to the extant scientific knowledge base in the field of health-enhancing recreational physical activity aimed at preventing stress-related states. The proposed approach to the use of GLZ-models in the study of students stress tolerance opens up new opportunities for analyzing the complex relationships between types of PA and psycho-emotional states.

CONCLUSION: The findings confirm prior research on the significant impact of PA on mental well-being. Studies highlight PA as a key adaptive mechanism in stress management, while the type and context of PA influence its effectiveness in alleviating stress. Predictive models developed in this study suggest that while team sports participants exhibited better performance, their high PTSD risk nullified stress-reducing effects. This may stem from competition-induced emotional strain, as elevated cortisol levels hinder psychological recovery. In contrast, mental fitness and adventure tourism groups

showed superior outcomes, aligning with research on the stress-reducing effects of less competitive, nature-based activities. Adventure tourism, in particular, fosters resilience through nature exposure, social support, and personal achievement. Despite the statistical significance of the models, further refinement is needed, particularly through larger, more diverse samples and a focus on sex-based differences. Given the unique stressors of wartime conditions, integrating non-competitive PA– such as adventure tourism and mental fitness – into student wellness programs is essential.

**AN INVESTIGATION INTO THE HEALTH-PROMOTING LIFESTYLE AMONG ITALIAN INDIVIDUALS AND ITS INTERACTION WITH SOCIODEMOGRAPHIC VARIABLES AND PERSONAL CHARACTERISTICS.**

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INTRODUCTION: Lifestyle is shaped by sociodemographic and environmental factors (e.g., age, sex, economic conditions, education, employment, housing, social inclusion, infrastructure access) that interact with individual behaviors (e.g., diet, physical activity levels, spirituality, social engagement, and healthcare) [1]. In Italy, regional disparities exist in health systems, economic conditions, infrastructure, and employment [2]. In this context, monitoring people's lifestyles and well-being is essential for improving health interventions. Accordingly, this cross-sectional study explores the relationship between sociodemographic factors, health-promoting behaviors, and perceived well-being in Italy.

METHODS: An online survey was distributed through Google Forms to people aged 18–70, containing 12 sociodemographic items and two validated questionnaires. The Health Promoting Lifestyle Profile II assessed health-promoting behaviors (i.e., Health Responsibility HR, Interpersonal Relationships IR, Nutrition N, Physical Activity PA, Spiritual Growth SG, Stress Management SG) while the WHO-5 Well-Being Index measured perceived well-being. Descriptive statistics were reported. Independent t-tests examined sex differences in health behaviors and well-being, while ANOVA models (followed by Bonferroni post-hoc test) assessed differences among variables per sociodemographics. Pearson's r coefficient explored the relationships between health behaviors and well-being. Statistical significance was set at $p < 0.05$.

RESULTS: 186 individuals (mean age= 40±12years) participated: 126 women (mean age= 41±12years; height= 165±5cm; weight= 61.5±10.7 kg; BMI= 23.3±3.8 kg/m²) and 60 men (mean age= 39±12 years; height= 178±7cm; weight= 78.7±11.9kg; BMI= 23.6±3.5 kg/m²). ANOVA revealed significant differences in HR, IR, and SG scores based on sociodemographics (F= 3.1 to 8.73; p=< 0.001 to p = 0.037). Post-hoc analysis shows women reported higher HR than men. Higher HR was also reported for individuals living with other adults and under 18 compared to those living alone. Regarding SG and IR, people living with under 18 scored higher values than those living alone or with other adults. Additionally, a recent improved financial status links with higher SG and IR. No significant differences were found for well-being across sociodemographics, while IR, N, and PA showed small-to-moderate positive correlations with the WHO-5 score (R=0.131 to 0.620).

CONCLUSION: Findings suggest that, in Italy, factors such as sex, housing, and financial status interact with health-promoting behaviors. Notably, living with children seems to encourage focusing on aspects like health guidance, personal needs, and love. A higher income fosters well-being, as individuals feel more confident and stable, allowing for deeper relationships. Finally, behaviors such as PA and N correlate with well-being, highlighting their role in enhancing life quality.

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## Oral Presentations

### OP-AP25 Performance Analysis in Individual Sports

**ANALYSIS OF THE TENNIS EXPERTS' ANTICIPATORY PERFORMANCE IN GRAND SLAM FINAL MATCH (FEDERER AND DJOKOVIC, WIMBLEDON FINALS MATCH, 2019)**

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INTRODUCTION: During professional tennis match-play, the demands for movement efficacy increase due to the high level of technical-tactical expertise of competing athletes (1). To gain an advantage, athletes may require increased perceptual-cognitive performance (anticipation) during rally exchanges to cope with these increased demands. Expert receivers (ball incoming) demonstrate an ability to use perceptual cues in the form of postural kinematics, such as hip and shoulder movement (2) and body movement dynamics (3), to proactively anticipate an opponent's stroke intention (4). In addition, they exploit the same abilities as hitters (ball leaving) to disguise their strokes to cause deception (5). Therefore, the analysis aimed to understand the anticipatory and deceptive behavior of two expert performers in-situ of grand slam tennis match-play.

METHODS: Anticipatory performance was analyzed during two sets, with a frame-by-frame video analysis using Dartfish (v7.0.20114, Dartfish, Fribourg, Switzerland). Every receiver's (ball incoming) movement response initiated pre-impact was

defined as anticipation. The response orientation corresponding to the post-impact ball direction was classified as correct, while in the opposite direction, as an incorrect anticipatory response. The disguising stroke execution intention (ball leaving) was analyzed as the hitter's stroke intentions judged for stroke direction opposite from the post-contact direction (6). To judge the stroke intentions, kinematics of trunk (hip and shoulder) rotations during shot preparation for the forehand (7) and backhand (8) were observed. We analyzed both performances, acknowledging that if disguising did not occur and execution followed previously judged intentions, the receiver's anticipatory responses were categorized as "incorrect", and the disguised stroke execution should be acknowledged as "correct".

RESULTS: Analysis data showed that both experts as receivers initiated:

(A) 98 correct anticipatory responses to hitter's 300 strokes

(B) 52 incorrect anticipatory responses to hitter's 83 disguised strokes.

By combining (A) and (B), receivers' efficiency in anticipatory movement increased from initially observed 98 correct responses (success rate 54%) to 150 (83%), showing that receivers' efficiency of the anticipatory movement responses should not be analysed without the consideration of hitters' expertise in disguising stroke performance.

CONCLUSION: The analysis suggests that future research should consider the mutual relationship between receivers' and hitters' perceptual-cognitive abilities for anticipation.

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**DEVELOPMENTAL TRAJECTORIES OF TALENTED TENNIS PLAYERS DURING ADOLESCENCE: A PROSPECTIVE LONGITUDINAL APPROACH**

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INTRODUCTION: Talent typically emerges during adolescence (1), as athletes develop physically, psychologically and socially during this period (2). Talent development is assumed to be a complex, often non-linear and individual-specific process. Yet, longitudinal studies on junior performance during adolescence are limited (4), and many studies retrospectively analyze elite players (5). The current study aims to address this gap by prospectively examining the developmental trajectories of a broad sample of talented tennis players during adolescence, based on a continuous and objective performance measure (i.e., rating). Additionally, the relationship between performance at age 16 and preceding ages is studied. Differences between male and female players will be highlighted.

METHODS: Growth Mixture Modeling (GMM) was performed to analyze the development of performance of 755 youth tennis players (at least once ranked top-300 nationally in their age category), aged from 11.5 until 16 years (N=469 males, N=286 females). Players' individual singles rating of the national rating-system in the Netherlands was taken at half-yearly intervals. Correlations were calculated to analyze the relation between rating at age 16 and the preceding ages. Overlap percentage with preceding ages was calculated for the top 5% and the top 5 players at age 16.

RESULTS: To fit the developmental trajectories, a 4-class solution performed best for male players and a 5-class solution was best for female players. For both genders, quadratic fixed and mixture effects were included. The male class with the best performance at age 16 displayed a non-linear developmental trajectory, coming from little improvement up until age 13.5, after which performance improved rapidly. On the other hand, the female class with the best performance at age 16 showed a linear developmental trajectory throughout. For both the whole male and female sample of players, the correlation between rating at the age 16 and at preceding ages increases steadily from .60 at age 11.5 to .95 at age 15.5. The overlap percentage for the best 5% and best 5 is consistently around 15% higher for females than for males between age 11.5 to age 14.

CONCLUSION: The growth mixture models for male and female players both show diverse developmental trajectories. Performance in male players remained consistent among the classes between ages 11.5 and 13.5, after which performance diverged. This resulted in a non-linear developmental class trajectory for the best male class. Performance in female players showed no divergence point, as the best female class showed consistent linear improvement from 11.5 onwards. These findings could be related to gender-based differences in maturation. Given the linear trajectories and consistently higher overlap percentage, talent identification could be feasible at earlier ages for female compared to male players.

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**ADVANTAGES AND DISADVANTAGES OF LONG-HITTER SWING TECHNIQUES: A COMPARATIVE ANALYSIS OF CHINESE AND INTERNATIONAL PROFESSIONAL GOLFERS (2022-2023)**

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INTRODUCTION: INTRODUCTION: As golf continues to expand and benefit from technological innovations, courses are lengthening, making tee-shot distance increasingly critical in competition. Long hitters gain advantages in club selection, greens in regulation (GIR), and putting performance. However, emphasizing distance too heavily may compromise stability and fairway accuracy, particularly if techniques from long-drive contests are applied to formal stroke play. Consequently, professionals must balance power and control, preserving both distance and consistency.

METHODS: We analyzed PGA Tour data (2022-2023) from Chinese professional players (n=4, representing all Chinese male players who participated in PGA Tour events during this period) and leading international professional players (n=10, selected based on their consistent ranking within the worlds top 50 and average driving distance exceeding 310 yards). Performance metrics were analyzed using TrackMan and ShotLink systems, focusing on driving distance, accuracy, GIR, and world rankings.

RESULTS: The average driving distance for the top 10 professional players worldwide is 313.2 yards, whereas Chinese professional players average 299.0 yards, indicating a distinct advantage for international professional players in terms of driving distance. The average driving accuracy of international professional players is approximately 58.8%, while that of Chinese professional players is approximately 57.2%, both close to the tour average of approximately 59%. Despite the minor difference, an integrated analysis of overall competitive performance and world ranking suggests that driving accuracy has no direct, significant impact on ranking. The top 10 professional players worldwide generally achieve a GIR rate of approximately 70%, whereas Chinese professional players typically achieve approximately 65%, reflecting disparities in technical details and training methodologies. Top 10 professional players driving distance averages 318.8 yards, while those within the top 50 average 312.8 yards, demonstrating a positive correlation between driving distance and higher world rankings. This further confirms the importance of driving distance for overall competitive performance.

CONCLUSION: Our analysis indicates that longer driving distance tends to associate with better tournament performance and higher world rankings. Chinese professional players displayed notable differences in driving distance (14.2 yards lower) and GIR (5% lower) compared to top international professional players. Based on these findings, we recommend developing targeted training programs emphasizing strength, flexibility, and swing mechanics, supported by modern technology, to improve driving distance while maintaining consistent accuracy.

**TAEKWONDO KICKING MOVEMENT QUALITY ASSESSMENT BASED ON INERTIAL MOTION CAPTURE**

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INTRODUCTION: Taekwondo leg techniques demand high-speed execution and complex coordination, making their training and evaluation a long-standing focus in both teaching and research. Unlike traditional camera-based motion capture systems, inertial motion capture systems—composed of multiple IMUs—offer significant advantages, including portability and minimal dependence on environmental conditions. This study utilizes high-dimensional motion data collected through an inertial motion capture system and applies deep learning models to achieve objective recognition and quality assessment of Taekwondo leg techniques. By enabling automated action classification and scoring, this approach provides a more scientific and practical solution for Taekwondo instruction and training.

METHODS: A total of 20 participants (both professional athletes and amateur practitioners) were recruited. Each participants wore an inertial motion capture system (Noitom Perception Neuron 3) attached to key body segments (e.g., waist, thighs, ankles) while performing five types of Taekwondo kicking techniques (front kick, roundhouse kick, side kick, back kick, spinning hook kick). The raw data underwent preprocessing steps including data cleaning, windowing, and normalization. For action classification, we implemented an improved one-dimensional convolutional neural network (1D CNN) and a Transformer architecture, enhanced with techniques such as Dropout, Batch Normalization, and L2 regularization to improve model accuracy and generalization. Building on the action recognition results, we employed an autoencoder to reduce dimensionality and constructed a Gaussian Mixture Model (GMM) with the Expectation-Maximization (EM) algorithm to generate a quality assessment score. The log-likelihood values derived from the GMM were mapped to a 0–10 scoring range through a monotonically decreasing function. Expert evaluations were used as a reference for tiered comparisons, and a CNN-based regression model was developed to predict final scores for each kicking technique.

RESULTS: The 1D CNN achieved an accuracy of 93%, up from an initial 87%, while the refined Transformer model achieved a 96% accuracy rate. The automated scoring system demonstrated an approximately 85% agreement with expert-based tier assessments, indicating strong consistency between objective and subjective evaluations. Furthermore, the model exhibited stable predictive performance for different kicking techniques, with the side kick attaining a mean absolute deviation of 0.555 and a root mean square deviation of 0.645 in score prediction.

CONCLUSION: Deep learning approaches based on an inertial motion capture system can effectively recognize Taekwondo leg techniques and provide a relatively objective, interpretable quality assessment framework. This research gives valuable support for technical monitoring and scientific management in Taekwondo training, with potential applications in objective performance evaluation and intelligent training systems for other sports.

**PACING PERCEPTIONS AND PREDICTION OF MARATHON PACING OUTCOME**

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INTRODUCTION: Even pacing is integral to achieving optimal marathon performance and the fastest time, with runners who maintain close-to-even splits considered to possess superior pacing ability. Marathon pacing significantly influences race outcome, yet its determinants are not fully understood. This study explores how pacing and racing perceptions impact marathon performance, while adjusting for important co-variables.

METHODS: A questionnaire developed in 2021 was administered during the spring (March-May) and autumn (September-December) marathon seasons of 2022. Participants were runners who had completed their goal marathon within six weeks prior to survey completion. The survey was distributed online using JISC Online Surveys (Version 2) and promoted via social media to local, national, and international running groups. It gathered data on demographics, training habits, and pacing views (rated on a 1-5 scale). Race splits were obtained from official race websites post-race, and pacing outcome was assessed by calculating slowing (%) in the second half of the race compared to the first. After exclusions, 182 complete responses were analysed using simple and multiple regression to examine the relationship with pacing outcomes.

RESULTS: In simple regression analyses, marathon time ($P < 0.001$, Adj $R^2 = 0.22$) and pacing flexibility ($P = 0.004$, Adj $R^2 = 0.038$), positively influenced pacing outcomes. In contrast, kilometres per week ($P = 0.004$, Adj $R^2 = 0.04$), importance of marathon finishing time ($P = 0.022$, Adj $R^2 = 0.02$), and view on pacing importance to marathon performance ($P < 0.001$, Adj $R^2 = 0.11$), had negative influences. To adjust for important confounders and isolate potential true effects, a multiple regression was conducted. This model was statistically significant ($P < 0.001$), explaining 32% of the variance in pacing outcomes (Adj $R^2 = 0.32$). Within the multiple regression, finish time ($P < 0.001$, $R^2$ change = 0.178) and importance of marathon finishing time ($P < 0.001$, $R^2$ change = 0.05) emerged as positive predictors. Conversely, sex (coded as 0 for males and 1 for females; $P< 0.001$, $R^2$ change = 0.06) and view on pacing importance to marathon performance ($P = 0.003$, $R^2$ change = 0.04) were significant negative predictors. Notably, distance per week, which was significant in simple regression, was not significant in the multiple regression ($P = 0.90$, $R^2$ change = 0.00).

CONCLUSION: These findings suggest that runners who understand and prioritise pacing as a key element of their race strategy, rather than focusing solely on finish time, are more likely to optimise their pacing and achieve their best performance on race day. This likely intrinsically regulated approach highlights autonomy and personal mastery, enhancing an athletes ability to monitor their effort and exercise intensity during a race. These skills are crucial for effective race performance and pacing.

## Oral Presentations

### OP-SH06 Sport Management and Law I

**THE NEOHUMANIST INTERFACE: THE IMPACT OF RESIDENTS PERCEPTIONS ON URBAN COMMUNITY COHESION AT DIGITAL SPORTING EVENTS**

ZI, Y.

*SHANGHAI UNIVERSITY OF SPORT*

Introduction: The Renaissance concept of "virtù", which emphasizes the citizens ability to shape social life, has been revitalized in Shanghais large-scale sports events in the digital era. Sports events have evolved along with the development of social productivity, and have continued to evolve along with human civilization to meet the needs of people for sports competitions in different historical periods. Shanghai, as a world-famous sports city, has gradually formed a new form of sports competition under the development of digital technology, showing the dual characteristics of digitization and competitiveness. This study combines historical sports sociology and digital technology to explore how traditional sports events reconstructed by digital technology activate urban community cohesion.

Methods: The study mainly adopts research methods such as literature review, questionnaire survey, data analysis and expert interviews. First of all, we searched with the theme of "digital sports events", "community digital sports" and "influence", and established two factors, six topics and three factors of community cohesion that constitute residents perception. 3 factors and 10 topics that constitute community cohesion. Next, the authors attended 10 major sporting events as participant observers and distributed 1,600 questionnaires to the residents of the communities where they were held, obtaining a total of 1,434 valid samples with a validity rate of 89.63%. Finally, data were analyzed using Amos27 and SPSS27 The purpose of this study was to investigate the relationship between residents perceptions of digital sports events and community cohesion using validated factor analysis (CFA) and structural equation modeling (SEM).

Results: The study showed that community residents attending digital sports events were predominantly male 873 (60.9%), the age of the participants involved in this study was predominantly between the ages of 20 to 30 years old 985 (68.7%), and the level of education was predominantly bachelors degree and above residents 1076 (75.1%). The results showed that perceived benefits were positively related to resident participation, social interaction, and sense of community be-

longing. Whereas, perceived cost was negatively related to resident participation and positively related to social interaction and sense of community belonging.

Discussion: The study draws the following insights: (1) Perceived benefits for residents of digital sports events are necessary to generate urban community cohesion. (2) Interaction among residents participating in digital sports events and sense of community belonging are both high-frequency elements in the pathway portfolio. (3) A highly educated young population is an important antecedent for the high impact of digital sports events in the community.

**RESEARCH ON THE INTEGRATION OF COMMERCE, TOURISM, CULTURE, AND SPORTS PROMOTED BY SPORT EVENTS**

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INTRODUCTION: The integration of commerce, tourism, culture, and sports (CTCS) is an essential approach in the new era to meet the diverse needs of the public, unlock the potential for social consumption, optimize industrial structures, and achieve high-quality economic development. Sport events serve as a bridge to highlight the unique characteristics of CTCS integration, unleashing the powerful synergy of commerce-driven industrial development, tourism-driven urban integration, culture-driven societal enrichment, and sports-driven vitality. Therefore, in-depth exploration of successful experiences from cities across various countries and proposing optimization pathways can offer theoretical and practical insights for the sustainable economic growth.

Methods

The study primarily adopts methods such as literature review, case analysis, and field investigation. Relevant studies were retrieved from CSSCI journals in the CNKI and WOS database using the keywords "sport events" and "industrial integration" in their titles covering the past five years. A total of 308 and 344 papers were identified, respectively. More than 60 articles from core academic journals and over 10 reports and monographs were reviewed. Case studies of over 10 countries, including the United States, the United Kingdom, France, Italy, Japan, and Australia, were conducted. Additionally, interviews were carried out with more than 10 experts in the field of sport events.

RESULTS: The study reveals that the contextual drivers for promoting the integration of CTCS through sport events stem from three aspects: 1) The practical necessity of meeting peoples aspirations for a better life. 2) The national demand for driving high-quality economic development. 3) The strategic imperative of achieving the goal of a modernized and strong nation.

The research identifies four key lessons from developed countries regarding the promotion of CTCS integration through sport events: 1) Setting new benchmarks for integration with a focus on collaboration and socialization. 2) Building new platforms for integration by emphasizing quality and branding. 3) Creating new scenarios for integration by leveraging agglomeration and differentiation. 4) Fostering a new ecosystem for integration based on inclusivity and scientific approaches.

Discussion: The study suggests that advancing the integration of CTCS through sport events should focus on the following four dimensions: 1) Enhancing comprehensive planning and deployment, improving governmental governance capacity, and stimulating social actors vitality. 2) Strengthening cross-industry product linkages, reshaping the event supply system, and optimizing event portfolio design. 3) Creating holistic event experiences, enhancing spatiotemporal connections of events, and leveraging technological empowerment. 4) Promoting inclusive sharing of outcomes, addressing diverse public needs, and paying attention to event-related trends and innovations.

**IOT - INNOVATION. OLYMPICS. TECHNOLOGY.**

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INTRODUCTION: Since the appearance and widespread use of computers, we have witnessed a technological transformation in all areas, transforming the functioning of different social subsystems. Sports innovation refers to innovations and developments in the field of sport that aim to improve the performance of sports disciplines, enhance the experience of athletes and spectators, and make sports infrastructure and organisational operations more efficient (Tjønndal, 2018).

METHODS: Our research aims to answer the question: what are the main areas of innovation in ensuring the effectiveness of the Olympic Movement? In the analysis of the last Olympic cycle(s), we have processed primary and secondary sources, analysed the delivery solutions and innovation strategies of the Olympics, the relationship between successful nations in terms of sporting performance and innovation. We conducted expert interviews in the field of innovation and sport event organisation.

RESULTS: Three areas of innovation emergence were identified and analysed: (1) organisational innovation: the protection and development of the Summer Games as a brand, (2) sport innovation: the sporting competition of sports, competitiveness and future of business, (3) sport performance innovation: the central actor in all of this, the athlete.

For the Paris Summer Olympics, we identified 8 areas of change (operating model, programme, broadcast technology, opening and closing ceremonies, Athlete first, image elements, sustainability and social aspects), change drivers and innovations, drawing parallels between the 1924 and 2024 Paris Olympics. We analysed the developments in the 29 sports, grouping the innovation objectives into two main categories: enhancing sporting performance (data collection, analysis and development) and enhancing the consumer experience (transparent, scoring, broadcastability). For the 12

countries that have been in the top ten at the last four Summer Olympics, we examined the Global Innovation Index of these countries. For the Netherlands, strong growth was identified: both in sport performance and in innovation capacity.

Discussion: Examining the Olympic Movements effectiveness based on sports innovation requires a systemic approach when considering organisational culture, leadership, the global market environment and technological developments. Firstly, the relationship between the picture presented by the innovation composite indicators of each country and the evolution of the countries sport performance. Also of importance is the typical operating model of each country: the role of the state and the business world.

Reference

Tjønndal, A. (2017): Sport innovation: Developing a typology. European Journal for Sport and Society, 14(4), 291-310.

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**THE SOCIAL, COMMUNITY, AND SPORTING IMPACT OF MEDIUM AND SMALL-SIZED SPORTS EVENTS: EVIDENCE FROM THE ITALIAN NATIONAL UNIVERSITY CHAMPIONSHIPS**

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*UNIVERSITY OF CASSINO AND SOUTHERN LAZIO*

INTRODUCTION: Medium and small-sized sports events promote community engagement, social cohesion, and local economic benefits. While large-scale events like the Olympics receive extensive attention, smaller events remain underexplored despite their socio-economic potential. This study examines the 2022 Italian National University Championships (CNU), which attracted 2500 university athletes, assessing its influence on local spectators sense of belonging, community pride, motivation to be physically active, and satisfaction.

METHODS: A structured questionnaire was administered to 221 local spectators, measuring variables such as service satisfaction, community pride, motivation to be physically active, and sense of belonging. Correlation and regression analyses identified key predictors of community connection and engagement.

RESULTS: Higher satisfaction with event services correlated with overall satisfaction ($r = 0.511$, $p < 0.01$), while excitement for competitions also positively influenced satisfaction ($r = 0.598$, $p < 0.01$). Sense of belonging was strongly associated with event satisfaction ($r = 0.551$, $p < 0.01$) and community pride ($r = 0.548$, $p < 0.01$). Attending the event as spectators motivated individuals to be more physically active, indicating a positive sporting impact. Negative experiences ($r = -0.261$, $p < 0.05$) reduced satisfaction, but the association with logistical difficulties was weak ($r = -0.091$). Regression analysis confirmed pride in the host city as a significant predictor of belonging (Coef. = 0.238, $p = 0.046$), while motivation to engage in future community events emerged as the strongest factor (Coef. = 0.592, $p = 0.000$). Security concerns also positively influenced belonging (Coef. = 0.388, $p = 0.012$), while environmental concerns had an adverse effect (Coef. = -0.446, $p = 0.009$).

Discussion and CONCLUSION: The findings of this study reinforce the idea that medium and small-scale sports events, when effectively managed, can have lasting positive social impacts, particularly in terms of community engagement, sporting impact and pride. Satisfaction with event logistics and participants perceptions of security measures enhanced personal enjoyment and level of engagement. Managing negative effects and controlling undesirable impacts, such as environmental concerns and disruptions, is crucial to maintaining benefits. Future studies should continue exploring how different types of stakeholders perceive social impacts, how strategies can be developed to maximize the positive outcomes and the role of sustainable practices in maximizing social and environmental benefits.

Our findings offer valuable insights for event organizers, policymakers, and stakeholders seeking to optimize sports events for community and social development minimizing dissatisfaction and promoting environmentally sustainable practices.

**THE PHENOMENON OF ABUSE IN HUNGARIAN SPORTS THROUGH COACHES' EXPERIENCES**

SZEKERES, D.1, NOVÁK, J.2, DÓCZI-VÁMOS, G.2, SOÓS, I.3

*HUNGARIAN UNIVERSITY OF SPORTS SCIENCE*

Diána Szekeres, János Novák, Gabriella Dóczi-Vámos, István Soós:The Phenomenon of Abuse in Hungarian Sports Through Coaches' Experiences

INTRODUCTION: The topic of child protection in the Hungarian sports world has only come into focus in recent years due to changes in the social environment and the unresolved scandals that have come to light. Since 2017 January 1st, all national sports federations in Hungary are required to implement an ethics and child protection code. In 2022, a comprehensive project titled "Child, Youth, and Professional Protection in Sports" was launched, aiming to understand Hungarian sports culture and the sports family through a multidisciplinary approach.

METHODS: The research project, which incorporates sociological, legal, pedagogical, and psychological aspects, attempted to identify the social, organizational, and individual risk factors of becoming a victim. This presentation shows the experiences of the primary data collection phase of the project, derived from a survey conducted among coaches, with a particular focus on the different forms of abuse. Responses were collected from 64 sports, at different levels of sport, from various age groups, both genders, and all counties in Hungary, resulting in the organization of responses from a total of

863 coaches. We examine the occurrence of abuse in four areas (neglect, emotional, physical, and sexual abuse (with and without contact), while also addressing certain issues that may negatively affect coaching work.

RESULTS: The survey results are presented according to the following dimensions: (1) coaches' perceptions as athletes and coaches of the occurrence of violent and abusive coaching differ, in fact, it is more subtle, (2) their knowledge of the child protection policy applicable to their sports federation as well as their organization is very low, the data show a lack of knowledge about child protection policies: 42% of respondents did not know if their sports organisation had such a policy, and 39% had no knowledge about the policies in place at the sports federations, and (3) their experiences, knowledge, and perceptions regarding problematic behaviors affecting young people range widely, with excessive phone use being the most common (81%), while various forms of abuse are also experienced by a relatively large number of coaches.

Conclusions

The findings indicate that the knowledge of Hungarian sports professionals in victimization, assistance and protection is inadequate, therefore, as the research highlights, there is an urgent need for developing abuse-prevention protocols, creating appropriate organizational cultures, and – most importantly – raising awareness and expanding knowledge of Hungarian sports professionals. The research significantly contributes to the development of the regulatory environment and the creation or updating of ethical codes and procedures for sports organizations.

## 17:00 - 18:15

## Oral Presentations

### OP-AP31 Team Sports VII - Talent Support and Youth Training

**TOWARDS FAIR FITNESS ASSESSMENT IN SOCCER: A GRADING FRAMEWORK INTEGRATING CHRONOLOGICAL AGE AND BIOLOGICAL MATURATION STATUS IN ELITE AUSTRIAN YOUTH PLAYERS**

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*1: DEPARTMENT OF SPORT AND EXERCISE SCIENCE, UNIVERSITY OF SALZBURG; 2: OLYMPIC TRAINING CENTER SALZBURG; 3: DEPARTMENT OF SCIENCE, ANALYSIS AND DEVELOPMENT, AUSTRIAN FOOTBALL ASSOCIATION*

INTRODUCTION: Normative reference values for fitness performance are widely used for talent identification and training monitoring in elite youth soccer. However, accurately interpreting performance metrics requires consideration of key developmental factors, particularly the relative age effect and maturation status (1). To ensure fair, individualized and developmentally appropriate fitness benchmarks for elite youth soccer players, we introduced and evaluated a 5-point scoring approach that factors in exact age and maturation, enabling consistent performance comparisons across tests and players.

METHODS: We analysed fitness test data from a sample of 2989 U13 and U14 players (12.4±0.6 yrs), selected nationwide into one of 29 accredited youth development centres between 2016 and 2023. Athletes completed an annual battery of 12 fitness tests (2), with their biological age estimated using the Mirwald equation. In a previous categorical framework, norm values ranging from 0 to 5 points were calculated using SD ranges around the mean and identical norms within the same birth year. In contrast, the new approach uses the same point scale but assigns individualized norms for each birth date by accounting for the relationship between test performance and both chronological and biological age.

RESULTS: Across fitness tests, the BIC and AIC criteria identified linear regressions as the best fit for capturing the relationship between test performance and both chronological and biological age. Biological age was more strongly linked to fitness gains than chronological age with medium effects in running speed tests ($r^2$=.099-.175; p<.001; BF10>100; 0.41-0.55 SDs per yr), CMJs and multiple-choice RT ($r^2$=.097-.105; p<.001; BF10>100; 0.42-0.43 SDs per yr) as well as large effects in medicine ball throw ($r^2$=.479; p<.001; BF10>100; 0.91 SDs per yr). As intended, mean scores did not differ between the two grading approaches (d<0.191). However, individual-level variations were evident, with 16.4% of players exhibiting changes of 1-2 points, 1.2% of 2-3 points, and 0.2% of even 3-4 points in the ball throw.

CONCLUSION: Our results revealed a substantial fitness development in U13 and U14 elite youth soccer players in 8 out of 12 tests, which are particularly influenced by anthropometric and power changes, whereas elementary speed, coordination and flexibility hardly improved. Given that the relative age effect is most pronounced at ages 12-14, our findings highlight the importance of considering both exact age and maturation when evaluating and interpreting fitness performance metrics in this age group. By accounting for both factors and maintaining overall comparability, our revised scoring approach introduced meaningful individual-level variability, emphasizing the need for tailored fitness benchmarks to ensure fair and developmentally appropriate assessments in elite youth soccer.

REFERENCES:

1 Sweeney & Lundberg, Sci Med Footb, 2014

2 Gonaus & Müller, J Sports Sci, 2012

**DIFFERENCES IN GAME-BASED PERFORMANCE BY PLAYING POSITION IN YOUNG ELITE MALE TEAM HANDBALL PLAYERS**

WAGNER, H., RADIC, V., HINZ, M.
*UNIVERSITY OF SALZBURG*

INTRODUCTION: In male team handball, different playing positions have specific physical demands due to their tactical roles. Backcourt players (backs) rely on physical strength for one-on-one situations and perform long-distance throws. Wing players (wings) focus on speed for fast breaks and jumping from wide angles for better throwing positions. Pivots face the most physical contact with defenders and require high aerobic capacities. Previous studies have shown that general physical performance (e.g., strength and power) and match performance (e.g., heart rate, game statistics, or position tracking data) differ across playing positions. However, game-based physical performance has not been analyzed, although this is crucial for training young elite players to reach a world-class level based on their specific positions. Consequently, the aim of this study was to analyze game-based performance in young elite male team handball players based on their playing positions.

METHODS: Forty-eight young elite male team handball players (age: 17.5 ± 1.9 years, body weight: 82.5 ± 9.9 kg, body height: 1.86 ± 0.05m), including 23 backs, 17 wings and 8 pivots participated in the study. All players trained 7–8 sessions per week at an elite team handball academy and competed at the highest international level for their age group. To determine specific physical performance, all participants performed the team handball game-based performance test. A one-way ANOVA was used to compare the performance differences among backs, wings and pivots.

RESULTS: Significant differences between playing positions ($P < 0.05$) were found in peak oxygen uptake, heart rate, fast break and offense time, jump height during the jump shot, and body mass. Wings showed the best performance in fast break (1.78 ± 0.08 s), offense time (5.74 ± 0.19 s), jump height during the jump shot (0.39 ± 0.06 m), and peak oxygen uptake (72.4 ± 8.4 ml/kg/min). Backs performed best in ball velocity during the jump shot (25.1 ± 1.5 m/s), while pivots had the highest body weight (90.5 ± 14.1 kg).

CONCLUSION: As expected, pivots were the heaviest due to facing the most physical contact with defenders during matches. Wings were the fastest on the court and jumped the highest, while backs demonstrated the highest throwing velocities, as they frequently perform long-distance throws during games. However, the high levels of peak oxygen uptake for wings and backs (around 70 ml/kg/min) and pivots (around 60 ml/kg/min), along with no significant differences in defense time between positions, highlight the importance of both aerobic and anaerobic performance for all players to maintain an active and dynamic defense throughout the entire match. We suggest implementing a selective position-specific strength and power training program, while also incorporating a balanced position-independent high-intensity on-court training, for young elite male team handball players to reach a world-class level.

**PERFORMANCE AND BODY COMPOSITION EVALUATION DURING 1 YEAR OF YOUNG ELITE FOOTBALL PLAYERS IN MALTA NATIONAL TEAM**

GRIMALDI, A., PETRELLI, A., PANZETT, W., ATTARD, K., FENECH, D., FARRUGIA, E., STRAFACE, N., CIONE, E., CANNATARO, R.
*UNIVERSITÀ DELLA CALABRIA*

INTRODUCTION: The attention and care of youth sectors have been growing in recent years; on the other hand, especially in the younger age groups, it is important to ensure adequate support for the physiological development of the boys; there are no standardized evaluation protocols; in our work, we report the work carried out with the Maltese national team, which supervises young footballers throughout the year, even if they play and train with their club teams.

METHODS: The sprint test was performed on artificial turf using three timing gates. A target marker was positioned 3 m beyond the final timing gate. The best performance was recorded for each distance. The 30-15 Intermittent Fitness Test was conducted on artificial turf following the official protocol outlined on the test's website. Countermovement jump height, CMJ-modified reactive strength index, and multi-rebound performance were assessed using force plates. The best of two trials was recorded. For the Triple Hop Test for distance, participants executed a rapid countermovement followed by three consecutive forward hops, landing on both feet after the final jump. The jump distance was measured from the starting line to the heel of the closest foot upon landing. Bioimpedance analysis was performed with BIA101 Anniversary (Akern Srl, Florence, Italy) and an ultrasound device (BX2000, IntelaMetrix, Brentwood, CA, USA) to determine the thickness of subcutaneous fat.

RESULTS: Sprint performance (10m: U15: 1.91 ± 0.09 s, U16: 1.88 ± 0.10 s, U17: 1.84 ± 0.09 s, U18: 1.84 ± 0.09 s; 30m: U15: 4.58 ± 0.23 s, U16: 4.45 ± 0.20 s, U17: 4.31 ± 0.17 s, U18: 4.33 ± 0.16 s), endurance using the 30-15 Intermittent Fitness Test (VIFT: U15: 19.56 ± 0.93 km/h, U16: 19.96 ± 0.81 km/h, U17: 19.87 ± 1.10 km/h, U18: 19.78 ± 0.86 km/h), CMJ modified reactive strength index (U15: 0.51 ± 0.08 m/s, U16: 0.51 ± 0.09 m/s, U17: 0.56 ± 0.07 m/s, U18: 0.62 ± 0.11 m/s), CMJ jump height (U15: 32.40 ± 4.73 cm, U16: 33.66 ± 4.09 cm, U17: 35.79 ± 4.04 cm, U18: 36.90 ± 5.01 cm), multi-rebound reactive strength index (U15: 1.96 ± 0.38 cm/ms, U16: 1.99 ± 0.30 cm/ms, U17: 2.29 ± 0.33 cm/ms, U18: 2.20 ± 0.37 cm/ms), triple hop test for distance (average distance: U15: 5.79 ± 0.69 m, U16: 6.06 ± 0.48 m, U17: 6.43 ± 0.37 m, U18: 6.56 ± 0.56 m), Levi Mass Index (U15: 2.28 ± 0.53 kg/m², U16: 2.60 ± 0.50 kg/m², U17: 2.76 ± 0.48 kg/m², U18: 3.04 ± 0.47 kg/m²), and phase angle (U15: 6.59 ± 0.72°, U16: 7.04 ± 0.76°, U17: 7.39 ± 0.73°, U18: 7.77 ± 0.63°).

CONCLUSION: Results revealed a consistent improvement in speed, reactive strength, and lean mass with increasing age, reflecting the combined effects of natural physical development and training adaptations. It is concluded that football training can support the physiological growth of young people, specifically due to the combination of the support of the

national team and club teams. These findings provide benchmarks for talent identification and offer insights into the progression of physical development.

**THE RELATIVE AGE EFFECT IN YOUTH FEMALE ACADEMY ATHLETES: IS THERE A DIFFERENCE BETWEEN TEAM AND INDIVIDUAL SPORTS?**

VELENTZA, E., MARIDAKI, M., TSOLAKIS, C., APOSTOLIDIS, N.
*NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS*

INTRODUCTION: Relative age effect (RAE) refers to those (dis)advantages and outcomes that result from the age differences between athletes born in the same year but different birth months [1]. Research supports that in male sport academy level RAE is present [2], however limited data are available in female sport academy level, and specific to team and individual sports, with recent research presenting the highest level of RAE risk in female preadolescent (≤ 11 years) and adolescent (12-14 years) age categories, but a moderate-to-high heterogeneity in competitive and representative level [3]. Therefore, the objective of this study was to further investigate the RAE difference between team and individual sports in female academy athletes aged 9-12 years old related to athletic performance.

METHODS: A total of 370 female academy athletes born between the years 2010 and 2013 were collected and analysed from team (n =104, basketball, volleyball, handball) and individual (n =266, gymnastics, track and field, fencing, judo, swimming) sports. The athletes were 9 (n =160), 10 (n =102), 11 (n =94), and 12 (n =114) years old. Univariate analysis was used to investigate the differences, as well as the effect sizes expressed as partial eta-squared. Speed (20m) and power (medicine ball throw 1kg, (MB1kg); jump and reach test, (JR)) assessments were analysed by birth quartiles, year of birth and type of sport.

RESULTS: The univariate analysis demonstrated significant difference for individual sports at the age of 9 years old (born 2013) in 20m ($F = 3.656$, $p = .013$, $\eta 2 = .023$), and specifically between Q1 (M 3.97 ±0.72) vs. Q4 (M 4.25 ±0.65, $p = .031$). There were no other differences between team and individual sports related to 20m. Related JR, one significant difference was observed between team and individual sports, and specifically at Q1 (16.75 ±3.32 vs. 29.91 ±1.38, respectively, $F = 13.409$, $p < .001$, $\eta 2 = .028$). In MB1kg there were significant differences in individual sports at the age of 12 years old (born 2010) ($F = 8.163$. $p < .001$, $\eta 2 = .037$) and specifically between Q2 (349.17 ±22.05) and Q3 (336.25 ±26.99) vs. Q4 (453.46 ±21.18, $p = .002$ and $p = .002$, respectively). Further differences were found between team and individual sports at the Q2 ($F = 4.324$, $p = .038$, $\eta 2 = .010$; 415.45 ±63.93 vs. 349.17 ±81.40, respectively) and Q3 ($F = 5.627$, $p = .018$, $\eta 2 = .013$; 430.00 ±75.50 vs. 336.35 ±85.35, respectively).

CONCLUSION: The novel finding of this research was that academy female athletes, who participated in individual sports revealed better performance in JR test at the age of 9 and lesser performance in MB1kg at the age of 12, compared to team sports.

Moreover, at the age of 9 years old female athletes born in Q1 revealed better performances in speed compared to Q4, as well as at the age of 12 years old female athletes born in Q2 and Q3 achieved higher performances in MB1kg compared to Q4. All differences demonstrated small effect size.

1.Brustio et al. (2021) 2. Hill et al. (2020) 3. Smith et al. (2018)

**STRENGTH TRAINING FREQUENCY AFFECTS EXPLOSIVE STRENGTH AND REPEATED SPRINT ABILITY BUT NOT MUSCLE GROWTH OR MAXIMAL STRENGTH IN WELL-TRAINED JUNIOR FOOTBALL PLAYERS**

HAMARSLAND, H., MOEN, H., MØLMEN, K.S., RØNNESTAD, B.R.
*UNIVERSITY OF INLAND NORWAY*

INTRODUCTION: Athletes in team sports must carefully balance and prioritise different types of exercise training to optimise adaptation, rest and performance. Heavy strength training is an effective method for enhancing muscular strength and physical performance in team sport athletes. However, the effects of different training strength frequencies with the same weekly training volume are underexplored in this population. This study examined the effects of higher versus lower strength training frequency on muscle growth, muscle strength, and physical performance during an 11-week intervention in well-trained junior football players.

METHODS: Thirty-four well-trained male junior football players (17.5 ± 1 years) completed an 11-week lower-body heavy resistance training program. Players were randomised to a high-frequency group (HF: 32.1±2.4 sessions) or a low-frequency group (LF: 15.9±0.9 sessions), with both groups maintaining the same weekly strength training volume. The program consisted of nine lower-body exercises with loads ranging from 5-10 repetition maximum (RM). Vastus Lateralis muscle thickness was assessed using ultrasound, while muscular strength and performance were measured using a 1RM trap bar deadlift, counter movement jump (CMJ) on a force plate, 40-meter sprint, and 6x30-meter repeated sprint tests. Group differences were analysed using ANCOVA, adjusted for baseline differences.

RESULTS: No significant group differences were observed for 1RM trap bar deadlift (HF: 11.9 ± 5.2%, LF: 12.2±10.3%, p=0.959, ES=0.04) or muscle thickness of the vastus lateralis (HF: 9.1 ± 6.4%, LF: 6.9±7.2%, p=0.345, ES=0.31). However, the HF group demonstrated greater improvement in CMJ than the LF group (9.1±13.5% vs. 0.9±7.6%, p=0.016, ES=0.75). The 40-meter sprint time had a numerical decrease in the HF group and an increase in the LF group, resulting in a group difference (HF: -0.47±2.1%, LF: 1.2±2.2%, p=0.016, ES=0.72). The LF group demonstrated enhanced fatigue resistance, as indicated by an improved maintenance of speed from the first to the last 30-meter sprint compared to HF (HF: 34.3 ± 33.4%, LF: -13.6 ± 86.4%, p=0.03, ES=0.78).

CONCLUSION: Heavy strength training effectively increased 1RM trap bar deadlift and lvastus lateralis muscle thickness, with no differences between groups. However, the different training frequencies elicited distinct responses in some performance-related outcomes. Lower-frequency training enhanced fatigue resistance, while higher frequency training improved rapid power production. These findings suggest that training frequency can be tailored to target specific training goals in well-trained male junior football players.

## Oral Presentations

### OP-AP30 Running III - Applied Physiology

**THE PHYSIOLOGICAL DETERMINANTS OF SUCCESSFUL MIDDLE-DISTANCE RUNNING PERFORMANCE**

OSBORNE, R., WANGDI, J.T., KIRBY, B.S., BLACK, M.I., VANHATALO, A., JONES, A.M.
*UNIVERSITY OF EXETER*

INTRODUCTION: The physiological underpinnings of successful middle distance (MD) running performance have proven challenging to determine and quantify. This is a consequence of the heavy reliance on both the mitochondrial (aerobic system) and glycolytic and high-energy phosphate (anaerobic system) contributions to energy transfer. Furthermore, most of the previous research on MD running performance has been conducted with male athletes. Consequently, we sought to investigate the physiological variables associated with male and female 1500 m running performance, with the aim of producing a mathematical model which enables the prediction of 1500 m performance.

METHODS: Twenty-one (n = 11 male, 1500 m personal best: 242.9 ± 5.8 s; n = 10 female, 1500 m personal best: 267.4 ± 7.1 s) MD athletes completed one laboratory visit and six field-based track assessments. We collected data on over seventy variables in total. During the laboratory visit, an incremental step test was conducted to determine maximal oxygen uptake (VO2max), running economy (RE), lactate threshold (LT) and lactate turnpoint (LTP). The six field-based performance tests included: a 10 m maximal sprint speed (MSS) test; a 20 s maximal rate of lactate accumulation (VLamax) sprint test; and 2, 4, 6 and 12-minute time trials for estimation of critical speed and D'. The participants' 1500 m seasons best (1500SB) speed was the performance outcome. Pearson's correlation and stepwise multiple linear regression were conducted to assess the strength of the relationship between the physiological and performance outcomes with 1500SB.

RESULTS: The mean VO2max, RE, LT and LTP were 65.5 ± 5.2 mL·kg−1·min−1 (male), 62.9 ± 4.8 mL·kg−1·min−1 (female), 221 ± 17 mL·kg−1·km−1, 14.5 ± 1.0 km·h−1 and 16.8 ± 1.2 km·h−1, respectively. CS was 4.8 ± 0.3 m·s−1 and D' was 161 ± 40 m. MSS and 20 s sprint speed were 8.0 ± 0.6 m·s−1 and 7.3 ± 0.5 m·s−1 , respectively. 20 s sprint speed had the strongest correlation with 1500SB ($r^2 = 0.76$, $P < 0.001$). The fitted regression model was: 1500SB (m·s−1) = .43 (20 s sprint speed) + .144 (LTP) + 0.335. The model explained 81.9% of variance in 1500SB ($F(2,14) = 37.11$, $P < 0.001$). Mean 20 s sprint speed (m·s−1) and LTP (km·h−1) were both significant predictors in the model (20 s sprint speed: $t = 5.88$, $P < 0.001$; LTP: $t = 4.87$, $P < 0.001$).

CONCLUSION: These findings indicate that 20 s sprint speed (m·s−1), and LTP (km·h−1) are the two most important physiological determinants of 1500 m running performance. These two variables incorporate both the aerobic and anaerobic contribution to energy transfer, highlighting that for successful MD performance, it is imperative that athletes train to improve energy transfer from all three energy systems (mitochondrial, glycolytic and high-energy phosphate).

**PHYSIOLOGICAL CHANGES AT THE MODERATE-TO-HEAVY INTENSITY TRANSITION AND 5-MIN TIME-TRIAL PERFORMANCE DECLINE IN RUNNING AFTER PROLONGED CYCLING**

FUK, A., VILLANOVA, S., QUAGLIAROTTI, C., FILIPAS, L., GALLO, G., GRAMAZIO, A., DELLO STRITTO, E., BAZZUCCHI, I., CONTI, A., LAMBERTS, R.P., PIACENTINI, M.F.
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INTRODUCTION: Long-distance triathlons are ultra-endurance multisport events that require sustaining high training volumes in the "moderate-to-heavy" intensity domain (MTHID)1. Recently, the concept of durability, defined as the time of onset and magnitude of physiological decline over time during prolonged exercise, has been studied in isolated cycling and running activities2. However, changes in running profiling when transitioning from prolonged cycling have yet to be studied. The aim of this study was to evaluate physiological changes while running at the MTHID after prolonged cycling and changes in performance during a 5-min time trial (TT) to better understand specific training and racing demands.

METHODS: Seven trained male triathletes (age: 36±8 y, relative VO2max: 61.7±4.9 ml·kg-1·min-1) completed two running tests on separate days, one performed in a "fresh" (FRE) and one in "fatigued" (FAT) condition. Fatigue was induced by performing a prolonged 150-min indoor cycling at 90% of LT1 power. The testing protocol was a submaximal incremental test on a treadmill with 5-min steps until the second lactate threshold (LT2), followed by an outdoor all-out 5-min TT. VO2, respiratory exchange ratio (RER), ventilation (VE), respiratory frequency (RF), HR, BLa and RPE were determined during the steps below (UNDER) and just above (OVER) the LT1FRE and compared to the same speed in the FAT condition. In addition, distance completed during the 5-min TT were compared between the conditions. Due to the small sample size, data were analyzed with a Wilcoxon signed rank test ($p < 0.05$) and presented as median (interquartile range).

RESULTS: Differences in both the UNDER and OVER period between the FRE and FAT condition were found in VO2 [UNDER: VO2FRE: 45.3(42.0-46.8) vs VO2FAT: 47.5(46.1-53.2) p=0.02; OVER: VO2FRE 47.7(46.3-51.2) vs VO2FAT 52.0(47.8-55.1) ml·kg-1·min-1; p=0.02], HR [UNDER: HRFRE 153(142-154) vs HRFAT 157(147-161); p= 0.02; OVER: HRFRE:160(150-163) vs HRFAT:163(153-168) bpm; p=0.02], BLa [UNDER: BLaFRE 1.6(1.5-1.7) vs BLaFAT 2.2(2.2-2.6); p=0.02; OVER: BLaFRE 2.1(1.9.-2.2) vs BLaFAT 2.4(2.2-2.8) mmol·L-1; p=0.02] and RER [UNDER: RERFRE 0.92(0.88-0.95) vs RERFAT 0.84 (0.83-0.87); p=0.04; OVER: RERFRE 0.92(0.90-0.96) vs RERFAT 0.87(0.84-0.89); p=0.02] Total distance covered during the 5-min TT, was less in the FAT condition [FRE:1483(1405-1538) vs FAT:1406(1374-1500) m; p=0.02].

CONCLUSION: Induced fatigued, resulted in higher VO2 costs, HR and BLa levels, with lower RER levels in data UNDER and OVER LT1 during a standardized submaximal test. In addition, the mean distance covered during a 5-min TT was lower in the FAT condition. These findings indicate that physiological markers change with increasing levels of accumulating fatigue, which should be considered when prescribing training and determining racing strategies in triathlons.

**NEUROMUSCULAR CONTRIBUTIONS TO RUNNING STRIDE MECHANICS: ASSOCIATIONS BETWEEN STRENGTH, POWER, AND BIOMECHANICAL PARAMETERS IN WELL-TRAINED RUNNERS**

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*POINT LOMA NAZARENE UNIVERSITY*

INTRODUCTION: Modifiable stride components—ground contact time (GCT), ground reaction force (GRF), flight time (FT), and stride frequency (SF)—substantially influence running economy. Less is known about how these parameters are related to force-time characteristics of dynamic movements like the countermovement vertical jump (CMJ) or isometric tests like the isometric mid-thigh pull (IMTP). This exploratory study examined the associations between neuromuscular performance measures and running stride parameters at three individualized paces in well-trained male and female runners.

METHODS: Stride parameters were assessed via a validated 2D video app [1] as participants (N = 16, age = 34.6 ± 5.7y, height = 171.7 ± 9.4 cm, mass = 66.5 ± 11.5 kg, $VO_2$max = 58.8 ± 5.6 ml·kg$^{-1}$·min$^{-1}$, 10 males, 6 females) ran on a treadmill at 3 stages (warm-up, easy aerobic, and half-marathon pace, individualized based on recent race performance). On a separate day, CMJ and IMTP tests were completed on force plates.

RESULTS: MANOVA revealed a significant multivariate effect of pace (Wilks' $\Lambda = 0.517$, $F(10,82) = 3.205$, $p < 0.001$), with GCT decreasing from stage 1 to 3 (diff = –0.044, $p < 0.001$) and stage 2 to 3 (diff = –0.031, $p = 0.0025$), while relative GRF increased from stage 1 to 3 (diff = 0.3023, $p = 0.0049$). FT, SF, and VO did not change significantly ($p > 0.06$). Correlational analysis revealed that GCT positively correlated with rate of force development (RFD) ($r = 0.29$–$0.40$) and concentric impulse ($r \approx 0.28$), while FT correlated with normalized peak force (PF) ($r = 0.39$–$0.54$). SF correlated inversely with force and impulse measures (up to $r = -0.64$), whereas VO correlated positively with force production metrics ($r \approx 0.46$–$0.56$).

CONCLUSION: Neuromuscular contributions to running mechanics arise from the interplay between lower-limb force, impulse, and stride parameters. Force, impulse, and RFD metrics are moderately associated with reduced GCT and enhanced relative GRF, demonstrating the neuromuscular system's role in optimizing the GRF/GCT relationship. In particular, the inverse association between SF and impulse measures indicates how efficient neuromuscular function supports more economical running mechanics, though this may be confounded by athlete height, as taller runners with greater mass tend to generate larger impulse values and longer legs may influence flight times. Together, these results indicate that power, force, and impulse capacities are associated with and may influence biomechanical factors related to running economy. Future research should further delineate these relationships by employing longitudinal studies to investigate causal links between targeted strength, power, and plyometric training and subsequent changes in stride characteristics over time.

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**EFFECTS OF DIFFERENT SHOCK-ABSORBING MIDSOLES ON KNEE BIOMECHANICS DURING SINGLE-LEG LANDING IN RECREATIONAL RUNNERS**

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*UNIVERSITY OF TAIPEI*

INTRODUCTION: Single-leg landing is a common yet challenging movement requiring appropriate knee force distribution. Footwear design can substantially influence lower-limb biomechanics by modulating impact absorption and muscular stabilization strategies [1,2]. Prior research has shown that variations in shoe cushioning and support can alter landing mechanics, affecting both injury risk and performance. However, there remains a need to systematically examine how barefoot (Bare), casual (Casual), and sports (Sports) footwear differ in their effects on knee angles, flexion moments, and vertical ground reaction force (vGRF) during single-leg landing.

METHODS: Six participants (3 males, age 24.0 ± 4.36 y; 3 females, age 23.7 ± 4.7 y), with no lower-limb injuries in the past six months, performed single-leg landings under three conditions: Bare (no shoes), Casual (shoes not meeting ≥ 50% shock absorption or ≥ 15 N/degree torsional rigidity), and Sports (meeting or exceeding these criteria). Kinematic data were recorded via a Vicon motion capture system (Vicon Motion Systems, Oxford, UK), and vGRF was measured using an AMTI force platform (AMTI, Watertown, MA, USA). A one-way repeated-measures ANOVA was used to assess differences

in knee angles (°), knee flexion moments (N·m), and vGRF (N) among the three footwear conditions. Where main effects were significant, Bonferroni-corrected post hoc tests were conducted ($\alpha = 0.05$).

RESULTS: Mean ± SD values indicated that the Sports condition produced significantly higher knee angles (62.50 ± 17.21°) than the Bare condition (57.83 ± 15.94°, $p < .05$), while Casual (60.67 ± 17.03°) did not differ significantly from either. Although knee flexion moments were numerically greater in Sports (1,722.00 ± 1,321.60 N·m) versus Bare (594.50 ± 157.10 N·m) and Casual (1,288.50 ± 1,025.00 N·m), variability among participants led to a non-significant overall effect ($p = .06$). Vertical ground reaction forces were significantly higher in Bare (2,015.33 ± 452.80 N) than in both Casual (1,753.50 ± 431.10 N) and Sports (1,741.67 ± 536.50 N, $p < .05$), suggesting that additional cushioning helps mitigate landing impact.

CONCLUSION: These findings demonstrate that footwear with enhanced shock absorption (Sports) can reduce impact forces and influence knee joint loading, potentially lowering the risk of landing-related injuries. While higher knee flexion moments in the Sports condition did not reach statistical significance, this trend may indicate greater muscular activation for joint stabilization [3]. Additionally, the increased knee angles observed with Sports footwear may facilitate improved force distribution across the lower limb [4]. Future research with larger samples and more diverse movement tasks is warranted to clarify how variations in shoe design can optimize both performance and injury prevention strategies.

**EFFECTS OF RUNNING SPEED AND ADVANCED FOOTWEAR TECHNOLOGY ON RUNNING ECONOMY IN NATIONAL TEAM TRIATHLETES AND HIGH-LEVEL RUNNERS**

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*SWISS FEDERAL INSTITUTE OF SPORT MAGGLINGEN: EIDGENOSSISCHE HOCHSCHULE FUR SPORT*

INTRODUCTION: Since its introduction in 2016, Advanced Footwear Technology (AFT) has played a crucial role in enhancing running economy (RE), contributing to recent faster times in elite running performance. While the effects of AFT on RE are increasingly well-documented, the degree of interindividual variability remains unclear. This is highly relevant for athletes looking to optimize their footwear selection. Thus, the aim of this athlete-driven applied study was twofold: first, to assess the potential benefits of AFT over standard footwear for individual athletes, and second, to determine whether a detectable difference RE exists between two AFT models.

METHODS: Eleven athletes (age 27.3 ± 6.5 years), including four national-team triathletes (2 males, 2 females) and seven high-level male runners completed a standardized treadmill protocol on two testing days to assess RE at three different running speed (RS) (stage 1, stage 2 and stage 3) while wearing a control shoe (CON) without a carbon plate and two AFT models (AFT 1 and AFT 2). The specific brand and model of each shoe was selected by the athletes. Following a 10-min warmup, the test session consisted of three 5-min running intervals (one per shoe), interspersed with a 5-min standing passive recovery (to allow for shoe change) at 12, 14, 16 km/h (n = 4), or 14, 16 and 18 km/h (n = 7) depending on sex and performance level. The shoe order was randomized and mirrored on the second day, while stage speeds were reversed in descending order. Gas exchange using the Douglas bag method and heart rate (HR) were measured in the last 60 s of each stage. Blood lactate (BLA) was measured between the stages. The data of both days were averaged for analysis.

RESULTS: A total of 21 shoe models (8 CON, 13 AFT) were tested. Regardless of shoe type, higher RS increased RE ($p=.02$). For CON, RE at stage 1 was 183.9±9.2 ml/kg/km, increasing by 4.1±1.2 ml/kg/km at stage 2 ($p=.002$) and by 12.2±1.2 ml/kg/km at stage 3 ($p<.001$). Shoe type significantly influenced RE, with both AFT models consistently lowering RE compared to CON. Overall, AFT shoes led to a 3.5±5.4% improvement ($p<.001$). Specifically, compared to CON, AFT1 reduced RE by -3.2±0.9% at stage 1, -3.7±1.0% at stage 2, and -3.9±0.9% at stage 3, while AFT2 reduced RE by -2.7±1.1%, -3.7±1.0%, and -4.2±1.0%, respectively. No significant differences were observed between AFT models ($p=.417$) or in the interaction between shoe type and RS ($p>.05$). Individual differences accounted for 91% of the total variance in RE (ICC=.91). HR response aligned with RE changes, while no differences in BLA were observed between shoes.

CONCLUSION: These findings confirm previous research that increasing RS worsens RE, while AFT models enhance it. The measurable differences observed between AFT were minimal, and the lack of statistical significance suggests a uniform effect across AFT models. However, the large interindividual variability in responses highlights the necessity of a personalized approach to footwear selection.

## Invited Symposium

### IS-MH07 Emerging perspectives in exercise oncology: insights from exercise-induced cancer suppression to pragmatic implementation Exercise Oncology: New Insights

**EXERCISE MEDICINE AS NEOADJUVANT, ADJUVANT, REHABILITATIVE AND PALLIATIVE THERAPY IN CANCER MANAGEMENT**

ROBERT, N.

*EDITH COWAN UNIVERSITY*

Exercise has been demonstrated to be an effective medicine across the cancer spectrum from initial diagnosis through to palliative and end-of-life care. In this setting it is termed "exercise oncology". As a neoadjuvant therapy, exercise medicine is highly beneficial in preparing the patient physically and psychologically for the primary cancer treatment. Improving

physical fitness, body composition, and overall resilience positions the patient much more favorably to tolerate surgery, chemo, or radiation therapy. The most common application is exercise medicine neoadjuvant to surgery where it has been demonstrated to reduce adverse events during the operation, reduce surgical complications, reduce length of hospital stay, and facilitate recovery. When implemented adjuvant to chemotherapy or radiation therapy, exercise medicine ameliorates side-effects and is increasingly being demonstrated to enhance the effectiveness of the primary therapy through a range of mechanisms. For chemotherapy, exercise increases perfusion through the tumors delivering more chemotherapy to cancer cells. Acute and chronic exercise enhances radiation therapy effectiveness by reducing hypoxia, facilitating the oxygen enhancement effect and innate immune response. On completion of the cancer treatment exercise medicine is used extensively to rehabilitate the patient, facilitating recovery, increasing physical fitness and improving body composition while also reducing the risk of onset of other chronic diseases. In the long-term, ongoing exercise is critical for reducing the risk of cancer recurrence, by creating a more cancer suppressive environment through cytokine signaling and increased immune cell concentration and surveillance, as well as reducing risk of other diseases such as cardiovascular and metabolic that can arise due to prior cancer treatments. For patients with incurable cancer, exercise medicine has an important role through to end of life by slowing decline in physical function, quality of life, and mental health with emerging research being reported as causative extension of survival. In this presentation we will explore all these quite amazing aspects of exercise medicine in the management of patients with cancer. Medical doctors, oncologists, nurses, clinical exercise physiologists, physiotherapists, fitness professionals, patients and carers will find this presentation of interest as it will create an understanding of the critical role of exercise medicine for all people going through a cancer journey.

**TOWARDS OPTIMAL DOSE AND TYPE OF EXERCISE FOR CANCER CARE: INSIGHTS FROM MOLECULAR MECHANISMS**

NATALUCCI, V.

*UNIVERSITY OF MILAN*

To maintain cellular homeostasis, cells must reside in an optimal environment, have the capacity to sense surrounding signals, and respond to these cues precisely. In cancer, however, this balance is disrupted, and communication between healthy and malignant cells no longer conforms to normal regulatory mechanisms. Cancer progression is frequently driven by the dysregulation of multiple cellular pathways, where dysfunctions across various molecular circuits facilitate malignant transformation. Efforts to counteract these processes often impact multiple cellular pathways, highlighting the complexity of targeting cancer biology. Within this intricate landscape and in an era marked by precision oncology, cancer prevention strategies have evolved to address the multifaceted process of carcinogenesis. Recently, these strategies have broadened to integrate exercise medicine and nutritional therapy throughout the continuum of cancer care. These approaches aim to reduce cancer incidence and inhibit tumor progression by addressing metabolic and cellular vulnerabilities in cancer. Exercise requires skeletal muscle to engage in "crosstalk" with other organs through voluntary contractions. This inter-organ communication induces biomechanical and metabolic adaptations in skeletal muscle, cardiac tissue, and adipose tissue, as well as systemic changes that have shown potential to modulate tumor biology and improve clinical outcomes. Both preclinical and clinical studies show that exercise-conditioned serum, derived from human subjects pre- and post-exercise, exhibits inhibitory effects on cancer cell growth (e.g., reducing proliferation and metastatic potential) and survival (e.g., diminishing cell viability), while also increasing cell death via apoptosis and necrosis across various tumor types. These findings underscore the therapeutic promise of exercise in oncology and its role in potentially improving patient outcomes. In both acute and chronic contexts, each component of exercise—defined by the FITT-VP principle (frequency, intensity, time, type, volume, and progression)—is essential for mediating the effects. Current evidence is that a single session of moderate-to-vigorous intensity aerobic exercise can exert suppressive effects on cancer cells and lead to significant increases in circulating bioactive factors. Conversely, in structured training programs (whether short-term or chronic), training volume appears to be a key factor in modulating cancer cell inhibition and altering circulating factors, regardless of the specific mode of exercise used. However, the question remains unanswered:

**HOW TO EFFECTIVELY IMPLEMENT EXERCISE AS A STRATEGY TO SUPPORT PATIENTS WITH CANCER IN THE REAL-WORLD SETTING?**

AVANCINI, A.

*UNIVERSITY OF VERONA*

Physical activity and exercise have been proven to confer several important benefits to patients with cancer. There is an inverse relationship between physical activity and mortality, and preclinical evidence supports these findings, highlighting how exercise may slow tumor progression. Beyond the possible impact on prognosis, exercise has been confirmed to be important supportive care during the cancer journey by optimizing patients' physical fitness, managing symptoms and treatment-related side effects, and enhancing effectiveness of other cancer treatments and quality of life. Several national and international scientific societies, including the American College of Sports Medicine, the American Cancer Society, and Exercise and Sports Science Australia, have proposed dedicated guidelines for exercise in cancer and strongly recommend avoiding inactivity and engaging in regular exercise. Despite the benefits and published guidelines, a large number of patients affected by cancer are insufficiently active. In this regard, a recent multicenter investigation conducted in Italy on 549 patients found that 92% did not reach a sufficient level of physical activity. Implementing exercise in oncology is far from simple. Patients themselves may face several obstacles in starting an exercise program, ranging from the adverse events or sequelae experienced during cancer treatment, such as fatigue, dyspnea, and loss of muscle mass, to non-health related issues, including lack of dedicated guidance from experienced experts, lack of family support and distance

from facilities. In addition, the scarce knowledge about the beneficial role of exercise and the confidence in its promotion by oncologists and healthcare professionals may negatively influence the adoption of physical activity or targeted exercise medicine among patients. In a multi-level view, even just the word cancer inspires fear among lay people, with more than half of the general population afraid of cancer more than other diseases. These cultural myths and beliefs have led patients with cancer to be stigmatized, isolated from social life, and should not perform activities such as exercise. In this presentation, we will explore all these challenging aspects, the barriers and facilitators concurring in an effective exercise implementation in the cancer context. Several stakeholders, including clinicians, exercise specialists, physiotherapists, oncologists, healthcare professionals, patients, and their caregivers, may find this presentation appealing.

## Oral Presentations

### OP-BM07 Neuromuscular Physiology III - Ageing

**NEUROMUSCULAR DETERMINANTS FOR THE DIFFERENCES IN POWER OF THE KNEE EXTENSOR MUSCLES IN YOUNG AND OLDER ADULTS**

JAMES, J., KERN, L., WRUCKE, D., KRONER, K., DOBRZYCKI, I., ZEPEDA, C., KLAMECKI, L., TOUANNAS, J., ACKLIE, P., HUNTER, S., SUNDBERG, C.

*MARQUETTE UNIVERSITY*

INTRODUCTION: Aging is accompanied by a progressive decline in skeletal muscle mass and function that leads to impaired mobility of older adults. Importantly, the ability to produce power is one of the strongest predictors of physical function with aging, and power declines at a greater rate than the loss in mass (~2-4%/yr vs. ~0.5-1%/yr) (1-2). These observations suggest factors such as impaired neural activation, altered intrinsic contractile properties, and/or the selective atrophy of the myosin heavy chain (MyHC) II muscle fibers may contribute to the more rapid decline in power relative to muscle mass. Thus, the aim of this study was to determine the primary factors responsible for the age-related decline in power.

METHODS: 10 young (23±3 yrs, 5 women) and 13 older adults (72±5 yrs, 7 women) performed maximal velocity contractions lifting a load that was 20% of the maximal voluntary isometric contraction to assess power of the knee extensors. Voluntary activation and contractile properties were measured with electrical stimulation. Biopsies were obtained from the vastus lateralis to assess fiber type distribution and proportional area with immunohistochemistry. Knee extensor muscle volume was quantified with MRI, and the fiber type specific volume was estimated as the product of fiber type proportional area and volume.

RESULTS: Power was ~46% lower in older (120±37W) compared to young (223±73W; p=0.001), while muscle volume was ~34% lower with age (1692±625 vs. 1123±302cm3; p=0.021). When power was normalized to muscle volume, specific power in older adults remained ~23% lower than young (p<0.001). Voluntary activation was near maximal in young (92±7%) and older adults (93±6%) and did not differ with age (p=0.95). In contrast, the involuntary electrically-evoked twitch (Qtw) was ~36% lower in older (49±14Nm) compared to young (76±24Nm) and closely associated with power (R2=0.91; p<0.001). MyHC I proportional area was greater in older adults (62±15% vs. 40±12%, p=.001), and MyHC II proportional area was lower with age (39±16% vs. 60±12%; p=0.002). The estimated volume of muscle composed of MyHC I did not differ with age (p=0.840), but MyHC II muscle volume was ~56% lower in older (458±242cm3) than young (1033±500cm3; p=0.006). Accordingly, there were strong associations between the estimated MyHC II muscle volume and both power (R2=0.77; p<0.001) and Qtw (R2=0.78; p<0.001). In contrast, there were only weak associations with MyHC I muscle volume and both power (R2=0.21; p=0.029) and Qtw (R2=0.24; p=0.019).

CONCLUSION: These preliminary data suggest that the greater age-related loss in power relative to muscle mass of the knee extensors is determined, at least in part, by the selective atrophy and/or loss of MyHC II fibers and that interventions should target fast fiber atrophy to help attenuate the loss of power with age.

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**CHANGES IN MOTOR UNIT PROPERTIES AFTER EIGHT WEEKS OF RESISTANCE TRAINING IN YOUNG AND OLDER ADULTS**

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INTRODUCTION: Aging is associated with a progressive decline in neuromuscular function, partly due to neural alterations, particularly affecting motor unit (MU) function and properties. In contrast, resistance training can enhance muscle force production and control by partially reversing age-related neural alterations at the MU level. Previous evidences in young and older adults have shown that short-term resistance training (< 6 weeks) increases MU discharge rate (MU DR), in turn mediating the early force gains. However, the time course of MU adaptations to longer resistance training interven-

tions remains elusive. This study aimed to investigate and compare the effects of an eight-week resistance training intervention on MU properties in young (YA) and older adults (OA).

METHODS: Eleven OA (age: 71.4±5.2 yr) and twelve YA (age: 23±2.4 yr) participated in an 8-week dynamic and progressive resistance training protocol. Measurements were taken at baseline (T0), after 4 weeks (T4), and at the end of the intervention (T8). During these sessions, participants performed maximal (MVF) isometric knee extensions and submaximal trapezoidal ramps (35, 50, 70% MVF). Simultaneously, high-density surface EMG signals muscle were recorded from vastus lateralis muscle and decomposed offline into individual MU spike trains. Training-induced changes in MU properties, including recruitment (MU RT), derecruitment (MU DERT) thresholds and average discharge rates (MU DR), were analyzed with generalized mixed-effects models. Repeated measure correlations were performed to assess the association between changes in MU DR and MVF.

RESULTS: Preliminary results revealed that, after the training protocol, MVF increased similarly in both YA and OA (time effect, $p < 0.001$). Specifically, MVF increased by ~10% between T0-T4 ($p < 0.001$), by ~9% between T4-T8 ($p < 0.001$), and by ~20% between T0 -T8 ($p < 0.001$). Similarly, MU DR increased after the training protocol (time effect, $p < 0.001$), but with a different time-course between OA and YA (time by group effect, $p = 0.008$). Specifically, MU DR increased between T0-T4 in both OA ($p = 0.039$) and YA ($p = 0.002$), but between T0-T8 in YA ($p < 0.001$) only. Interestingly, the initial changes (T0-T4) in MU DR were moderately associated with changes in MVF (rrm = 0.51, 95% CI [0.126, 0.763], $p = 0.013$). Conversely, no changes were observed in normalized MU RT (% MVF) and MU DERT after the training.

CONCLUSION: Eight weeks of resistance training increased MVF in both OA and YA, with comparable MU adaptations particularly during the first four weeks of training. Notably, the observed association between changes in MU DR and MVF emphasizes the similar early (< 4 weeks) adaptability of the nervous system to resistance training in OA and YA. However, the relative contribution of neural adaptations to muscle force production may diverge between OA and YA in the subsequent weeks of training.

**PERSISTENT INWARD CURRENT ALTERATIONS IN YOUNG AND OLDER ADULTS FOLLOWING BED REST AND RECOVERY**

MARTINO, G., KALC, M., SARTO, F., KRAMBERGER, M., FRANCHI, M.V., NARICI, M.V., PIŠOT, R., SIMUNIC, B., HOLOBAR, A., DE VITO, G.

*UNIVERSITY OF PADOVA*

INTRODUCTION: Bed rest represents a well-accepted model to study the effects of prolonged periods of muscle disuse due to injury, surgery, illness, hospitalization or spaceflight. Muscle disuse is primarily associated with a reduction in muscle mass and strength and, in addition to functional alterations of the peripheral nervous system, changes in central activation have been suggested to play an important role in the loss of muscle strength. We recently showed that persistent inward current (PIC), an intrinsic motoneuron property proportional to monoaminergic neuromodulatory input, is reduced after 10 days of lower limb suspension (1). However, our previous study did not consider that the decreased maximal voluntary contraction (MVC) after disuse leads to changes in the assessed torque profiles across time points, introducing a confounding factor in estimating changes in PICs. This study aims to assess PIC changes after prolonged bed rest followed by supervised recovery in young and older adults at matched torque profiles across time points.

METHODS: Nine young (YA, age 22±4) and 10 older (OA, 69±3) healthy males underwent 21 (BR21) and 10 days (BR10) of bed rest, respectively, followed by 21 days of endurance training (ET). High density surface electromyography (HDsEMG) was recorded from vastus lateralis muscle during isometric triangular contractions at 20% of pre bed rest (BR0) MVC. After decomposing motor unit (MU) firing rates from HDsEMG signals, PICs were estimated via paired motor unit (MU) technique (2) as the delta frequency (ΔF) of a lower threshold MU (control unit) at the time of recruitment and derecruitment of a higher threshold MU (test unit). Individual ΔF differences across time points were assessed using linear mixed models.

RESULTS: A total of 234 (58 at BR0, 74 at BR21 and 102 at RT) and 373 (111, 126 and 136) MUs were successfully decomposed from HDEMG signals for YA and OA groups, respectively. From the total MU pool, we identified 251 (37 at BR0, 51 at BR21 and 70 at RT) test units in YA and 284 (82, 98 and 104) test units in OA. In YA, ΔF values decreased at BR21 compared to BR0 ($p<0.001$) and were restored after RT compared to BR21 ($p<0.001$). Similarly, in OA ΔF values were lower at BR10 compared to BR0 ($p<0.002$) and RT ($p<0.03$).

CONCLUSION: This is the first study assessing the neuromodulatory contribution to force generation after prolonged bed rest in young and older individuals. Remarkably, even adopting the same torque profiles for the assessment, we found changes in PIC estimates across time points. These results further highlight the important role of neuromodulation in muscle force generating capacity following muscle disuse and its recovery through physical activity.

This study was cofinanced by the ARIS (project J5-4593 and programme P2-0041), the ASI (n.2024-5-E.0 - CUP n.I53D24000060005) and the MUR (PRIN 2022 PNRR, 'ReActiveAge', project P2022FNCPR).

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**IN VIVO AND EX VIVO SKELETAL MUSCLE CHARACTERISTICS OF THE NEW—OVER 90 YEARS OF AGE— FEMALE WORLD RECORD HOLDER IN THE 200M SPRINT: A CASE REPORT**

COLOSIO, M., DOBRZYCKI, I., TEIGEN, L.E., PILOTTO, A.M., ANSALDO, M., GATTI, M., BRUSCO, C.M., PELLEGRINO, M.A., BOTTINELLI, R., FRANCHI, M.V., PORCELLI, S., SUNDBERG, C.W.
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INTRODUCTION: We had the unique opportunity to test the 91-year-old female that set the W90+ world record (WRW) in the 200m sprint last year, with a time of 51.47s, which was 1.48s faster than the previous record. We aimed to characterize the in vivo and ex vivo skeletal muscle determinants underpinning her elite performance and compare them, when possible, to data in the literature.

METHODS: Knee extensor muscle architecture was evaluated with ultrasound, and force, power and fatigability assessed with dynamometry. A biopsy was obtained from the vastus lateralis to assess single fiber contractile mechanics, fiber type distribution, capillarization, and markers of denervation.

RESULTS: CSA at 50% femur length was 36.5cm2, while fascicle length, pennation angle and muscle thickness were 6.7cm, 11.56°, and 1.4cm, respectively. Knee extensor MVIC was 79Nm, power output was 28W and fatigability (reduction in power during a 4-min exercise) was 43%. Single fiber absolute and size-specific force were 0.88±0.20mN and 114±11kN/m2 for myosin heavy chain (MyHC) I fibers and 0.74±0.24mN and 168±16kN/m2 for MyHC II fibers. VL fiber type distribution was 38% MyHC I, 49% IIa, 5% I-IIa, 5% IIa-IIx and 2% IIx. Interestingly, the MyHC I fibers (4267±2181μm2) were ~55% larger than MyHC II fibers (2752±1608μm2). Together with larger CSA, MyHC I fibers had higher capillary-fiber contacts and capillary-to-fiber ratio (4.28 and 1.67) compared to MyHC II fibers (2.68 and 1.03). Less than 1% of the fibers were positive for the denervation marker NCAM, and no fibers were positive for embryonic MyHC. In addition, no MyHC I fibers were positive for neonatal MyHC (nMyHC), while ~1% of MyHC II fibers were nMyHC positive.

CONCLUSION: The WRW's knee extensor muscle CSA, architecture, force, power and fatigability were consistent with individuals of the same age (1,2). Type I fiber absolute force was ~30% greater than young and older females, while type II fiber absolute force was higher than older females in their 70s but lower than younger females (3). She had exceptionally large type I fibers and a high percentage of type II fibers (4,5). The capillarization of the type I fibers was comparable to that of women in their 60s, but lower for the type II fibers (6). Interestingly, there was minimal evidence of denervation compared to what is expected in the ninth decade of life (7). We speculate that the WRW's exceptional performance was driven, in part, by a low prevalence of denervation and a high proportion of fast fibers, along with her remarkably large and well vascularized slow fibers. This highlights the potential effect of sprint training to promote health and youthfulness, even in very advanced age.

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## Invited Symposium

### IS-PN06 Sex Differences in Hemodynamics and Oxygen Transport during Maximal, Supramaximal, and Time-Trial Exercises: Insights from Normalization Strategies and Thermodilution Measurements

**SEX DIFFERENCES IN CARDIAC OUTPUT, LEG BLOOD FLOW, AND OXYGEN EXTRACTION AT $VO_2$MAX AND DURING TIME-TRIAL EXERCISE: INSIGHTS FROM THERMODILUTION-BASED MEASUREMENTS**

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Historically, most exercise physiology research has been conducted on males, with findings often generalized to females. However, females and males have distinct body sizes and compositions, and their cardiovascular system is scaled differently, which may impact the applicability of these results. Recent studies suggest that males and females differ in central and peripheral factors limiting maximal oxygen uptake ($VO_2$max), yet much remains unknown about the mechanisms behind these potential differences and their implications for performance. Understanding sex-specific differences in the cardiovascular system and the oxygen transport chain from the lungs to the muscles is critical for advancing our knowledge of sex differences in athletic performance. This lecture will present insights from cutting-edge research utilizing gold-standard catheter-based techniques, including thermodilution for precise assessment of cardiac output, stroke volume, and leg blood flow during exercise, as well as direct measurements of peripheral oxygen extraction. These

methods offer the highest precision in assessing the physiological limits to $VO_2$max, allowing for an in-depth comparison of the oxygen transport chain between males and females. Data from submaximal, maximal, and time-trial exercise conditions will be presented, with a special focus on how closely the maximal hemodynamic responses observed at $VO_2$max are sustained during prolonged, competition-like exercises (time trials). Furthermore, the lecture will address the impact of normalizing hemodynamic variables, given that males and females differ substantially in muscle mass—the primary tissue consuming oxygen during exercise. This symposium will appeal to exercise physiologists, sports scientists, clinicians, and professionals working with female athletes, providing a comprehensive view of the mechanisms underlying sex-specific performance differences.

**SEX DIFFERENCES IN FUNCTIONAL RESERVE: FOCUS ON HEMODYNAMICS AND OXYGEN TRANSPORT**

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Understanding the limits of human performance requires examining the concept of "functional reserve," defined as the capacity to sustain or generate additional power even at the point of exhaustion. Research on how males and females utilize this reserve during high-intensity exercise remains limited, leaving critical gaps in our understanding of the underlying mechanisms. While recent evidence suggests that physiological responses to supramaximal exercise are broadly similar between sexes when normalized for lean mass, key questions remain about the compensatory mechanisms that could offset the presumed lower anaerobic capacity in women and the superior oxygen extraction observed in females during supramaximal exercise. This presentation will characterize the hemodynamic and oxygen transport responses to repeated bouts of supramaximal exercise in men and women, exploring how sprint interval training (SIT), with or without ischemia-reperfusion episodes at exhaustion, influences the functional reserve. We will focus on hemodynamics, oxygen delivery, and muscle blood flow using state-of-the-art invasive techniques, including thermodilution for measuring cardiac output, stroke volume, and leg blood flow, as well as peripheral muscle oxygen extraction. The lecture will explore whether SIT can modify the functional reserve differently in males and females and whether the application of ischemia-reperfusion immediately post-exercise may further enhance training adaptations. Additionally, we will investigate the potential of ischemia-reperfusion as a strategy to optimize hemodynamic responses and oxygen extraction during high-intensity efforts. By examining these factors, we aim to determine if targeted interventions can enhance the functional reserve and extend performance capacity. These findings will provide exercise physiologists, sports scientists, and health professionals with a deeper understanding of how training protocols can be optimized to leverage sex-specific adaptations, potentially informing strategies to enhance both performance and recovery in male and female athletes.

**SEX DIFFERENCES IN $VO_2$MAX AFTER NORMALIZING BLOOD VOLUME AND $O_2$ CARRYING CAPACITY**

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Maximal oxygen consumption (VO2max), a hallmark of aerobic capacity, is associated with large mortality reductions as well as cardiometabolic benefits. Understanding the physiological determinants of sex-differences on VO2max is a fundamental topic in exercise physiology that may have a crucial impact in the prevention of cardiovascular and metabolic diseases. Intrinsic sex differences in fundamental blood attributes have long been hypothesized to contribute to the gap in cardiorespiratory fitness between men and women. The aim of the present study was to understand whether sex differences in VO2max can be explained by blood volume and effective hemoglobin. This lecture will present insights from state-of-the-art methods for blood normalization by using blood withdrawal and O2 carrying capacity reduction via carbon monoxide rebreathing as well as exercise echocardiography inside a lower body negative pressure chamber (to induce hemodynamic loads characteristic of the upright position). We will present data on pulmonary, cardiac and hemodynamic variables from rest to peak incremental exercise as well as at a fixed submaximal workload in women and men prior to and after blood normalization. This symposium will address a relevant knowledge gap in our basic comprehension of cardiovascular physiology that may appeal to a broad audience including exercise physiologists, sports professionals and clinicians.

## Oral Presentations

### OP-AP29 Power and Strength II - Cluster Sets and Lower Limbs

**CHRONIC ADAPTATIONS TO A 6-WEEK PERIODIZED CLUSTER SET FREE-WEIGHT BACK SQUAT TRAINING INTERVENTION ON MAXIMUM AND SPEED STRENGTH**

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INTRODUCTION: Cluster set (CS) training, which incorporates intra-set rest intervals, is thought to optimize neuromuscular adaptations by sustaining higher movement velocities compared to traditional sets (TS) (Suchomel et al., 2018). While its acute effects are well-documented, research on the long-term benefits of CS training, especially within periodized programs, is limited (Haff, 2024). Understanding these chronic effects is essential for developing effective, evidence-based

training strategies to enhance athletic performance. This study investigated the effects of a 6-week periodized CS training intervention on maximum and speed strength during the free-weight back squat.

METHODS: Eighteen trained adults (8 males, 10 females) with at least one year of strength training experience (1RM: females 1.23 ± 0.15; males 1.64 ± 0.30 times body weight) were randomly assigned to CS or TS groups. Both groups completed 12 training sessions over six weeks, with intensities progressively increasing from 70% to 85% 1RM and set repetitions decreasing from 8 to 3. CS sessions included 30-second intra-set rest periods using several variations in CS configurations, while TS sessions used continuous repetitions with 180-seconds inter-set rests. Outcomes measured pre- and post-intervention included dynamic 1RM in the free-weight back squat, maximum isometric strength, and strength endurance. Additionally, countermovement jump (CMJ) height and barbell velocity at 70% 1RM (v70) were assessed during each session.

RESULTS: Significant improvements were observed in 1RM strength (CS: +8.5 ± 6.2%; TS: +9.7 ± 3.8%; $p < 0.05$) and v70 (CS: +11.1 ± 12.6%; TS: +13.9 ± 9.7%; $p < 0.05$) for both groups. However, there were no significant differences in these improvements between groups, as analyzed by linear mixed-effects models (LMMs). Sex did not significantly influence outcomes, as no group × sex × time interactions were observed ($p > 0.05$). CMJ height, maximum isometric strength, and strength endurance showed no significant changes or differences between groups ($p > 0.05$).

CONCLUSION: Both CS and TS protocols are equally effective for improving maximal dynamic and speed strength over a 6-week periodized training program. Neither protocol significantly enhanced CMJ height, isometric strength, or strength endurance. Contrary to our hypothesis that CS would optimize neuromuscular adaptations by sustaining higher movement velocities, the findings indicate no significant differences between CS and TS.

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**CLUSTER-SET VS. TRADITIONAL-SET POSTACTIVATION POTENTIATION PROTOCOLS: IMMEDIATELY AND RECOVERY TIME EFFECTS ON LOWER-LIMB EXPLOSIVE POWER**

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INTRODUCTION: Postactivation potentiation (PAP) is a theory that a muscle contraction will increase the intensity of a second contraction that follows. Acute performance increase mostly occurs as a result of a neuro-physiological, i.e. neural stimulus, and creates physiological effects; maximum voluntary muscle contraction amount, muscle contraction speed or faster contracting motor units are activated. PAP mechanism has been studied and used for a long time in the warm-up phase before performance, especially in jumping and explosive branches. However, there is still a need for studies on this subject. The main objective of present study was to investigate immediately and recovery time effects on countermovement jump (CMJ) and reactive strength index (RSI) of cluster-set and traditional-set configuration of vertical jump exercise.

METHODS: A total of twenty-seven physically active female and male university students (mean age 19.5±1.6 year, height 174.1±8.9 cm, weight 65.6±10.3 kg and body fat 14.9±6.4 %) participated voluntarily. Subjects were randomly divided into two groups: cluster-set (CS) and traditional-set (TS) groups. Subjects completed the study in 2 testing sessions; 1st is familiarisation and 2nd is experimental sessions. During the familiarisation session, PAR-Q, height, body weight and body fat % were determined. After that, subjects performed CMJ, Drop Jump (DJ), CS: 3 set, rest 2 min/set; 1 set = 5 x 2 rep, rest 15 sec/2 rep or TS: 3 set x 10 rep; 3 min/set rest) protocol, Borg Scale, Total Quality Recovery Scale (TQR). After 24 hours, subjects participated in experimental session and performed warm-up, Pre-test (CMJ and DJ), aforementioned CS / TS, Borg Scale, Test, TQR, Post-test1, TQR and Post-test2, respectively. Artificial intelligence application My Jump 2 was used to calculate Reactive Strength Index and vertical jump distance which evaluated post-activation potentiation of low extremity muscles. Two Way ANOVA repeated measures analysis of variance test, 2 groups (CS and TS) x 4 time (Pre-test, Test, Post-test1 and Post-test2) was used to determine comparisons and differences. Bonferroni test was used for pairwise time and group comparisons.

RESULTS: The results showed not statistically significant difference between the changes of CS and TS protocols for CMJ ($F = 1.488$, $\eta_p^2 = .056$) and RSI ($F = 2.377$, $\eta_p^2 = .087$). There are no statistically significant difference of CMJ by time of CS ($F = 1.313$, $\eta_p^2 = .116$). However, there are statistically significant difference of CMJ by time of TS ($F = 3.665$*, $\eta_p^2 = .196$; *Post_3 min vs. Post_6 min). Also, there are not statistically significant difference of RSI by time of both CS ($F = 1.115$, $\eta_p^2 = .100$) and TS ($F = 1.672$, $\eta_p^2 = .100$).

CONCLUSION: In conclusion, both CS and TS protocols have similar acute effects on vertical jump exercise-based PAP and recovery. Further research with more complex and larger studies is recommended to confirm and extend these findings.

**BOX JUMPS VERSUS SQUAT JUMPS: AN ANALYSIS OF EFFECTS ON GLUTEAL FUNCTION, BONE DENSITY, AND LOWER EXTREMITY MUSCLE MASS**

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INTRODUCTION: The primary aim of this study was to compare the effects of box jumps and squat jumps on gluteal strength, gluteal hypertrophy, lean muscle mass, bone density, and jump height in healthy college-aged individuals.

METHODS: Forty-eight healthy college-aged men and women (18-25 years old) were recruited for this randomized controlled trial from a university setting. Participants were assigned to box jump, squat jump, or control groups. Intervention groups participated in a 12-week plyometric training program (three workouts per week), while the control group was instructed to avoid plyometric activities. Outcome measures were assessed at baseline and week 12 using a handheld dynamometer (HHD) for gluteal strength, a tape measure for gluteal hypertrophy, dual-energy X-ray absorptiometry (DEXA) for lean muscle mass and bone density, and a Vertec device for jump height.

RESULTS: Data from thirty-four participants (11 females, 23 males) who completed data collection were used in the study. One-way ANOVAs revealed no significant difference ($p = 0.05$) between groups of males and females combined. However, females in the box jump group showed increased gluteal girth compared to females in the squat jump and control groups. Paired t-tests revealed significant increases ($p = 0.05$) in bilateral hip extension strength and jump height for both intervention groups, but not the control group. Further analysis showed sex-specific adaptations, with squat jumps leading to greater jump height increases in males and box jumps leading to greater gluteal hypertrophy in females. All males demonstrated an increase in bilateral hip extension strength. Other measured variables showed no statistically significant changes from baseline.

CONCLUSION: Box jump and squat jump interventions both effectively increased hip extension strength and vertical jump height. However, exercise selection may need to be tailored based on sex to optimize training outcomes. These findings provide valuable insights for clinicians and fitness professionals working with college-aged individuals. Incorporating box jumps and squat jumps into rehabilitation or training programs can help improve strength and functional performance. Furthermore, recognizing sex-specific adaptations has the potential to personalize plyometric exercise prescription, leading to more effective training programs and improved outcomes.

**THE VOLUME OF PLYOMETRIC TRAINING INFLUENCES MEDIAL GASTROCNEMIUS STIFFNESS**

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INTRODUCTION: The stiffness of the muscle-tendon unit (MTU) for the plantar flexor muscles functions as an enhancement mechanism for athletic performance (1). Long-term plyometric training programs likely influences MTU stiffness of the plantar flexors (2,3). Nevertheless, the optimal training volume (sets x repetitions) to induce these adaptations remains unknown due to the significant variability of the available protocols (4). The present study aimed to assess the effect of varying plyometric training volume on the MTU of the plantar flexors.

METHODS: Four moderately trained participants (2 males, 2 females out of the 16 participants that will be recruited for the ongoing study) performed a control condition and 4 progressive training volumes of hopping exercise at 5 different sessions randomly. Based on previous studies on training volume it was defined as: Low (2 sets x 10 reps), Moderate (6 sets x 10 reps), High (10 sets x 10 reps), and Very High (14 sets x 10 reps). Before and after the training protocol, the medial gastrocnemius stiffness of the right leg was evaluated with ultrasound, during gradually increasing ramp contractions to maximal voluntary contraction (MVC) force. Vertical ground reaction forces during hopping were recorded with a force platform to calculate peak force (expressed as % of body weight) and the net force-time integral (impulse) from touchdown to takeoff. Moreover, the jumping performance of participants was assessed with drop jumps (DJ) from heights of 20 and 40 cm. Two-way ANOVA was used to examined the differences in examined variables between the different conditions.

RESULTS: The pilot results showed that medial gastrocnemius stiffness changed significantly ($p<0.05$) only after the High and Very High training-volume conditions and was unchanged for the Low and Moderate volumes. MVC force was decreased ($p<0.05$) only after the High and Very High training-volume conditions. DJ performance from 20 and 40 cm remained unchanged ($p>0.05$) across all conditions. Both peak force and impulse was significantly ($p<0.05$) decreased at the final sets of High and Very High training volume conditions.

CONCLUSION: Greater plyometric training volume increased MTU stiffness of the plantar flexors and decreased the maximal ground reaction force. Our study has important implications in the optimization of plyometric training protocols. When the primary objective of a training program is to enhance the stiffness of the muscle-tendon complex of the plantar flexors, a medium training load of hopping is insufficient to produce significant changes.

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**THE SCALING FACTOR BETWEEN GROUND CONTACT TIME AND JUMP HEIGHT IN DROP JUMPS: A LINEAR RELATIONSHIP AT THE INDIVIDUAL LEVEL**

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INTRODUCTION: The extent to which jump height scales with changes in ground contact time (GCT) remains unknown. Establishing this relationship would enable more accurate comparisons of rebounds with different GCTs. Currently, to reliably compare reactive strength index (RSI) values, it is necessary to consider only those with similar contact time parameters.

METHODS: Elite track and field athletes performed drop jumps from a 40 cm box under three distinct instructional conditions: 1) Trade-off strategy – minimizing GCT while maximizing jump height; 2) Maximizing jump height; 3) Minimizing GCT. A hierarchical linear regression model was applied, with GCT and sex (male/female) as independent variables and jump height as the dependent variable.

RESULTS: Compared to the trade-off condition, focusing on short GCT led to a 21 ms reduction in GCT ($P < 0.0001$) but also a 5.9 cm decrease in jump height ($P < 0.0001$). Conversely, prioritizing jump height increased jump height by 4.8 cm ($P < 0.0001$) but prolonged GCT by 49 ms ($P < 0.0001$). However, RSI remained unaffected by instructions ($P=0.567$). A significant main effect of GCT on jump height was observed ($\beta=0.154$; $P < 0.00001$). The full model, incorporating random and fixed effects, accounted for 94% of the variance in jump height.

CONCLUSION: At the individual level, we found a linear relationship between GCT and jump height indicating that for every 1 ms increase in GCT, jump height increases by 0.154 cm. This relationship underscores the importance of considering the GCT-jump height trade-off when assessing drop jump performance and highlights the need for evaluations across various GCT ranges rather than relying solely on one jump strategy.

## Oral Presentations

### OP-BM20 Cortical Activity

**NEURAL OSCILLATORY RESPONSES TO EXPERIMENTAL MUSCLE PAIN AT REST AND DURING CYCLING EXERCISE**

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INTRODUCTION: Pain experienced during exercise acts as an inhibitory factor that can alter motor output, reduce exercise tolerance, and limit the physiological and cognitive benefits of physical activity. Despite this evidence, the brain responses that characterize exercise-induced pain remain poorly understood. The present study sought to investigate electrical brain activity measured via electroencephalography (EEG) in response to exercise-relevant experimental muscle pain at rest and during cycling exercise.

METHODS: Twenty-one healthy participants completed four experimental conditions twice, with each lasting 255 s: (i) resting (sitting) while fixating on a point (FIX), (ii) resting fixation with pain intervention (PAIN), (iii) submaximal (30% of peak power output) single-leg cycling (CYCL), and (iv) submaximal single-leg cycling while pain intervention applied to the non-exercising leg (CYCL+PAIN). Experimental pain was induced using a combination of blood flow occlusion and low-intensity electrically evoked quadriceps muscle contractions. A 32-channel EEG system was used to record brain signals throughout each condition and to determine spectral power for alpha, beta, and gamma frequency bands at four distinct brain regions, bilaterally encompassing fronto-central and centro-parietal cortices. Perceived leg pain (0-10 visual analog scale) was monitored throughout the tasks.

RESULTS: Compared to FIX and CYCL, occlusion in the non-exercising leg during the PAIN and PAIN+CYCL conditions resulted in an average pain rating of ~$6.52 \pm 3.9$ ($P<0.001$). At a resting state, pain induced a significant reduction in alpha ($P<0.001$) and beta ($P<0.001$) power in fronto-central, and centro-parietal brain areas, while gamma suppression was only observed in fronto-central brain areas ($P<0.001$). Changes occurred bilaterally with no observable differences between brain hemispheres. During cycling, superimposed pain did not significantly alter frequency band power compared to cycling alone.

CONCLUSION: These findings suggest that tonic experimental muscle pain is characterized by distinct frequency band modulations at rest that are not observed during cycling. Pain-induced gamma suppression is a novel finding that may suggest unique cortical processing specific to exercise-relevant muscle pain. It is plausible that a greater pain stimulus may be required to detect pain-evoked modulations during cycling. Overall, this study provides novel insights into the neural responses to muscle pain, while contributing to understanding EEG spectral analysis' utility for studying pain during exercise.

**ELECTROCORTICAL ACTIVITY IN REAL-WORLD CROUCHING START OF ELITE SPRINTERS**

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INTRODUCTION: A quick start to an imperative tone (starting gun) following a warning tone ("set") is a crucial factor influencing sprint performance, though the neural mechanisms that support the quick start are still unclear. Previous neuroimaging studies have reported that when a response to an auditory stimulus is required, brain activity is modulated preceding that stimulus [1]. Thus, examining brain activity prior to a crouching start may help us understand a part of the neural mechanisms underlying the quick start. We aimed to investigate electrocortical activity during a crouching start using electroencephalography (EEG), which enables the examination of brain activity modulation within its limited time frame.

METHODS: Seventeen sprinters (10 males, aged 19–27 years) performed the following tasks: a starting task and a non-starting task. In the starting task, participants were instructed to position their hands and feet on the starting line and starting blocks, lift their hips in response to a warning tone, and initiate the start upon hearing an imperative tone after about 1700 ms. In the non-starting task, they positioned their hands and feet but remained relaxed without focusing on starting. After the warning tone, they were asked to lift their hips but instructed to disregard the imperative tone and avoid starting. Each task consisted of 30 trials. EEG signals were recorded using a portable EEG system with 63 electrodes. EEG prior to the imperative tone was used for source analysis. Statistical significance for differences between the two tasks in event-related spectral perturbation was tested using bootstrap statistics with false discovery rate correction. The significance level was set at $p < 0.05$.

RESULTS: Statistical analysis in the anterior cingulate cluster revealed, during the starting task, a significant increase in theta (4–8 Hz) and alpha (8–13 Hz) power during the first half of the interval between the warning and imperative tones ($p < 0.05$), while power across a broad frequency range, from theta to gamma (30–40 Hz), significantly increased during the second half of this interval ($p < 0.05$).

CONCLUSION: The anterior cingulate cortex is thought to be involved in error detection and intentional motor control [2]. An enhancement of power has been considered to characterize brain states with reduced information processing [3]. In summary, our results suggest that during a crouching start, neural processing related to these cognitive functions in the anterior cingulate cortex is reduced. This reduction in neural processing may lead to an increase in attentional resources for the imperative stimulus, potentially contributing to the quick start. The findings may serve as fundamental knowledge for enhancing performance in sports requiring a quick response.

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**POST-STROKE CORTICAL CONTRALESIONAL CONNECTIVITY LEADS TO RANGE OF MOTION ASYMMETRY AND AFFECTS WALKING PERFORMANCE IN STROKE SURVIVORS**

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INTRODUCTION: Stroke may lead to plastic structural changes within areas of the ipsilesional and contralesional hemispheres of the brain, which increase cortical interhemispheric imbalance (1). Maximum joint range of motion (ROMmax) impairments may also occur in the paretic limb, leading to an increased ROMmax asymmetry between lower limbs and reduced motor performance in functional tasks, such as walking (2). However, the association between post-stroke connectivity of each cortical hemisphere, hip flexion ROMmax symmetry between limbs and walking performance is poorly understood. The present study examined the specific influence of post-stroke cortical connectivity in the ipsilesional and contralesional hemispheres of the brain on hip flexion ROMmax asymmetry and walking performance in stroke survivors.

METHODS: Twenty hemiparetic chronic stroke patients (57.5 ± 14.8 yr, 26.7 ± 22.2 m post stroke) were assessed for cortical functional connectivity of the ipsilesional and contralesional general hemispheres and specific primary motor cortex (M1) areas of the brain with resting-state electroencephalography (EEG). Patients were also assessed for hip flexion active ROMmax of the paretic and non-paretic limbs and 10-m walk test, and their between-limb ROMmax asymmetry was further calculated. Relationships between changes in these variables were examined by Pearson product–moment (r), and linear and multiple regression analyses.

RESULTS: Hip flexion ROMmax asymmetry was correlated ($P < 0.05$) with cortical connectivity of the entire contralesional hemisphere ($r = 0.52$) and specific contralesional M1 ($r = 0.47$) areas of the brain, while the time to complete 10-m walk test was correlated with cortical connectivity of the contralesional M1 area only ($r = 0.51$). Cortical connectivity of the contralesional hemisphere explained ~28% of the hip flexion ROMmax asymmetry, while cortical connectivity of the contralesional M1 explained ~25% of the total time to complete the 10-m walk test ($P < 0.05$). No correlations ($P > 0.05$) between the other variables were observed.

CONCLUSION: Cortical connectivity networks seem to shift mainly to the contralesional hemisphere after stroke episodes (3), which may in turn increase lower limb ROMmax asymmetry and reduce the ability of stroke patients to perform daily tasks, such as walking.

**CORTICAL CHANGES IN CHRONIC ANKLE INSTABILITY DURING DROP-LANDING: A PRELIMINARY STUDY**

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INTRODUCTION: Chronic ankle instability (CAI), primarily occurring at the peripheral level, has been demonstrated to induce alteration at the cortical level [1]. It is evidence of both structural and functional brain adaptations associated with CAI. The impact of these changes in CAI is apparent in various functional movements [2, 3]. Similarly, studies in knee injury revealed increased activity in the frontal and parietal cortex [4]. This heightened activation within brain regions associated with motor planning and sensory processing suggested that individual with peripheral injury may rely on higher-order attentional control and somatosensory processing to compensate for the neuromechanical deficit [1]. The aim of this study was to compare cortical measures of motor planning after between people with CAI and without CAI (non-CAI).

METHODS: Ten participants (5 CAI and 5 non-CAI) aged between 20 - 40 years with right dominant side were recruited. They were informed to perform 40-50 drop-landing trials. Cortical activity during the task was record using electroencephalogram (EEG). Firstly, raw data were processed using MATLAB, with the initial contact on the force plate defined as the point where a vertical ground reaction force of 20 N was detected. Secondly, movement-related cortical potentials (MRCPs) were extracted by analyzing EEG data within a time window extending 1500 ms prior to this point. The time window was divided into three consecutive 500 ms intervals relative to movement onset: readiness potential 1 (RP1), readiness potential 2 (RP2), and the negative slope (NS). Then, EEG data corresponding to MRCPs were structured into a 30×100 matrix, representing 30 electrode positions and 100 normalized time points as percentages of the MRCP duration. Further analysis focused on EEG signals across delta, theta, alpha, and beta frequency bands. Lastly, group differences during the pre-landing phase were assessed using a two-sample t-test within the statistical non-parametric mapping (SnPM).

RESULTS: A significant difference was observed during the NS, with the CAI group demonstrating higher absolute EEG power than non-CAI group in the alpha band over Cz position ($\rho = 0.029$) and in the beta band over FC1 position ($\rho = 0.031$). However, no significant differences were identified between the groups during the RP1 and RP2.

CONCLUSION: During drop- landing, the CAI group exhibited increased both alpha power over the central brain area and beta power over the left frontal region. These observed differences in cortical activation point towards an altered neural mechanism of movement control and brain processing in individual with CAI. This suggests an adaptation of brain processes, particularly those involved in cortical motor planning, specifically for the demand of drop-landings.

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**SKILLED PASSING IN FOOTBALL MAY REGRESS FOLLOWING AN ANTERIOR CRUCIATE LIGAMENT INJURY AS A RESULT OF CORTICAL CHANGES: PRELIMINARY EEG EVIDENCE**

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries impact football players substantially, leading to performance declines and premature career endings. Emerging evidence demonstrates neurophysiological alterations in injured individuals and characterize ACL ruptures not merely as peripheral injuries but as complex conditions with neurophysiological aspects. The objective of the present study was to compare kicking performance and the associated cortical activity between injured players and their healthy counterparts. Understanding the neurophysiological implications of an ACL injury within the football context may elucidate mechanisms that impair sport-specific performance and guide practical strategies for restoring the pre-injury level of performance.

METHODS: Ten reconstructed players and 15 healthy controls performed a short-distance kicking task. Kicking biomechanics were recorded using wearable inertial measurement unit sensors and the consistency was assessed by analyzing trial-to-trial non-linear fluctuations in kicking behavior using multiscale entropy (MSE). Cortical activity was captured with a 64-electrode mobile electroencephalography (EEG) system. Kick-induced cortical patterns in posterior and frontal regions were described based on source-derived event-related spectral perturbations (ERSP). The kick-related complexity of these two regions were analyzed using MSE.

RESULTS: MSE analysis of kicking biomechanics revealed increased trial-to-to complexity in foot external rotation among injured players. ERSPs indicated significant differences in posterior alpha and frontal theta oscillations during between the groups. Furthermore, the kick-related complexity of these two regions was reduced in injured players at medium and coarse scales as indexed by MSE.

CONCLUSION: The current findings suggest behavioral changes during kicking in injured players potentially as a result of proprioceptive deficits. This may necessitate compensatory strategies at a cortical level involving augmented attentional demands at the cost of processing visuospatial information. This conflict may hinder the integration of task-relevant information across distributed networks and indicate an increased cortical load. Our study provides preliminary insights into

the neurophysiological implications of an ACL injury within the football context, proposes kicking performance as a domain to consider in practical implementations following injury and underscores the potential for prospective research.

# Oral Presentations

## OP-MH29 Metabolic Syndrome and Diabetes I

### PRE-MEAL AND POST-MEAL EXERCISE: LONG-TERM INTERVENTIONS ON 24-HOUR CONTINUOUS GLUCOSE IN YOUNG ADULTS WITH OVERWEIGHT AND OBESITY

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*PEKING UNIVERSITY*

INTRODUCTION: While the optimal timing for exercise to control glucose levels remains unclear, especially regarding the long-term effects of exercise timing, this study aims to investigate the long-term effect of exercise timing in relation to meal times—specifically, pre-meal and post-meal exercise—on glucose homeostasis in young adults with overweight and obesity using continuous glucose monitoring (CGM).

METHODS: A randomized controlled study was conducted on 34 overweight and obese young adults aged 18 to 35 who underwent a 10-week intervention with different exercise timings. The pre-meal exercise group performed at least 30 minutes of moderate-intensity (65% HRmax) aerobic exercise within 60 minutes before a meal, while the post-meal exercise group performed the same within 0-90 minutes after a meal, five times a week. The exercise intervention was conducted at a smart health station with at least two supervised exercise sessions per week and three self-exercise sessions, monitored by a heart rate belt. The primary outcome was 24-hour continuous glucose levels measured via CGM (SIBIONICS), with secondary outcomes being physical and mental health indicators. Participants maintained their usual dietary habits during the intervention and wore an actiGraph 3X accelerometer to monitor physical activity levels before and after the intervention. Paired t-tests were used for within-group comparisons, and covariance analysis was used for between-group comparisons.

RESULTS: There were no significant differences in 24-hour mean glucose (98.23±3.16 vs. 97.77±4.22 mg/dL), mean amplitude of glucose fluctuation (MAGE, 31.87±4.37 vs. 33.12±6.82), coefficient of variation of glucose (CV%, 15.68±1.50% vs. 16.92±3.50%) and continuous overall glycemic effect (CONGA,15.37±2.34 vs. 16.11±3.21 mg/dL) between or within the pre-meal and post-meal exercise groups (all $p > 0.05$). However, the hypoglycemia index significantly decreased in the pre-meal exercise group ($p = 0.039$). Regarding mental health indicators, only the pre-meal exercise group showed a significant improvement in mindfulness awareness. After the intervention, both groups increased their daily moderate-intensity physical activity time and reduced their sedentary time.

CONCLUSION: A 10-week pre- or post-meal exercise intervention did not significantly affect 24-hour continuous glucose levels. Compared to post-meal exercise, pre-meal exercise may reduce the risk of hypoglycemia in young adults with overweight and obesity.

### EXPLORING THE RELATIONSHIP BETWEEN EXERCISE TIME, VOLUME, FREQUENCY, CONSISTENCY, AND GLYCEMIA AFTER A 26-WEEK MHEALTH EXERCISE INTERVENTION IN INDIVIDUALS WITH TYPE 2 DIABETES IN A REAL-WORLD SETTING

LOW, J., HESKETH, K., FALKENHAIN, K., LEE, H., JUNG, M.E., SINGER, J., JONES, C.A., RUSSON, C., COCKS, M., MCMANUS, A., LITTLE, J.P.

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INTRODUCTION: Exercise interventions play a pivotal role in managing type 2 diabetes (T2D), yielding significant benefits in glycemic regulation. Despite the role that exercise time, volume, frequency, and consistency play in exercise prescription for T2D interventions, research is still discrepant on what metric(s) might have a more potent effect on improving glycemic regulation. The purpose of the present study was to explore the relationship between exercise metrics (duration, volume, frequency, and consistency) and markers of glycemic regulation [HbA1c and continuous glucose monitoring (CGM) metrics including mean 24-hour glucose, glycemic variability, and eA1c] after a 26-week mHealth intervention.

METHODS: This was a secondary analysis of the MOTIVATE T2D trial (NCT04653532); an RCT investigating the feasibility of an mHealth exercise intervention. Inactive individuals with newly diagnosed (<2 years) T2D (N= 58) completed blood and 14-day CGM testing before (T0) and after (T1) a 26-week mHealth exercise intervention. HbA1c was assessed using a lab-based point-of-care machine (Afinion 2, Abbot Inc.). CGM analysis was performed at T0 and T1 using an online no-code webtool called Diametrics (diametrics.org). Participants were asked to wear a fitness watch during the 26-week tailored intervention, and raw exercise data from each recorded session were extracted. Exercise metrics (duration, volume, frequency, and consistency) were calculated across i) the total 26-weeks; ii) the first 13 weeks (where personalized support and changes were provided); iii) the last 13 weeks (where support was reduced) of the intervention and were compared to the CGM metrics at T1. A linear model was used to examine the predictors of mean 24-hour glucose, glycemic variability (SD, CV), HbA1c, and eA1c at T1.

RESULTS: Average duration (57 ± 36 minutes) of each exercise session significantly predicted HbA1c ($\beta$ = -0.23 (0.07), P = 0.002), 24-hour mean glucose ($\beta$ = -0.03 (0.01), P = 0.01), eA1c ($\beta$ = -0.02 (0.01), P = 0.01), and glucose standard deviation

(β = -0.01 (0.0), P = 0.003) at T1. Exercise minutes (duration) accumulated during the first 13 weeks of the intervention (2931 ± 3362 minutes) were also a significant predictor of HbA1c (β = -0.001 (0.0), P = 0.01), 24-hour mean glucose (β = -0.002 (0.0), P = 0.01), eA1c (β = -0.0001 (0.0), P = 0.01), and standard deviation (β = -0.005 (0.0), P = 0.03).

CONCLUSION: Average exercise session duration and total exercise minutes accumulated during the first 13 weeks of the intervention predicted HbA1c, mean 24-hour glucose, eA1c, and glucose standard deviation at the end of a 26-week mHealth exercise intervention. These findings suggest that accumulating more minutes (duration) of exercise is an important metric for improving glucose regulation in people with newly diagnosed type 2 diabetes, especially in the early phases of an exercise intervention.

**THE EFFECTIVENESS OF A COMBINED TRAINING PROGRAM IN REDUCING ANXIETY AND DEPRESSION IN SUBJECTS WITH TYPE 2 DIABETES: A CONTROLLED STUDY**

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INTRODUCTION: While previous research has explored the individual effects of aerobic and resistance training on anxiety and depression in individuals with type 2 diabetes, the combined impact of these exercise modalities remains underexplored. This study examines the effectiveness of a 24-week combined aerobic and resistance training program in reducing anxiety and depression scores in this population.

METHODS: The study involved 43 inactive women aged 39 to 70 years with type 2 diabetes. Participants were assigned to a combined aerobic and resistance training (n=31) or a sedentary control group (n=12). Participants in the training group engaged in supervised combined exercise training sessions three times a week over 24 weeks. Beck Anxiety Inventory (BAI) and Beck Depression Inventory-II (BDI) were used to determine depression and anxiety scores.

RESULTS: At baseline both groups scored similarly on the BAI and BDI. After 24 weeks, the trained group showed significant reductions in anxiety scores (12 weeks: 5.96 ± 2.88; 24 weeks: 4.83 ± 1.42), whereas the control group exhibited increased anxiety (12 weeks: 15.25 ± 5.86; 24 weeks: 19.41 ± 1.08). Significant differences were observed between groups. The trained group maintained stable depression scores (12 weeks: 5.51 ± 2.71; 24 weeks: 5.58 ± 3.59), while the control group's scores increased (12 weeks: 15.58 ± 6.12; 24 weeks: 19.58 ± 0.99). Significant differences between groups were observed at 12 weeks (p = 0.001) and 24 weeks (p = 0.000).

CONCLUSION: The training program significantly reduced anxiety and stabilized depression in the trained group compared to the control group. These findings highlight the programs effectiveness in managing anxiety and depression over time.

**USING ECOLOGICAL MOMENTARY ASSESSMENT TO EXPLORE ADHERENCE TO JUST-IN-TIME PROMPTS FOR INTERRUPTING SITTING AND INCREASING WALKING PACE IN PATIENTS WITH PREDIABETES AND TYPE 2 DIABETES**

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INTRODUCTION: Interrupting prolonged sitting and increasing physical activity (PA) are crucial for managing prediabetes and type 2 diabetes. However, achieving these behavioural changes remains challenging. The ENERGISED trial leveraged mHealth technologies to deliver occasional just-in-time prompts, suggesting either sitting interruption or increased walking pace at the right moment—when patients had been sedentary for over 30 minutes or walking for at least 5 minutes, respectively. This study, embedded within the ENERGISED trial, aimed to explore patients' self-reported adherence to these prompts using ecological momentary assessment (EMA).

METHODS: Patients from the intervention arm of the ENERGISED trial (n = 172), receiving just-in-time prompts suggesting sitting interruption or increased walking pace, were eligible. Fifteen minutes after a just-in-time prompt, they received an EMA survey with a 50% probability, limited to no more than once every other day. Delivered via the HealthReact app, the survey asked whether they adhered to the suggestion to interrupt sitting or increase walking pace. If not, they were asked to specify the reason, including physical and social constraints, concurrent activities, environmental context, lack of motivation, or technical limitations such as delayed prompt delivery or missed prompts. The survey also measured fatigue, stress, and pain levels on 0–10 Likert scales. Descriptive statistics and logistic mixed-effects models were used to analyse adherence and its moderators.

RESULTS: Forty-one patients (50% female; median age: 61 years; 29% prediabetes) participated for a median of 252 days (IQR 157–314). They received 2,125 sitting interruption suggestions and 1,712 walking pace suggestions, of which 949 and 729, respectively, were followed by an EMA survey. In total, 394 (42%) and 338 (46%) surveys were completed. Sitting was interrupted following 26% of relevant prompts; the most common reason for non-adherence was engagement in concurrent activities such as driving or focused work (44%). Walking pace increased in response to 28% of prompts; the primary reason for non-adherence was that walking had already ceased (39%). Higher fatigue (OR 0.983, 95% CI 0.969–0.997, p = 0.019) and stress (OR 0.979, 95% CI 0.961–0.997, p = 0.026) reduced the odds of increasing walking pace, while pain had no significant effect. Adherence to sitting interruption was not moderated by fatigue, stress, or pain. Neither sex nor age influenced adherence to either suggestion.

CONCLUSION: The effectiveness of just-in-time suggestions to reduce prolonged sitting and increase PA intensity in patients with prediabetes and type 2 diabetes is limited by inappropriate triggering—either during activities that prevent sitting interruption or due to delays causing prompts to be received after walking has ceased. Future approaches should optimise prompt timing to better target moments when patients are most receptive and able to act.

**EFFECTS OF AN EXERCISE- AND NUTRITION- BASED EDUCATIONAL CAMP ON GLYCEMIC CONTROL IN ADULTS WITH TYPE 1 DIABETES: THE ACT1ON NON-RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Maintaining glycemic control is a major challenge for people with T1D, as fluctuations increase the risk of complications and double diabetes – people with T1D with also insulin resistance, typical of T2D 1. Educational camps have shown to improve glycemic control in children with T1D, but their effectiveness in adults with T1D remains unexplored 2,3. For these reasons, this study evaluates the effectiveness of an exercise- and nutrition-based educational camp (EG) compared to usual care (UC) in adults with T1D.

METHODS: A total of 48 adults (42.4±12.3 years; 21 (47.7%) women) with T1D were recruited through consecutive sampling for the ACT1ON study and assigned to either the EG or UC (n = 24 each). Glycemic control outcomes (HbA1c, GMI, Time-in, above, and below range, mean, and CV of glucose) were retrieved for the 3 months before and after the intervention. Moreover, at both time points, the IPAQ-SF and IFIS questionnaires were filled out by the participants. Intervention effects on primary and secondary endpoints were analyzed using a generalized linear mixed model for repeated measures.

RESULTS: No participants dropped out of the EG, while four dropped out from the UC. The EG showed significantly greater reductions in HbA1c, GMI, time above range, mean glucose, and SD compared to the UC ($p<0.050$). Moreover, we found a significant increase for the time in range for the EG compared to the UC and no differences in the time below range ($p=0.010$). However, self-reported physical activity, sedentary time, and fitness perception did not differ between groups ($p>0.050$).

CONCLUSION: Our findings suggest that an exercise- and nutrition-based educational camp improves glycemic control in adults with T1D, potentially lowering the risk of double diabetes, as shown by the greater decrease in HbA1c and GMI. These results underscore the value of structured educational interventions. Future research should assess the long-term sustainability of these benefits and optimize program implementation in clinical care.

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## Oral Presentations

### OP-MH28 Parkisons Disease

**IMPACT OF TARGETED PHYSICAL ACTIVITY PROGRAMS ON FUNCTIONAL PERFORMANCE AND CLINICAL OUTCOMES IN PARKINSON'S DISEASE**

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INTRODUCTION: Mitochondrial dysfunction and oxidative stress are associated with Parkinson disease (PD) and are intrinsic factors related to its pathogenesis. Physical activity (PA) enhances cognitive function in older adults, reduces motor deficits, promotes neuron formation, and slows age-related neuronal loss. Herein we compare the effects of two different PA programs in PD patients analyzing relevant clinical aspects and its impact on mitochondrial function.

METHODS: Patients with early-stage PD (stage H&Y II; n=24) were randomized into 3 groups of 8 patients. The effects of two different PA programs were compared. The first group performed basic physical training (BPT) based on strength and resistance; a second group performed BPT combined with functional exercises (BPTFE) to stimulate the specific sensorimotor pathways that are most affected in PD (proprioception-balance-coordination) together with dual task training; a third group served as control. Subjects performed 3 sessions per week for 16 weeks. Motor function, quality of life, sleep quality,

cognitive aspects, humor and overall satisfaction (CSQ-8) were evaluated. Skin fibroblasts were collected for mitochondrial analysis to explore their potential as biomarkers for PD progression.

RESULTS: The CSQ-8 results demonstrated high levels of satisfaction, with mean scores ranging from 3.4 to 4.0 indicating overall positive feedback. The application of BPT and BPTFE programs significantly improved Sit-to-stand (STS) and Timed Up and Go (TUG) test performance ($p < 0.001$). Specifically, significant improvements were observed in the STS ($p = 0.001$), with both BPT and BPTFE groups demonstrating superior performance compared to the Controls ($p < 0.003$). Similarly, the TUG test showed significant improvements ($p = 0.0042$) in both intervention groups compared to the Controls ($p = 0.0039$ and $p = 0.0028$, respectively). However, no statistically significant differences were observed in quality of life (PDQ-39, $p = 0.810$) or depressive symptoms (BDI, $p = 0.577$) across the groups. Despite the lack of statistical significance, a small to moderate reduction of discomfort was noted in the BPTFE group compared to controls for both quality of life (MD = -7.71, r_rb = -0.339) and depressive symptoms (MD = -6.57, r_rb = -0.429). Mitochondrial analyses are currently ongoing and will provide further insights into their role in PD.

CONCLUSION: These findings confirm that both BPT and BPTFE interventions effectively enhance physical function in PD patients. While clinical outcomes related to mood and quality of life did not reach statistical significance, the observed trends suggest potential benefits, warranting further investigation. These results highlight the importance of incorporating targeted PA programs into PD management.

**IV-VIVO ASSESSMENT OF MUSCLE MICROSTRUCTURAL PROPERTIES IN PARKINSONS DISEASE USING QUANTITATIVE ULTRASOUND RADIOFREQUENCY TECHNIQUE**

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INTRODUCTION: Parkinsons disease (PD) is the second most prevalent neurodegenerative disorder, affecting approximately 1% of individuals over 60 years [1]. Current clinical assessment tools, such as the Hoehn-Yahr Scale and the Unified Parkinsons Disease Rating Scale (UPDRS) are non-quantitative, and this could potentially lead to diagnostic errors [2].

This study investigates the potential of ultrasound Nakagami imaging to quantitatively evaluate muscle characteristics in PD patients, as previously proposed for patients with Duchene Muscle Dystrophy [3]. The aim was to determine whether Nakagami imaging can effectively reflect disease severity and thus provide a reliable, quantitative tool for monitoring disease progression.

METHODS: The study included 17 PD patients (7M/10F) and 15 healthy controls (7M/8F). Based on UPDRS Part III assessment and Hoehn-Yahr (H-Y) scale scores, PD patients were divided into an early-stage group (H-Y $\leq$ 2, n = 7) and a late-stage group (H-Y > 2, n = 10). The International Physical Activity Questionnaire (IPAQ) was utilized to assess physical activity levels in all participants.

B-mode and Radiofrequency (RF) data were collected from the tibialis anterior (TA) and the gastrocnemius medialis (GM) on the most and the less affected limb by means of an ultrasound apparatus (ArtUs EXT-1H, Telemed UAB). B-mode data were used to investigate muscle geometrical characteristics and RF data to compute the Nakagami parameters.

RESULTS: The three groups were matched for age (69-77 years), stature (1.64-1.68 m), body mass (68-73 kg) and IPAQ scores (2231-3210). A 2-way ANOVA (group x limb) indicate no differences between limbs in all the investigated parameters; thus, only the differences between groups are reported. Significant differences in the Nagakami parameters were observed between controls and late-stage patients in GM ($p<0.001$) and in both the superficial ($p<0.01$) and deep ($p<0.05$) compartments of TA. Significant differences were also observed between early-stage and late-stage patients but in GM only ($p<0.001$). No statistical differences were found between controls and early-stage patients and no differences in muscle geometry were found among groups. Finally, a significant correlation was observed between the GM Nakagami parameter obtained from the most affected side and the Hoehn-Yahr scale ($R=0.619$, $p=0.01$).

CONCLUSION: Ultrasound Nakagami imaging is a promising quantitative tool for evaluating muscle characteristics in PD patients. The Nakagami parameter can distinguish the severity of the disease, providing a quantitative means to monitor the progression of Parkinson's disease. Further research is needed to validate these findings on a larger sample of patients and to explore the clinical applicability of this technique.

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**FORCE STABILITY AND MOTOR UNIT BEHAVIOR ARE ALTERED IN PARKINSON'S DISEASE PATIENTS DURING DUAL-TASK KNEE EXTENSION**

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INTRODUCTION: Parkinson's disease (PD) is a neurodegenerative disorder that affects neuromuscular control, reducing mobility and quality of life. These deficits arise, in part, from altered motor unit (MU) recruitment and discharge modulation. PD patients exhibit poorer force steadiness and greater MU firing variability than healthy individuals. Additionally, PD

symptoms are often asymmetric. Dual tasking, which combines motor and cognitive demands, further challenges neuromuscular control, yet its effects on MU firing behaviour remain unclear. This study examined how dual tasking affects force steadiness and MU behaviour in PD patients compared to healthy controls.

METHODS: Fifteen PD patients (6 females, age: 63.8 ± 6.2 years, UPDRS III: 14.7 ± 6.8) and fifteen healthy participants (7 females, age: 63.7 ± 7.2 years) performed a 32-second force-tracking trapezoidal knee extension task at 30% of maximal voluntary contraction (MVC) on an isometric knee dynamometer. The tasks included a) a single visuomotor condition with trapezoidal force tracking, and b) a dual-task condition requiring concurrent serial subtraction by three from a randomly selected number. High-density surface electromyography (HDsEMG) was recorded from the vastus lateralis using 32-electrode arrays, and MU firings were extracted. Outcome measures included force steadiness (coefficient of variation, CV), tracking error rates, mean MU discharge rate (DR), recruitment threshold (RT), and derecruitment threshold (DT). Data were analysed using linear mixed-effects models in R.

RESULTS: Results showed that PD exhibited greater CV during the dual task than controls ($p = 0.03$), indicating increased force variability under cognitive load. Tracking errors were also higher in PD across both tasks ($p = 0.01$), suggesting impaired force regulation. PD showed an increase ($p = 0.01$) in DR from 8.96 pps (single-task) to 9.35 pps (dual-task), while controls showed no change. When controlling for task condition, DR was significantly lower in the single-task condition (8.73 pps) than the dual-task condition (9.22 pps, $p = 0.03$), but no differences were found in controls or in the unaffected limb of PD patients. Recruitment thresholds were lower in PD (17.2% MVC) than controls (18.3% MVC), though the difference was not significant.

CONCLUSION: These findings suggest that dual tasking influence force control in PD, increasing MU discharge rates and neuromuscular demands. The results align with previous research, confirming that PD exhibit irregular MU firing patterns and lower recruitment thresholds. Combining force steadiness measures with HDsEMG analysis appears promising for detecting early-stage motor dysfunction in PD. Future studies should explore neuromodulatory and inhibitory mechanisms and assess the potential of this methodology for tracking PD progression and optimizing rehabilitation strategies.

Nishikawa et al., Eur J Neurosci, 53(6), 2021.

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**EFFECTS OF WALKING TRAINING ON BIOCHEMICAL LEVELS OF PEOPLE WITH PARKINSON'S DISEASE**

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INTRODUCTION: Walking training is recognized as a safe and effective exercise strategy for people with Parkinsons disease (PD), promoting improvements in functional capacity, postural control and walking through the step length and average velocity and balance, reducing the risk of falling. However, the effects of this training on the biochemical parameters of people with PD remain largely unexplored since risk factors associated with metabolic syndrome, such as dyslipidemia and impaired glucose metabolism, can contribute to the development and progression of PD. Also, alterations in serum cholesterol levels, including low total cholesterol, triglycerides, and high levels of HDL cholesterol, may be linked to the progression of PD. So, this study aimed to verify the impact of walking training on biochemical markers in people with PD.

METHODS: Sixteen people with PD (72 ± 7 yrs; height of 160 ± 10 cm; weight of 66.7 ± 16.7 Kg) were recruited for a 16-week walking training program of two sessions per week. The training program involved a 10-min warm-up (stretching), 30-min of walking and motor coordination exercises (70% walking, 30% strength/balance tasks), and a 10-min cooldown. Intensity was controlled by perceived exertion, and participants were instructed to either walk the longest distance or walk at the highest possible speed depending on the daily goal. Clinical assessments (MMSE, UPDRS-II/III) were conducted to characterize participants and functional capacity (6-minute walking test: 6MWT), and biochemical marks (HDL, LDL, VLDL, total cholesterol, glucose, total protein, Triglyceride and Nitric Oxide) assessments were performed at baseline and after 16 weeks. Paired t-tests were used to compare pre- and post-training values, and Pearson's correlation analysis was applied to examine associations between variables.

RESULTS: Sixteen weeks of walking training could significantly improve the 6MWT (Pre: 448.4 ± 71.9 m; Post: 516.6 ± 83.3 m; $p = 0.037$). Additionally, significant reductions were observed in HDL (Pre: 69.5 ± 23.5 mg/dl; Post: 24.5 ± 8.8 mg/dl; $p < 0.001$), total cholesterol (Pre: 215.6 ± 39.1 mg/dl; Post: 179.3 ± 47.9 mg/dl; $p = 0.016$), glucose (Pre: 105.7 ± 6.3 mg/dl; Post: 100.5 ± 6.5 mg/dl; $p = 0.016$), and total protein levels (Pre: 7.01 ± 0.4 g/dl; Post: 6.4 ± 0.2 g/dl; $p < 0.001$). No significant changes were detected in other biochemical markers. Additionally, improvements in 6MWT performance were positively correlated with the variations of LDL levels ($r = 0.490$; $p = 0.024$), suggesting a potential link between functional capacity and lipid profile adaptations.

CONCLUSION: Walking training can positively improve the functional capacity in people with PD, and lead to favorable changes in biochemical markers, including reductions in HDL, total cholesterol, glucose, and total protein levels. These findings suggest that walking training may not only enhance motor function but also improve metabolic parameters associated with PD progression.

**IMPACT OF PARKINSON'S DISEASE SEVERITY ON SINGLE- AND DUAL-TASK TURNING PERFORMANCE: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: Parkinson's Disease (PD) is a progressive neurodegenerative disorder that severely impacts mobility, particularly turning movements, which are essential for daily activities. Impaired turning is linked to a higher risk of falls and reduced quality of life in individuals with PD (lwPD). While gait disturbances in PD have been extensively studied, the impact of disease severity on turning performance, especially under dual-task conditions, remains underexplored. This study aimed to compare single- and dual-task turning performance and assess the influence of PD severity on turning performance.

METHODS: Seventy individuals with mild to moderate PD (H&Y II–III; 70.9 ± 6.9 years) underwent clinical assessments (MDS-UPDRS II: 14.0 ± 7.2 AU; MDS-UPDRS III: 30.8 ± 12.7 AU; MoCA: 24.7 ± 2.6 AU). Participants performed turning tasks under single-task (ST) and cognitive-motor dual-task (DT) conditions while wearing APDM tri-axial accelerometer sensors in the "ON" medication state. Turn angle, angle variability, duration, duration variability, velocity, and velocity variability were analyzed across ST and DT conditions between mild and moderate lwPD.

RESULTS: lwPD with mild PD (H&Y II) exhibited differences in ST turn duration and velocity ($p < 0.05$) compared to those with moderate PD (H&Y III), while DT turn angle, duration, and velocity also significantly differed ($p < 0.05$). In the mild PD group, turning velocity was 11% slower during DT compared to ST ($p < 0.05$). In the moderate PD group, DT resulted in smaller turning angles, greater angle variability, slower turning velocity, and increased velocity variability compared to ST ($p < 0.05$).

CONCLUSION: Disease severity significantly impacts turning performance, particularly under dual-task conditions. As PD progresses, turning becomes more impaired, with increased variability and reduced stability. These findings highlight the importance of early identification of mobility deficits and the need for targeted interventions to mitigate fall risk and enhance mobility in individuals with PD.

## Oral Presentations

### OP-SH18 Psychology III - Motivation

**AFFECTIVE EXPERIENCES FROM EXERCISE PREDICT 1-YEAR PHYSICAL ACTIVITY BEHAVIOR IN MIDDLE SCHOOL STUDENTS**

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Introduction: The transition from childhood to adolescence is a critical period for the development of physical activity (PA) behaviors, as this stage marks the beginning of a well-documented decline in PA levels that continues into adulthood. However, it remains largely unknown which determinants are most influential in this stage of life. According to the Affective-Reflective Theory (ART) of physical inactivity and exercise proposed by Brand and Ekkekakis, PA behavior is driven by both "reflective evaluations" and "affective valuation". The concept of "affective valuation" has been further refined into the construct of "affective exercise experiences", defined as a summary valenced appraisal—ranging from pleasant to unpleasant—based on an individuals lifetime associations with exercise and their corresponding affective responses. This study aims to assess the predictive power of affective exercise experiences in determining PA behavior among middle school students. The hypothesis is that attraction to exercise—the motivational outcome variable in the conceptual model proposed by Ekkekakis et al.—effectively predicts PA behavior after one year.

Methods: Data were collected as part of an annual PA monitoring project conducted in schools in Ferrara, Italy. Students completed the International Physical Activity Questionnaire for Children and Adolescents (IPAQ-A) and the Affective Exercise Experiences Questionnaire (AFFEXX). Only students with two assessments spaced one year apart were included in the study.

Results: A total of 228 middle school students (mean age = 12.62 ± 0.83 years; 135 males, 93 females) were assessed over two consecutive school years. At baseline, participants were highly physically active, engaging in an average of 21 ± 23 MET/h/week of PA, predominantly at vigorous intensity (162 ± 192 min/week), with a smaller portion performed at moderate intensity (92 ± 155 min/week). All AFFEXX domains measured at baseline were significantly correlated with PA at follow-up (r values ranging from 0.14 for energy-calmness to 0.38 for showing-off–shying away). Regression analysis indicated that attraction towards exercise significantly predicted follow-up PA ($\beta = 5.9$, $p < 0.001$). When examining the relationship between attraction and PA intensity, attraction significantly predicted vigorous PA ($\beta = 51.1$, $p = 0.002$), whereas its effect on moderate PA was not significant ($\beta = 16.2$, $p = 0.11$).

Conclusion: These findings highlight the role of affective experiences from exercise in shaping future PA behaviors, particularly in relation to vigorous-intensity activities. Understanding children's affective appraisals of exercise, their exercise environment, and their overall attraction to exercise may be crucial for promoting sustained PA engagement in youth.

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**KEY MOTIVATIONAL FACTORS FOR DRIVE FOR MUSCULARITY IN BODYBUILDING**

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INTRODUCTION: The aspiration for a muscular physique has been a defining characteristic of modern fitness cultures, with bodybuilding serving as a prominent subculture centered on muscle maximisation.At the core of this community is the Drive for Muscularity (DFM),which functions as both a psychological and cultural construct.DFM reflects an individuals strong inclination to enhance muscularity in pursuit of a well-defined physique.This drive is intertwined with broader themes of masculinity,body image,personal identity, and the quest for social validation.The motivational underpinnings of DFM are multifaceted.While many individuals are driven by aspirations of self-improvement and increased self-confidence, additional influences may also play a role.Despite the increasing interest in understanding the motivations behind DFM, there is a notable paucity of research focusing on Filipino population.Integrating Self-Determination Theory (SDT) into the DFM construct provides a framework for examining the role of three fundamental psychological needs—autonomy, competence, and relatedness—in shaping individuals motivations and behaviors in their pursuit of muscularity.

Methods:A total of 117 participants,conveniently sampled,participated in the present study.The age group ranged from 18-65,Filipino males (68.4%) and females (31.6%).The average age is 32.25 years (SD = 9.58).Participants were recruited from a local gym in Davao City,Philippines.The study received ethical approval from the Hungarian University of Sports Science.The Drive for Muscularity Scale (DMS) a 15 item instrument designed to assess the individuals' attitudes and behaviour in relation to their pursuit of muscularity.A 6-point Likert scale ranging from (1) never to (6) always,with higher scores indicating a greater drive for muscularity.Two reasons for utilizing DFM:1)participant identification & 2)to evaluate the drive for muscularity of the target population and ensure generalizable results. The Motives for Physical Activity Measure Revised (MPAM- R),a 30-item questionnaire evaluates five motives for physical activity engagement.A 5-point Likert scale, where 1 represents "not true for me" and 5 signifies "very true for me". Utilizing MPAM-R facilitates an understanding of the underlying reasons influencing physical activity engagement.Descriptive statistics was employed to analyze the key motivational factors for drive for muscularity.

Results/concusions:Participants engage in an average of 1.92 hours of workout per week (SD = 0.89),and exhibit varying degrees of muscularity-oriented behaviors (M=3.55) and attitudes (M=2.75).High scores in interest/enjoyment(M=4.19),competence(M=4.20),appearance(M=4.08), and fitness(M=4.51) suggest positive perceptions in these areas, while social engagement (M=2.88) shows more variability.Grounded in SDT this research will further explore key motivational determinants such as personal goals, body image satisfaction and social media influence.

**AN INVESTIGATION OF THE BIDIRECTIONAL RELATIONSHIP BETWEEN SELF-EFFICACY AND ULTRA-CYCLING PERFORMANCE: THE NORTH CAPE 4000 STUDY**

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*UNIPV*

INTRODUCTION: Ultra-cycling is defined by its extreme length and duration (over 24 hours), along with numerous variables that impact the outcome. Among these, psychological variables are thought to play an important role. The main aim of this study was to investigate 1) the relationship between self-efficacy before the race (SEpre) and performance, and 2) the effect of race performance on SE during an unsupported ultra-cycling event known for its iconic route of over 4000 km from Rovereto to North Cape.

Method: All 350 participants to the North Cape 4000 were asked to volunteer for this observational study which included the completion of a battery of questionnaires before and after the race. The questionnaires included the Endurance Sport Self-Efficacy Scale (Anstiss et al., 2018). A preliminary study found that the items of this scale are relevant to ultra-endurance. Additional questions included goal setting, training status and other variables. Performance was evaluated in three ways: race time; goal achievement (GA, reaching vs not reaching the personal goal); and finisher status (FS, finishing vs not finishing the race within the time limit of 21 days). Pearson analyses were conducted to evaluate the correlations between SEpre and SEpost minus SEpre (ΔSE) with race time. A logistic regression was used to assess the relationship between SEpre and GA. Two-way (GA x time; FS x time) repeated-measure ANOVAs were used to assess the change in SE between pre- and post-race, and the moderating effects of GA and FS. Significance was set at $p < 0.05$ for all analyses.

RESULTS: The pre-race questionnaire was completed by 77 participants, with 63 (54 males, age 47±12 years) also completing the post-race one. The SE of the participants increased significantly after the race (SEpre 76 ± 11 vs SEpost 80 ± 10, p=0.001). The ΔSE was slightly higher among those who achieved their personal goal (n = 39, 5.7 ± 2.7) than those who did not (n = 24, 2.8 ± 0.9). However, the difference is not statistically significant (p=0.220). Similar results were found for the analysis with FS as the moderator (43 finishers, 20 not finishers). No significant correlations with race time were found for SEpre and for ΔSE. Logistic regression found no significant associations between SEpre and GA, and between SEpre and FS.

Conclusions

Contrary to our hypotheses, we found no associations between self-efficacy before the race and various performance measures. We also failed to find the expected moderating effects of GA and FS on the effect of participating in the race on

SE. The significant increase in SE among the participants who took part in the North Cape 4000 suggests that simply participating in this challenging event provides a mastery experience sufficient to increase SE.

Anstiss, P. A., Meijen, C., Madigan, D. J., & Marcora, S. M. (2018). Development and initial validation of the Endurance Sport Self-Efficacy Scale (ESSES). Psychology of Sport and Exercise, 38, 176–183.

**NEED SATISFACTION AND PHYSICAL PERFORMANCE IN ADOLESCENT HANDBALL PLAYERS: AN INTERDISCIPLINARY STUDY**

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INTRODUCTION: Research has consistently demonstrated the important role of basic need satisfaction in shaping adolescent team sport players' psychological experiences and physical efforts. Despite these insights, few studies have integrated objective physical measures with traditional self-report instruments. This study aims to bridge this gap by examining the dynamics between adolescent team sport players feelings and sport enjoyment, and their physical performance in youth team sport practices, ultimately providing interdisciplinary insights and suggestions for future research.

METHODS: The study followed two adolescent handball teams (n = 50) over the course of 11–12 practices across a 4-week period. Data were collected on both psychological variables such as players feelings of pleasure/displeasure and sport enjoyment, and physical performance measures such as players intensity (high-intensity events > 1.5 m/s; HIE) and workload (PlayerLoadTM) in practice. A Bayesian two-level regression analysis was employed to evaluate the relationship between basic need satisfaction and the psychological and physical outcomes.

RESULTS: The analysis indicated a good overall fit to the data (PPp = 0.48, 95% Confidence Interval = [-21.17, 25.71]). Basic need satisfaction was found to have credible positive associations with psychological outcomes (feelings of pleasure and sport enjoyment) as well as physical measures (greater PlayerLoadTM and high-intensity events > 1.5 m/s; HIE), with regression coefficients ranging between 0.82 and 0.91. These findings support the notion that need satisfaction plays a significant role in enhancing both the mental and physical aspects of adolescent handball players' performance.

DISCUSSION: The results underscore the importance of fostering basic need satisfaction in young athletes, suggesting that enhanced psychological experiences (feelings of pleasure and sport enjoyment) may be closely linked with increased physical engagement and performance (players intensity and workload in practice). By integrating objective physical measures with subjective reports, the study provides a more comprehensive understanding of how psychological factors contribute to physical athletic performance. These interdisciplinary insights highlight the potential for developing targeted interventions in youth sports programs, as well as suggesting future research to further explore the intricate balance between psychological needs and physical effort in youth sport.

**COACHES AND PARENTS-INITIATED MOTIVATIONAL CLIMATE INFLUENCES WELL- AND ILL-BEING AND MOTIVATIONAL ORIENTATIONS OF YOUTH ATHLETES**

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Motivation plays a crucial role in sport, not only in shaping athletes intentions to participate while preventing dropout and burnout (Sarrazin et al., 2002; Fraser-Thomas et al., 2008; Vitali et al., 2015), but also in influencing well- and ill-being of youth athletes (Adie et al., 2010). A prominent theoretical framework to study motivation in sport is the achievement goal theory (Nicholls, 1984). This approach ascribes importance to individual motivational dispositions, as well as to situational factors (i.e., motivational climate). In a mastery (task-involving) climate, coaches and parents emphasize improvement and effort. Conversely, in a performance (ego-involving) climate, coaches and parents foster social comparison and normative-based evaluation. Despite evidence linking motivational climate with individual motivational orientations (task and ego), its influence on well- and ill-being (i.e., concentration disruption, somatic symptoms, and worry) of youth athletes is less known. To address this gap, we carried out a study with 690 youth athletes aged 8 to 15 years old (332 girls, mean age 11.00 ± 1.53 years). We tested a mediation model with coach- and parent-initiated motivational climate (performance and mastery) as predictors, individual motivational orientations (task and ego) as mediators, and well-being and sport-related ill-being (i.e., concentration disruption, somatic symptoms, worry) as outcomes. The model was tested on the whole sample and separately for younger (aged 8-10) and older (11-15) participants. Mediation analyses were carried out in MPlus (Muthén, & Muthén, 2017) using bootstrapping (5,000 resamples, 95% CI). Results regarding the whole sample showed that coach- and parents-initiated mastery climates were associated with greater well-being, lower concentration disruption and reduced worry via task orientation. No other significant effects emerged. Results for the two subsamples generally replicated these findings, except for the indirect effects of task orientation in the relation between coach/parents-initiated mastery climate and worry the younger children sub-sample. These results highlight the role of coaches and parents in promoting well-being and reducing sport-related ill-being of youth athletes. From an applicational perspective, educating significant adults on fostering a mastery climate is crucial, as it not only emphasizes effort, but ultimately enhances youth athletes general well-being, thus operating as a protective factor in life.

# Oral Presentations

## OP-MH15 Ageing I

### PROSPECTIVE FALL RISK AND FUNCTIONAL PERFORMANCE IN OLDER ADULTS WITH AND WITHOUT PROBABLE COGNITIVE IMPAIRMENT FOLLOWING AN EMERGENCY DEPARTMENT PRESENTATION

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INTRODUCTION: Severe falls among older adults are a major cause of emergency department (ED) visits, often leading to reduced physical activity, functional decline, and diminished quality of life. While an ED presentation due to a severe fall is itself a significant risk factor for negative health outcomes, cognitive impairment further exacerbates the risk of recurrent falls and functional deterioration. Identifying the distinct needs of individuals with and without probable cognitive impairment (pCI) is crucial for tailoring secondary prevention strategies, such as balance and strength training.

METHODS: Participants were recruited from the SeFallED study, which follows individuals aged ≥60 years who presented to the ED after a severe fall but were not hospitalized. Functional (SPPB) and cognitive (MoCA) performance were assessed through home-based geriatric evaluations within four weeks of the fall, and subsequently at six and 12 months. Physical activity levels were quantified using a three-axial accelerometer (activPAL4, PAL Technologies Ltd., Glasgow, UK), worn continuously for seven days at each assessment point to record step count and sedentary time. Functional outcomes were analyzed using repeated measures ANCOVA, adjusted for age. Fall incidence was assessed via monthly telephone follow-ups and analyzed with chi-square tests.

RESULTS: After 12 months, valid data on recurrent falls were available for 126 older adults who are cognitively healthy (OACH, mean age 70.7, SD: 7.8; MoCA: 26.8, SD: 1.4) and 116 individuals with pCI (mean age 77.1, SD: 8.4; MoCA: 21.8, SD: 1.9). Recurrent falls were significantly more frequent in pCI (61/116) than in OACH (46/126; $p = 0.012$). Severe falls requiring medical attention occurred in 27 individuals with pCI, compared to 13 in OACH ($p = 0.018$). Despite these differences, functional performance (SPPB scores) and sensor-based measures of step count and sedentary time did not differ significantly between groups. Cognitive performance improved in both groups over time but remained significantly lower in pCI at all time points ($p < 0.001$), with mean scores consistently meeting MoCA criteria for pCI.

CONCLUSION: These findings highlight the elevated risk of recurrent and severe falls requiring medical attention among individuals with pCI, despite comparable functional performance to OACH. This suggests that fall risk in pCI may be influenced by cognitive-motor interactions rather than functional decline alone. Further research is needed to explore mechanisms underlying these associations and develop targeted interventions to reduce fall-related risks in this high-risk population.

1. Stuckenschneider T, et al: Sentinel fall presenting to the emergency department (SeFallED) - protocol. BMC Geriatr 2022, 22(1):594.

### SUBMAXIMAL ECCENTRIC TRAINING DURING IMMOBILIZATION DOES NOT PREVENT SERIAL SARCOMERE LOSS OR IMPAIRMENTS IN MECHANICAL FUNCTION IN OLD OR YOUNG RATS

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INTRODUCTION: The age-related loss of muscle mass is partly driven by a reduction in serial sarcomere number (SSN), and further SSN loss occurs during immobilization. SSN is associated with optimal force and power production and muscle passive tension, thus immobilization-induced SSN loss is especially a concern for older individuals who are often subjected to forced muscle disuse with illness and injury. We previously showed that submaximal eccentric resistance training increased SSN and improved muscle mechanical function in old rats. The present study investigated whether this training could prevent the losses of SSN and function when performed intermittently during immobilization.

METHODS: 10 old (32 months) and 10 young (8 months) rats underwent unilateral casting of the plantar flexors in a shortened position for 2 weeks. Thrice weekly, casts were removed for isokinetic eccentric resistance training of the plantar flexors with a stimulation intensity corresponding to 60% of the maximum torque development. Pre- and post-training we assessed in-vivo maximum isometric torque at ankle angles corresponding to stretched and neutral muscle lengths, the passive torque-angle relationship, and isotonic power.

RESULTS: The soleus and medial gastrocnemius were harvested for SSN measurements, with the untrained leg as a control. In both old and young rats, muscles of the casted leg had smaller muscle wet weights (-20-40%, $P<0.001$), physiological cross-sectional area (-6-20%, $P<0.001$), and SSN (-7-29%, $P<0.001$) than the control leg. Furthermore, maximum isometric torque (-37-46%, $P<0.001$) and isotonic power (-≈70%, $P<0.001$) decreased, and maximum passive torque increased (+≈400%, $P<0.001$) from pre- to post-training for both age groups. These changes are similar in magnitude to what we observed previously with casting alone.

CONCLUSION: Thus, irrespective of age, submaximal eccentric resistance training 3 days/week during casting did not prevent the losses of muscle contractile tissue and mechanical function.

**A COMPARATIVE STUDY OF BONE MINERAL DENSITY AMONG THE ELDERLY IN DIFFERENT OCCUPATIONS**

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INTRODUCTION: China is becoming one of the fastest-aging countries in the world. There is sufficient evidence to show that human health will gradually decline with people aging, including a significant decrease in bone mineral density (BMD) of the elderly, and a great increase in the risk of osteoporosis in the elderly group. Different occupations have great differences in the cumulative effect of physical activity during long-term work, and the benefits of long-term physical activity during work may result in different effects on the BMD of the elderly. This study compares the BMD of the elderly in different occupations.

METHODS: Using Internet to recruit elderly people who living in Beijing. The inclusion criteria of the subjects are: 60-70 years old, able to walk and communicate normally. Inviting included subjects to accept the BMD test. Before the start of the test, they are required to finish a questionnaire. The content of the questionnaire includes: the working years, the occupation, the category of the work and the level of physical activity during the working period. Standards for grouping the level of physical activity: According to the standards published by the World Health Organization (WHO), subjects are divided into physical active groups (performing 150 minutes or more of moderate to high-intensity physical activity per week) and physical inactive group (less than 150 minutes of high-intensity physical activity per week). Using the speed of sound (SOS), bone density T score (T-score), and bone density Z score (Z-score) to judge the subjects BMD situation. The independent sample T test tests the difference between different physical active groups.

RESULTS: A total of 770 subjects（64.86±2.98 yrs） were recruited for this study. There are 338 people (65.44±3.03 yrs) in the physical active group and 432 people (64.92±2.64 yrs) in the physical inactive group. It is found that the physical active group in SOS, T-score, Z-score were significantly higher than inactive group（4150.35±197.17 vs. 3689.01±189.73, -0.71±3.53 vs.-1.99±0.12, 0.27±2.61 vs.-1.15±0.35, P<0.05）; For male, the physical active group had significant higher in SOS, T-score, Z-score than the inactive group（4155.61±186.09 vs. 3687.61±168.09, -0.12±0.77 vs.-1.73±0.98, 0.2±0.8 vs.-1.08±0.99, P<0.05）; For women, the physical active group has significant higher SOS and Z-score than the inactive group (4148.20±101.36 vs. 3689.57±707.20, -0.30±1.07 vs.-1.2±1.04, P<0.05). In the physical active group, female T-score and Z-score were significantly higher than female (-0.12±0.77 vs. -0.76±0.91, 0.2±0.8 vs. -0.30±1.07, P<0.05).

CONCLUSION: The BMD of the elderly who are more physically active is significantly better than physically inactive during the work period. There is no significant difference in the T-score between the two groups in the female group. In summary, physical active during work helps to reduce the risk of BMD decrease, and the BMD in males is more likely to be improved by physical activity.

**DOMAIN-SPECIFIC PHYSICAL ACTIVITY AND RISK OF DEMENTIA IN OLDER ADULTS: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: Dementia poses a significant public health challenge among aging populations. Early identification of dementia risk is critical for implementing preventive interventions, and physical activity (PA) has emerged as a modifiable protective factor. While total PA is associated with reduced cognitive decline, the differential effects of domain-specific PA—leisure, transportation, and household—on dementia risk remain underexplored. This study aimed to investigate associations between PA domains and dementia risk in older adults, adjusting for demographic factors.

METHODS: This cross-sectional study included 765 retirees (mean age 72.8 ± 8.5 years; 64.8% female) from Tsinghua University, Beijing, China. PA was assessed using the Physical Activity Scale for the Elderly (PASE), with scores categorized into leisure, transportation, household, and total domains. Dementia risk was classified via the Ascertain Dementia 8-item Questionnaire (AD8), with scores ≥2 indicating high risk. Descriptive statistics, independent t-tests, and logistic regression were conducted, adjusting for age, gender, and BMI.

RESULTS: High dementia risk was observed in 31.5% of participants (n = 241). Compared to the low-risk group, high-risk individuals exhibited lower total PA (96.1 ± 64.0 vs. 109.2 ± 66.7, $p < 0.05$; Cohen's d = 0.20), transportation PA (25.3 ± 20.4 vs. 29.4 ± 25.3, $p < 0.05$; Cohen's d = 0.17), and household PA (34.2 ± 30.7 vs. 41.5 ± 34.0, $p < 0.01$; Cohen's d = 0.22). Leisure PA showed no significant difference ($p > 0.05$). In adjusted models, an increase in household PA was associated with a reduction in dementia risk (OR = 0.93, 95% CI: 0.89–0.98, p = 0.01). Leisure and transportation PA demonstrated no significant associations ($p > 0.05$).

CONCLUSION: Household PA was inversely associated with dementia risk in older adults, indicating the potential cognitive benefits of daily household engagement. Future longitudinal studies are needed to confirm causality, and interventions should prioritize domain-specific PA promotion, particularly household activities.

**GENDER DIFFERENCE IN CROSS-SECTIONAL AREA AND FAT INFILTRATION OF THIGH MUSCLES IN OLDER POPULATION ON MRI: AN AI-BASED ANALYSIS**

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INTRODUCTION: Aging alters musculoskeletal structure and function, affecting muscle mass, composition, and strength, increasing the risk of falls and loss of independence in older adults. This study assessed cross-sectional area (CSA) and fat infiltration (FI) of six thigh muscles through a validated deep learning model. Gender differences and correlations between fat, muscle parameters, and age were also analysed.

METHODS: This retrospective study analysed 141 participants (67 females, 74 males) aged 50-80 years. Participant underwent MRI scans of the right thigh and dual-energy X-ray absorptiometry to determine appendicular skeletal muscle mass index (ASMMI) and body fat percentage (FAT%). A deep learning-based application was developed to automate segmentation of six thigh muscle groups on MR images.

RESULTS: Deep learning model accuracy was evaluated using the Intersection over Union (IoU) metric, with average IoU values across muscle groups ranging from 0.84 to 0.99. Mean CSA was 10,766.90 mm² (females: 8,892.61 mm², males: 12,463.90 mm²; $p<0.001$), and the mean FI was 14.92% (females: 17.42%, males: 12.62%; $p<0.001$). Males showed larger CSA and lower FI in all thigh muscles compared to females. Negative correlations were identified in females between FI of posterior thigh muscle groups (biceps femoris, semimembranosus, and semitendinosus) and age, while no correlations were observed between CSA, ASMMI, or FAT% and age.

CONCLUSION: These findings underscore the impact of aging on muscle composition and distribution, emphasizing the need for gender-specific assessments in older adults. Furthermore, deep learning techniques accurately quantify muscle CSA and FI, reducing analysis time and human error.

## Oral Presentations

### OP-AP28 Statistics and Analyses II - Team Sports

**QUANTIFYING THE EXTERNAL GAME DEMANDS OF PROFESSIONAL, MALE BASKETBALL PLAYERS IN THE AUSTRALIAN NATIONAL BASKETBALL LEAGUE**

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INTRODUCTION: While professional basketball games have been shown to impose various movements on players such as sprints, jumps, accelerations, decelerations, and changes-of-direction (1), minimal research has quantified the external game demands of players competing in the Australian National Basketball League (NBL), with no research providing such data specific to playing role and position. To address this gap, this study examined the external game demands of professional, male basketball players competing in the Australian NBL, according to playing role and position.

METHODS: Twenty-two professional, male basketball players (age: 27.0 ± 3.3 years; height: 196 ± 8.2 cm; body mass: 94.0 ± 13.9 kg) from the same club were monitored over two consecutive competitive seasons (2021–2023) using microsensor technology (ClearSky T6; Catapult Sports). Players were categorised according to playing role (starters vs. bench) and playing position (frontcourt vs. backcourt). Accumulated (total) and relative (per min) external game demands were calculated for PlayerLoad™, Inertial Movement Analysis (IMA) count, jump count, and high-intensity jump count during active playing time. External game demands were compared between playing role and position via linear mixed modelling and effect size (Cohen's d) analyses.

RESULTS: Starters experienced significantly higher accumulated PlayerLoad™ in both backcourt (d = 1.39 (0.90, 1.88, large effect) $p<0.01$) and frontcourt (d = 1.66 (1.29, 2.04, large effect) $p<0.01$) positional groups, as well as significantly higher accumulated IMA (d=1.44 (0.95,1.94, large effect) $p<0.001$, and d=1.53 (1.15,1.90, moderate effect) $p<0.001$), respectively. Considering playing position, starting frontcourt players performed more total (d=1.15 (0.05,2.23, moderate effect) $p>0.05$) and high-intensity (d=1.02 (-0.07,2.11, moderate effect) $p>0.05$) jumps during games compared to backcourt players; however, these differences were not significant. Opposite to accumulated external game demands, there were no significant ($p>0.05$) differences in relative external game demands between playing roles and positions.

CONCLUSION: The current study is the first to quantify the external game demands of professional basketball players competing in the Australian NBL considering playing role and position. These findings demonstrate starters experienced greater accumulated external loads in games likely due to increased playing durations, which may highlight the need for compensatory training plans in bench players. The greater jump requirements for frontcourt players in games emphasise that position-specific training and tactical plans are warranted. In turn, the comparable external demands per minute of play across both playing roles and positions suggests all players may move at similar intensities during games.

**COMPARISON OF TACTICAL TENDENCIES BETWEEN 3X3 AND 5X5 BASKETBALL: ANALYSIS OF MEN'S AND WOMEN'S WORLD CUPS**

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INTRODUCTION: Basketball 3x3 was introduced by FIBA in 2010 [1]. Literature of tactics in this sport is limited, requiring investigations on differences to 5x5 basketball to support practice. The space creation dynamics (SCDs) - a set of offensive game action classes for creating space to score [2] - have been used to analyze basketball tactics and may support 3x3 and 5x5 comparisons. This study compared 3x3 and 5x5 basketball, women and men, analyzing the frequency and type of game actions, respective court zones used, and efficiency.

METHODS: Matches of women's (35 matches; 2118 ball possessions) and men's (41; 2316) in the 3x3 World Cup – 2023, women's (8; 1226) and men's (8; 1218) in the 5x5 World Cup – 2023 were assessed. A single researcher collected the data (Cohens Kappa result: > .90 for all variables). The following SCDs were notated: pick, screen, ball dribbled, ball not dribbled, hand-off, post-up, dime-in, spot-up, without ball and isolation. The court was divided in the zones: top (TOP), top of key (TPK), key (K), wing (W), short wing (SW), corner (C), short corner (SC), high post (HP), low post (LP). Efficiency was analyzed in points per possession (ppp). Bayesian methods were used to estimate the mean frequency of the SCDs per ball possession of each compared group (3x3W, 3x3M, 5x5W, 5x5M). Posterior distributions of means were computed from the Markov chain Monte Carlo draws. Statistical significance was considered when posterior probability of the mean difference exceeding 0 was > 0.90. Chi-square test was used to analyze differences in the use of court zones and respective SCD types (alpha = 0.05).

RESULTS: Posterior means of SCDs per ball possession were: 3x3W = 1.85, 3x3M = 1.95, 5x5W = 2.56, and 5x5M = 2.47. 5x5 (W and M) had significantly more SCDs per ball possession than 3x3 (M and W) although it represented less than one SCD per possession. TOP, TPK and W, added, presented proportions between 51% - 63% of all zones used by every group to create space. Significant association was found between zones and groups ($p < 0.001$): 3x3W - TPK (29.7%); 3x3M: SW (16.3%); 5x5W: K (8.2%); 5x5M: TOP (28.3%). Pick, screen and ball dribbled, added, presented proportions of the total SCDs performed between 57% - 70% for all groups. Significant association was found between groups and SCD types performance ($p < 0.001$), presented with the respective efficiency (ppp): 3x3W: post-up(12.2%, 0.5 ppp); 3x3M: handoff(17.4%, 0.58); 5x5W: screen(28.2%, 0.6); 5x5M: pick(28.2%, 1.1).

CONCLUSION: Basketball 3x3 and 5x5 had different game actions per possession but with minimal practical impact (less than one action). Worth noting, 3x3 possession time (12") is half of 5x5 (24"). Perimeter was mostly emphasized in both sports besides specific tendencies. Groups' preferred SCDs had small ppp rates.

1. Andrianova (2022) 2. Lamas et al. (2011)

**INVESTIGATING LOAD FLUCTUATIONS ACROSS QUARTERS IN MALE PROFESSIONAL BASKETBALL PLAYERS: IMPLICATIONS FOR GAME PERFORMANCE AND STRATEGY OPTIMIZATION**

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INTRODUCTION: Tracking the dynamics of game loads across quarters is crucial for coaches; however, a significant limitation in existing research is the lack of integration between dynamic inter-period changes and positional specificity. While some studies consider player positions, they often fail to account for temporal dynamics across game periods. Conversely, research focusing on inter-period variations typically overlooks the distinction between player positions. Therefore, further investigation to bridge this gap is essential. This study aims to examine between- and within-quarter variations in physical loads during basketball games, exploring their interrelationships and considering the influence of contextual factors on the load profiles experienced by backcourt and frontcourt players.

METHODS: A total of 16 professional male basketball players (8 backcourt, 8 frontcourt) from the Chinese National Basketball League were recruited. External load was assessed using Catapult S7 devices, capturing PlayerLoad and Inertial Movement Analysis (IMA) variables. Internal load was measured using the session rating of perceived exertion (sRPE) method. Opponent quality, match outcome, and scoring margin (contextual factors) were incorporated into the analysis. Data were analyzed using linear mixed-effects models and repeated-measures correlation analyses.

RESULTS: Frontcourt players exhibited more pronounced fluctuations in sRPE ($F=3.378$; $p < 0.05$) and IMA changes of direction (COD) left ($F=4.409$; $p < 0.01$) from the first quarter to the fourth quarter. In contrast, backcourt players demonstrated more stable between-quarter changes but showed larger within-quarter load variations, including higher IMA jump medium in the first three quarters ($p < 0.01$), and greater IMA accelerations (ACC) ($p < 0.05$) and decelerations (DEC) ($p < 0.01$) in the second and fourth quarters compared to frontcourt players. Medium to large ($r = 0.41–0.62$) correlations were observed between sRPE and PlayerLoad as well as total jumps across quarters for backcourt players. For frontcourt players, sRPE showed medium to large correlations ($r = 0.45–0.72$) with PlayerLoad, IMA COD, and IMA high jumps across quarters. Backcourt players reported higher sRPE during winning games compared to losing games ($ES = 0.34$; $p < 0.05$).

CONCLUSION: The study reveals distinct game load patterns for backcourt and frontcourt basketball players, with frontcourt players experiencing greater physical and perceptual fluctuations across the game, while backcourt players exhibit more consistent between-quarter loads but larger within-quarter variations. The higher sRPE reported by backcourt players during winning games suggests the influence of contextual factors on perceptual measures. These findings un-

derscore the importance of position-specific training strategies that optimally prepare backcourt and frontcourt players for the specific game loads.

**KINEMATIC VARIABLES AND MATCH OUTCOMES IN SERIE A: THE IMPACT OF ACCELERATION AND SPRINT DISTANCE**

TROIANI, P., LUCADAMO, A., LATERZA, F., SAVOIA, C., BERTOLLO, M., POMPA, D.
*UNIVERSITY*

INTRODUCTION: The influence of kinematic variables on the outcome of the match has not been extensively investigated, especially in the Italian First Division. Our objective is to fill this gap by analyzing key performance indicators derived from tracking data, focusing on how these metrics relate to different match results (win, draw, loss). This study aims to explore how kinematic, mechanical, and metabolic parameters influence match outcomes in the Italian Serie A during the 2022/2023 and 2023/2024 seasons.

METHODS: We employed a multinomial logit model to evaluate the probability of various match outcomes based on differences in physical metrics between competing teams. The response variable included three categories: win (W), draw (D), and loss (L), with the loss serving as the reference category. Key variables analyzed were Total Distance Covered (Diff_TDC), High-intensity acceleration distance (>3 m/s²; Diff_D_H-acc), sprint distance (> 25 km/h; Diff_D_VHSR), and Metabolic Power High-Intensity (Diff_D_MPHI).

RESULTS: Our findings indicate that Diff_H-acc and Diff_VHSR have a stronger impact on the probability of winning compared to drawing. In both leagues analyzed, these variables are significant when considering the "Win" category. However, for the "Draw" estimates, the p-values are slightly exceeded 0.05, with Diff_D_VHSR showing an even higher value in the 2023/24 season. This suggests that while these two variables have a relatively small influence on the probability of drawing versus losing, they significantly affect the probability of winning versus losing. Specifically, for the 2022/23 season, a 10-meter increase in the difference between the distances covered at high speed by the two teams raises the probability of winning by approximately 12.45%. In the 2023/24 season, the same increase in the explanatory variable leads to a rise of about 17.89%. In contrast, the impact of Diff_D_H-acc on the probability of success is more pronounced. Based on the estimated coefficients, in the first season, a 10-meter increase results in a probability increase of more than 46%. For the 2023/24 season, the probability of winning versus losing rises by approximately 33.6%.

CONCLUSION: From an applied perspective, our results underscore the importance of high-intensity actions, particularly accelerations, in influencing match outcomes. This insight aligns with existing literature emphasizing the tactical value of aggressive pressing and rapid transitions. Coaches and performance analysts can leverage these findings to prioritize training interventions that enhance players explosive capabilities, potentially leading to improved competitive performance. By integrating advanced statistical modeling with applied performance analysis, this study contributes to a deeper understanding of the physical demands in elite soccer and their relationship to tactical success in Serie A.

**TRENDS IN HIGH-INTENSITY RUNNING PERFORMANCE: A COMPARATIVE ANALYSIS OF PLAYERS IN THE FIFA WOMENS WORLD CUP**

LUO, J., CUI, D., QU, Y.
*CHINA INSTITUTE OF SPORTS SCIENCE*

INTRODUCTION: High-intensity running (HIR) is a key performance metric in modern football. However, research on HIR in the FIFA Womens World Cup remains limited[1]. This study analyzes 2019-2023 HIR trends using 2023 FIFA Womens World Cup post-match reports and FIFA research. Findings offer scientific insights to support coaches in optimizing training programs.

METHODS: Data were sourced from the 2019 FIFA World Cup Physical Report and 2023 FIFA Post-Match Summary Reports (116 matches).The analysis focused on full-match players HIR metrics across positions: goalkeepers (GK), forwards (FW), midfielders (MF), and defenders (DF), including total distance, high-speed running (Zone 4: 19-23 km/h), sprint running (Zone 5: >23 km/h), and HIR (>19 km/h). Statistical analysis utilized IBM SPSS Statistics 27 for 2023 data (Kruskal-Wallis and Mann-Whitney U tests, $p < 0.05$). For 2019 data, only percentage changes were calculated due to missing variance and sample size information.

RESULTS: GK showed a 10.8% decrease in total distance (2019: 5028m; 2023: 4485m), while Zone 4 running increased by 8.3% (2019: 24m; 2023: 26m). Both Zone 5 (2019:6m; 2023:4m) and HIR (2019:30m; 2023:29m) showed minimal changes.

DF showed a 2.1% decrease in total distance (2019: 9,933m; 2023: 9,725m), while Zone 4 running decreased by 5.9% (2019: 425m; 2023: 400m). Zone 5 distance showed minimal change (2019: 164m; 2023: 161m), and HIR decreased by 4.8% (2019: 589m; 2023: 561m).

MF showed minimal change in total distance (2019: 10,717m; 2023: 10,669m), while Zone 4 running decreased by 11% (2019: 526m; 2023: 468m). Zone 5 distance declined by 24.6% (2019: 183m; 2023: 138m), and HIR decreased by 14.5% (2019: 709m; 2023: 606m).

FW showed a slight increase in total distance (2019: 10,267m; 2023: 10,286m), with Zone 4 running increasing by 2.1% (2019: 530m; 2023: 541m). Zone 5 distance increased by 18.2% (2019: 220m; 2023: 260m), and HIR rose by 6.8% (2019: 750m; 2023: 801m).

Statistical Analysis: A significant difference was observed in the total running distance across positions (H = 420.901, df = 3, p < 0.001). Pairwise comparisons of outfield players revealed that FW and MF had significantly greater total running distances than DF (p < 0.001). Regarding Zone 4 and 5, FW had significantly higher distances than MF and DF (p < 0.001).

CONCLUSION: The results show that FWs metrics have increased, indicating a need for higher demands for HIR. In contrast, DF and MF slightly declined or remained stable, still above 2015 levels. This trend may result from improved player performance, higher match intensity, and advancements in 2023 tracking technology[1]. As in previous studies, DF covered the shortest distances due to defensive duties, while FW led in HIR, highlighting position-specific physical demands[2]. These trends stress the need for targeted training.

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## Oral Presentations

### OP-SH19 Identity and Gender

**ARE THERE GENDER DIFFERENCES IN ACADEMIC CAREER TRAJECTORIES? AN INVESTIGATION IN ITALIAN SPORT SCIENCE SCHOOLS AND DEPARTMENTS.**

PECCHINI, A., ROBAZZA, C., REGGIANI, L., SORGON, M., VITALI, F.

*UNIVERSITY OF VERONA*

INTRODUCTION: Women and men face different challenges in academic settings: despite women being approximately half of matriculating students in 2015, they represented only 28.8% of the total number of academics worldwide (UNESCO, 2018). The presence of gender differences in academia has been assessed through different perspectives: for example, female professors showed less risky research agendas (Santos et al., 2020) and fewer paper citations (Aiston and Jung, 2015). These inequalities are transversal to different fields and concern STEM disciplines specifically (Casad et al., 2020), such as surgery (Ferrari et al., 2022) and economics (Sarsons et al., 2021). In this study, we aim to investigate gender differences in academic career trajectories in a specific STEM field: the Italian Sport Science Schools and Departments.

Methods

All active members of 30 Italian Sport Science Schools and Departments in as many different universities were included in the study. From the data extracted from the curriculum vitae and personal websites' pages, we examined the academic career trajectories, taking into consideration the gender, the year in which the masters degree or PhD was obtained, the current position in academia, and the starting year of the actual position. The sample comprised 1,623 Sport Science academic members (674 women): 212 full professors, 482 associate professors, 314 assistant professors, and 615 temporary lecturers. Descriptive statistics, independent sample t-tests, and a fixed factor ANCOVA (gender x title) were conducted to analyze the data.

RESULTS: Descriptive analyses showed that women represented 42% of the total sample. Specifically, women comprised 51% of the assistant professors, 50% of the associate professors, and 35% of the full professors. Data from temporary lecturers were also analyzed, and women represented 32%. The Shapiro-Wilk test confirmed the normal distribution of the data (w=.97; p<.001). A title effect was present (p=<.001, d=.56), meaning that having a PhD title shortened the time to reach each academic position. A gender effect was present only for associate professors: men reached this position earlier than women (p=.013, d=.24).

Discussion: Descriptive data were coherent with the so-called "pipeline effect" in achieving gender equality in academia: although the number of assistant and associate professors was similar, women remained underrepresented in leadership positions (full professors) and less likely to achieve promotion (Waljee et al., 2015), as demonstrated by gender effect found for associate professors. Temporary lecturers, in contrast, aligned with the trend of female employment in sports-related fields (CONI, 2020), as this category typically comprises temporary professors responsible for teaching practical and applied sports lecturing. These results can stimulate a debate towards increasingly equitable and gender-inclusive academic paths.

**PERFORMANCE-ENHANCING DRUG ATTITUDE AND USE IN BODYBUILDERS: FOCUS ON THE PREDICTIVE ROLE OF PERSONALITY TRAITS AND IMPLICATIONS FOR REPRODUCTIVE HEALTH**

DE SANTI, M., SARLO, M., BORGHETTI, M., BRANDI, G.

*UNIVERSITY OF URBINO CARLO BO*

INTRODUCTION: The use of performance-enhancing drugs (PEDs) is a widespread and largely underestimated phenomenon, especially in amateur sports where there are no controls. Particularly, bodybuilders often resort to doping, risking compromising their general and reproductive health. This work aims to analyze the personality traits associated with the use of PEDs and the attitude to doping, and the implications for the reproductive health of bodybuilders.

METHODS: One hundred and four bodybuilders (31.7% female, 68.3% male) were asked to fill out an anonymous questionnaire about PED use, symptoms, and concerns about fertility, contextually with three validated questionnaires on per-

sonality traits: the Performance Enhancement Attitude Scale (PEAS), the Big Three Perfectionism Scale–Short Form (BTPS-SF), and the Ten-Item Personality Inventory (TIPI). Univariate and multivariate statistical analyses were used to find correlations between the variables.

RESULTS: The results revealed PED use in 36 bodybuilders (34.6 %), more in men (88.9 %) than in women (11.1 %). The most commonly used substances are anabolic androgenic steroids and growth hormone. In addition, males presented more symptoms, including those related to lower fertility, and had undergone tests or consulted a doctor to assess their ability to conceive. Notably, women who are concerned or have consulted a doctor about the effects of PEDs on their fertility said they do not use them. As expected, PED users had a higher attitude to doping (PEAS score). Regarding personality traits, the multiple regression analysis revealed that the attitude to doping was positively associated with narcissistic perfectionism and negatively with self-critical perfectionism.

CONCLUSIONS

This study confirms the high prevalence of doping in bodybuilding. The type of responses and gender differences suggest an underestimation of PED use, especially in females. This study confirms the danger of doping and the possible consequences that their use may have on the reproductive health of athletes. The assessment of doping attitude confirmed its predictive role in the use of these substances. In addition, although it is known in literature that perfectionism is associated with a greater attitude to doping, this study found that narcissistic perfectionism is particularly associated with it. On the contrary, self-critical perfectionism could represent a possible positive personality trait from a doping prevention perspective.

**ATHLETIC IDENTITY AND SPORT INJURY: A SYSTEMATIC REVIEW AND META-AGGREGATION**

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*UNIVERSITY OF MALAYA*

Objective: To systematically review qualitative studies on changes in athletic identity following sports injuries.

Methods: The study adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement. Electronic searches were conducted in Web of Science, Psychology & Behavioral Sciences Collection, PubMed, SPORTDiscus, and Scopus. Manual searches included forward and backward citation tracking via Google Scholar. Quality assessment employed the the Mixed Methods Appraisal Tool. Data extraction and synthesis followed the Joanna Briggs Institute (JBI) guidelines. We used the ConQual method, incorporating dependability and credibility evaluations to determine the confidence level of findings.

Results: A total of 24 studies were included. Meta-aggregation was used to synthesize findings into two overarching themes: "loss" (n = 17) and "reestablishment" (n = 7). The theme "loss" revealed that sports injuries lead to diminished athletic identity due to factors such as physical changes, absence from competition, and psychological challenges. The "reestablishment" theme showed that some athletes reconstruct their identity by engaging in roles such as coaching, volunteering, or participating in new sports.

Conclusion: Sports injuries have complex impacts on athletic identity, with some athletes facing identity loss and others successfully rebuilding their identity. Future research should focus on distinguishing between athletes and non-athletes, refining assessment tools. Practical strategies include psychological interventions, fostering multidimensional identities, and supporting post-retirement planning to aid injured athletes in identity recovery.

## Oral Presentations

### OP-SH07 Sport Management and Law II

**ESTABLISHING AUSTRALIA'S SCIENCE AND RESEARCH PRIORITIES FOR HIGH-PERFORMANCE SPORT: AN EVIDENCE-BASED APPROACH**

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*AUSTRALIAN SPORTS COMMISSION*

Introduction.

The significance of sport in Australia is underscored by its contribution to national health, social cohesion, and economic prosperity. Following the Tokyo Olympic and Paralympic Games, the Australian Institute of Sport identified science and research priorities, releasing in March 2022 the national high-performance (HP) sport Research Agenda (RA2022), with updates every 4 years, aligned to summer Games cycles. The intended beneficiaries of the agenda were athletes, coaches, teams and organisations within Australia's HP sport system. We report here on the process to develop and iterate thematic priorities for a national HP sport system.

Methods.

Priority setting was conducted using the framework outlined by the NSW Health Centre for Epidemiology and Evidence (1) and reported following the REPRISE guidelines (2). Stakeholder engagement was inclusive, with input from summer and winter Olympic, Paralympic, and Commonwealth sports. The process involved multiple phases: 1) after the Tokyo Games,

a diverse group of stakeholders generated the initial priorities; 2) a subgroup of participants (5 athletes, 5 coaches, 5 performance support practitioners, 5 researchers and 5 administrators) categorised and ranked the initial priorities to define emerging themes; 3) subject matter experts considered gaps in evidence and identified relevant sub-themes; 4) RA2022 was published in March 2022; 5) after Paris 2024, participants (including athletes, coaches) completed a survey on what science and research should focus on; 6) results were compared with RA2022 priorities, to highlight overlaps, gaps and/or discrepancies; 7) release of the updated national science and research priorities for HP sport (RA2025); 8) the next update will occur after Los Angeles 2028.

Results.

117 initial priorities were collected from 78 individuals (45% M, 31% F, 24% did not respond) from 31 organisations. Duplicated and out of scope priorities were removed, leaving 80 unique priorities. The equal representation subgroup identified four major thematic priorities: Successful Athlete, Coaching Science, Sports Performance Optimisation, and Practice Enhancement. A total of 154 participants from Paris 2024 Olympics or Paralympics responded to what science and research should focus on. All the RA2022 key themes were confirmed in RA2025. Emerging priorities include equipment and strategic insights.

Conclusion.

The RA2022 and the RA2025 update were developed with an evidence-based approach, supported by the National Institute Network Research Group and the National Sport Research Agenda Advisory Group. The process involved stakeholders likely to be affected by, or with an interest in, the research priorities. Appropriately developed and clearly communicated science and research priorities should facilitate the allocation of resources based on HP sport needs.

(1) Setting Research Priorities: A Guide (2023)

(2) Tong et al. (2019

**EXPLORING EQUESTRIAN EDUCATION THROUGH THE CONCEPT OF SPORT ECOLOGY**

THORELL, G., HEDENBORG, S., SÄTRE, A., KRONBORG, M., RADMANN, A., BROMS, L., ANDERSSON, P.

*KARLSTAD UNIVERSITY AND THE SWEDISH NATIONAL EQUESTRIAN CENTRES OF EXCELLENCE*

INTRODUCTION: Environmental sustainability is an important issue for the sports sector. Climate change threatens the future of sports through factors such as extreme weather conditions, rising sea levels, and reduced water resources. Most sports organizations are poorly equipped to assess and manage the risks associated with climate challenges (Orr & Inoue 2018). A lack of knowledge is one of the biggest barriers to implementing sustainable initiatives in the sports sector (Cury et al. 2022). In this study, we focused on equestrian sports, which have been criticized for their environmental impact. The aim of this study is to explore the challenges and opportunities that equestrian education institutions face concerning environmental sustainability.

METHODS: This study applies the concept of Sport Ecology as a theoretical framework. Institutional theory is used to explain the factors that enable or hinder environmental adaptations. The study used a qualitative approach with two methodological strategies. First, semi-structured interviews were conducted with representatives from equestrian education institutions and organizations (15=Sweden and 18=Norway). Second, 8 workshops were carried out.

RESULTS: Overall, environmental challenges in equestrian education are perceived as being linked to economy, time, and knowledge. There is an interest in sustainability, and institutions feel they comply with legislation, yet they are aware that more can be done. Raising awareness and integrating sustainability further into daily activities is seen as necessary, as well as increasing reminders for pupils, staff, and visitors at facilities. Respondents recognize the need for stronger integration in curricula, exercises, and activities, involving pupils and staff while collaborating with stakeholders working on these issues.

Discussion: To address the challenges posed by climate change, strategic and well-planned solutions are required, with interdisciplinary collaboration playing a key role (McCullough et al. 2020). There is a growing need to enhance knowledge and implementation of sustainable practices in equestrian sports. Sport ecology provides a relevant framework for analyzing and improving how the equestrian sector can adapt to climate change and reduce its environmental impact. Fields such as sport management, sports psychology, leadership, and pedagogy offer theories and methods that can contribute to developing sustainable strategies for equestrian educations.

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**DEVELOPMENT AND APPLICATION OF A SERVICE QUALITY EVALUATION SYSTEM FOR SPORTS PARKS IN CHINA**

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*SHANGHAI UNIVERSITY OF SPORT;EAST CHINA NORMAL UNIVERSITY*

INTRODUCTION: Recently, the Chinese government has issued several policies, such as the "Guiding Opinions on Promoting the Construction of Sports Parks," outlining development goals and requirements. However, issues like imbalance and inadequate growth in sports park development persist. Therefore, developing and applying a sports park service quality evaluation system to improve service quality is crucial for promoting sustainable and healthy sports park development.

METHODS: Using a mixed research method, the study proceeded as follows: 1) A review of domestic and international sources using keywords such as sports parks, service quality, and sports park service quality. 2) Interviews with 23 individuals (13 males, 10 females), including the public and experts in China, to explore the service quality model using grounded theory. 3) A survey of approximately 800 individuals (399 males, 401 females) in China across three rounds of questionnaires, leading to the development of a reliable and valid service quality evaluation system. 4) A case study in Shanghai, where field surveys, IPA (Importance-Performance Analysis), and other methods were used to survey 207 individuals (97 males, 110 females) who exercise in sports parks. Based on relevant policies and the current development status of Shanghai's sports parks, suggestions for service quality improvement were proposed.

RESULTS: 1) Based on theories like Maslow's Hierarchy of Needs, Service Quality Evaluation Theory, and New Public Service Theory, and from the public perception perspective, the sports park service quality model in China includes five dimensions: Tangibility, Reliability, Assurance, Responsiveness, and Empathy. This model covers 19 dimensions, 43 concepts, and 173 statements, such as transportation accessibility, park environment quality, public facility configuration, sports event variety, staff professionalism, park regulations, and multifunctional service integration. 2) Following strict procedures for scale development, the data from three rounds of questionnaires were analyzed using project analysis, exploratory factor analysis, and reliability and validity tests. As a result, a sports park service quality evaluation system was developed, consisting of 34 items across five dimensions: Tangibility, Reliability, Assurance, Responsiveness, and Empathy. 3) Based on the service quality indicators in the four quadrants of the IPA matrix, Shanghai sports parks should focus on improving service quality in areas such as health promotion services, sports events, sports fees, facility maintenance, facility configuration, and intelligent sports venue facilities, Resources should be allocated accordingly to enhance the overall service quality of sports parks.

CONCLUSION: Future empirical studies on sports park service quality in China should expand coverage to better align the development of sports parks with national construction, social development, and public needs.

**THEORETICAL FRAMEWORK AND PRACTICAL PATHS FOR GRASSROOTS SPORTS GOVERNANCE TO BUILD RESILIENCE IN URBAN COMMUNITIES**

DING, Y.
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INTRODUCTION: In the context of rapid urbanization, urban expansion and population agglomeration, community resilience has become a key to sustainable urban development and has attracted much attention from all sectors. Community resilience refers to the ability of a community to mitigate, adapt and recover from the negative impacts of disasters. Sports facilities help residents to improve their physical fitness, and they can also switch functions at special times, such as serving as emergency shelters or material distribution points, to enhance spatial resilience. Indeed, the social capital generated by sport, the self-organizing capacity of communities fostered by sports associations, and the role of sport in enhancing the physical and mental health capital of residents are significant but not yet fully exploited in enhancing community resilience.

METHODS: This study uses a combination of case studies and interviews. Seven communities with outstanding community sports governance in two districts of Shanghai were selected as case studies to analyse their demographics, spatial characteristics and governance experiences, and primary data were collected through interviews.

RESULTS: The study has constructed a theoretical framework for grassroots sports governance to enhance community resilience, which includes four aspects: reconfiguring community spatial resilience, accumulating community social capital, enhancing residents health capital, and stimulating the vitality of participatory governance. First, sports facilities can take over the function of emergency evacuation in special times, thus reconfiguring spatial resilience. Second, grassroots sports governance promotes the deepening of residents trust relationships and the expansion of social networks through organised activities, thereby accumulating social capital. Third, regular physical activity can increase residents physiological and psychological resilience and improve health capital. Finally, sports clubs create opportunities for residents to participate in community affairs, enhance their capacity for self-organisation, and stimulate the vitality of participatory governance.

Discussion: The discussion identified three key pathways for grassroots sport governance to enhance community resilience. At the facility level, based on the spatial resilience of facilities, risk is buffered through functional transformation. At the institutional level, the integration of resources, strengthening the synergy of multiple actors and cultivating the leadership effect of community elites to enhance community resilience. In the social capital dimension, sport practices catalyse the endogenous governance order, focus on cultivating sport communities, and enhance community cohesion. In summary, grassroots sport governance is of great importance in enhancing community resilience. Future urban development should pay attention to grassroots sports governance in order to enhance community resilience.

**DIFFERENTIAL IMPACT MECHANISMS OF AI RECOMMENDATIONS VERSUS SOCIAL RECOMMENDATIONS ON SPORTING GOODS CONSUMERS PURCHASE INTENTIONS: THE MODERATING ROLE OF PRODUCT TYPE**

CAI, C., CHEN, L.

*TONGJI UNIVERSITY ; JIMEI UNIVERSITY*

Introduction

This study investigates the distinct pathways through which these recommendation systems influence consumer decisions, focusing on how product type shapes their effectiveness. By contrasting AI-driven data precision with social-driven contextual resonance, this research addresses critical gaps in understanding interaction effects and contextualized adaptation strategies in recommendation systems.

Methods

Three mixed-design experiments (total N = 860; 47.1% male, 52.9% female; 55.8% exercised ≥4 times/month) were conducted to compare the effects of AI recommendations (e.g., biomechanical data for running shoes) and social recommendations (e.g., community preference tags for sportswear) on purchase intentions. Product type (performance/lifestyle), recommendation source (AI/social), and explainability (high: detailed rationale; low: generic claims) were experimentally manipulated. Mediation-moderation analyses were employed to examine dual pathways: goal-achievement efficacy (for AI) and social identity (for social recommendations). Data were analyzed using ANOVA, bootstrapping mediation (5,000 resamples), and moderated regression.

Results

AI recommendations significantly outperformed social recommendations for performance-oriented products ($M_{AI}$ = 5.81 vs. $M_{Social}$ = 4.32, $p < 0.001$), with goal-achievement efficacy mediating 41% of the effect (β = 0.41, 95% CI [0.28, 0.54]). Conversely, social recommendations enhanced adoption intentions for lifestyle products (Δ = +1.5, p = 0.002), primarily driven by social identity (β = 0.29, CI [0.15, 0.43]). High explainability in AI recommendations reduced the performance-lifestyle adoption gap (p = 0.017), while social tags amplified group belongingness effects (e.g., campus running clubs). Community-based filtering (e.g., "choices of same-campus runners") further narrowed disparities, increasing lifestyle product adoption by 18% (p = 0.009).

Discussion

Product type critically moderates recommendation system efficacy: performance goods demand AI's data-driven precision, whereas lifestyle goods thrive on social recommendations' contextual relevance. The proposed Dual-Path Adaptation Framework emphasizes synergistic integration of AI's objective utility and social systems' subjective alignment. For AI, enhancing explainability (e.g., biomechanical insights for shoes) mitigates cognitive dissonance; for social platforms, embedding community tags (e.g., "trending in your gym") fosters identity-driven adoption. Practically, brands should deploy hybrid systems—prioritizing AI for technical products and social cues for experiential goods. Theoretically, this study advances dual-process models in recommendation systems by delineating how cognitive and affective pathways interact with product attributes. Limitations include self-reported exercise frequency and cultural homogeneity; future work should validate findings across diverse demographics and product categories.

## 18:30 - 19:30

## Conventional Print Poster Presentations

### CP-AP03 Statistics and Analyses II - Football

**TOWARD PRECISION TRAINING VIA PRESCRIPTIVE MODELING OF THE RATINGS OF PERCEIVED EXERTION IN PROFESSIONAL SOCCER PLAYERS: A CAUSAL MACHINE LEARNING APPROACH**

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INTRODUCTION: Managing training loads in professional soccer requires balancing performance enhancement and injury prevention. Traditionally, this has been approached through predictive models that estimate internal load responses (e.g., rating of perceived exertion, RPE) based on external load parameters. While these models provide valuable insights into player workload, they fall short in offering actionable, personalized training prescriptions [1]. This study proposes a causal machine learning framework to move beyond prediction toward prescriptive modeling, optimizing training load recommendations for each player based on observed data.

METHODS: Fourteen male professional soccer players (age: 22.2 ± 4.5 years) from a Belgian Pro League club were monitored across a full competitive season, resulting in 974 recorded training and match observations. External load data — including total distance, high-speed running, accelerations, and metabolic power — were captured via 10 Hz GPS units (Catapult Optimeye S5). Internal load was assessed through sessional RPE, and additional pre-session wellness metrics (Hooper Index: sleep duration, muscle soreness, mood, fatigue, and stress) were collected daily. A total of 24 variables

were analyzed. Predictive modeling was conducted using linear regression, regression tree, XGBoost, and random forest, with variable importance assessed via SHapley Additive exPlanations (SHAP) to enhance interpretability. Prescriptive modeling was performed using a counterfactual recurrent network (CRN) to estimate individualized causal effects of training load on future RPE, allowing for targeted load recommendations.

RESULTS: XGBoost achieved the best predictive performance (RMSE: 1.262), with the total session distance emerging as the strongest predictor of RPE. While CRN had a slightly higher RMSE (1.379), it provided interpretable counterfactual insights, enabling training staff to simulate different load scenarios and anticipate individual player responses.

CONCLUSION: Our findings highlight the advantages of integrating causal machine learning into training load management in professional soccer. While traditional predictive models offer valuable estimations of RPE, they fall short in guiding individualized training decisions. By leveraging prescriptive modeling, we move toward actionable recommendations that consider the unique physiological and psychological profiles of each player. These findings align with prior research in [2] on machine learning techniques for optimizing training design and evaluation and extend the work of [1] by demonstrating how prescriptive analytics can enhance decision-making in elite sports settings. Future research should expand sample sizes and explore broader applications across various (team) sports to further validate these approaches.

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**DEVELOPING A DYNAMIC TIME-SERIES GOAL PREDICTION MODEL BASED ON POSITIONAL DATA: A CASE STUDY OF THE 2023 FIFA U-17 MEN'S WORLD CUP**

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*CAPITAL UNIVERSITY OF PHYSICAL EDUCATION AND SPORTS*

INTRODUCTION: Modern football goals determine outcomes, but their prediction is complex, influenced by strategies, player conditions, and in-game dynamics. Traditional models like xG rely on static data, missing tactical shifts and interactions. Advances in EPTS, OTS, and AI-driven analytics now provide high-resolution spatiotemporal data, enhancing accuracy. However, integrating dynamic and static features remains underexplored. This study develops a combined model to improve goal prediction methodologies.

METHODS: This study analyzed data from 52 matches in the 2023 U17 Men's World Cup, focusing on player positions, ball trajectories, and time-series events. Data was collected via an optical tracking system, with preprocessing and model development in MATLAB R2022b. Two feature types were extracted: dynamic features, capturing match evolution through x, y coordinates of 10 key events before a shot, and static features, including shot location, defensive pressure, and shooter posture for contextual insights. The target variable was goal occurrence (1 for goal, 0 for miss). Three deep learning models were implemented. The MLP model processed static features with two hidden layers (128 and 64 neurons, ReLU activation). The LSTM model analyzed sequential data with 30 hidden units and dropout to prevent overfitting. The LSTM+MLP hybrid model fused dynamic and static features at the mid-layer for improved prediction. All models were optimized using binary cross-entropy loss and the Adam optimizer. Data was split 80%-20% for training and testing, with oversampling to balance classes.

RESULTS: The LSTM+MLP hybrid model achieved the best performance in goal prediction, with an accuracy of 93.5%, recall of 95.7%, and precision of 89.8% on the test set, making it well-suited for real-time tactical analysis. The LSTM model excelled in extracting temporal features, achieving 91.7% accuracy and 90.1% precision. However, due to the absence of static feature support, its recall was limited to 86.5%, making it more suitable for post-match tactical review. In contrast, the MLP model, relying solely on static features, performed the weakest, with 80.4% accuracy and 71.5% recall, failing to effectively predict goal events and being applicable only to static tactical analysis tasks.

CONCLUSION: This study introduces a deep learning-based goal prediction model that leverages the strengths of LSTM and MLP to enhance goal-scoring event prediction, offering data-driven insights to support real-time tactical decision-making for coaches. The findings highlight that integrating time-series data with static tactical context significantly improves prediction accuracy. Moreover, the mid-layer feature fusion strategy employed in this study outperforms simple feature concatenation and late-stage fusion in effectively integrating dynamic and static features. Future research should focus on expanding the dataset to enhance model generalization and exploring model compression and lightweight design for real-time applications.

**WILL POSITIONAL SHIFTS REPLACE FORMATIONS? A TACTICAL REVOLUTION IN FOOTBALL**

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INTRODUCTION: The modern era of football has witnessed a significant increase in various aspects of the game, including the pace of play, player mobility, tactical mobilisation strategies, positional shifts, and the total distance covered at high intensity (1, 2, 3). Moreover, in the modern game, players positions and roles are more fluid and complex than ever before. This trend has significantly reduced adherence to rigid tactical formations (4-3-3-, 4-4-2, etc.). The main aim of this study is therefore to analyze the tactical formation used to position the teams in the process leading to the goal.

METHODS: Three machine learning models have been developed to evaluate the discrimination of the formation distribution in the buildup to a goal (60second) from the general formation distribution of the match and other different formations (60minutes). A panel data analysis was conducted in order to examine how football formations transform over different time intervals (0, 1-15sec, 16-30sec, 31-45sec, 46-60sec and Mean-60min. ). The Ordinary Least Squares (OLS) regression method was employed in order to model the Euclidean distances of player positions across various time intervals and to assess the impact of each interval. The dataset consists of 969,408,000 refined positional data points for analysis, derived from 306 matches played during the 2016–2017 Bundesliga season. Exclusion criteria were applied to ensure the datasets purity and homogeneity.

RESULTS: Model 1 (4-3-3) achieved 57% accuracy for 4-3-3 and 4-2-3-1 but only 29% for 4-4-2. Model 2 (4-2-3-1) demonstrated 43% accuracy across all formations. Model 3 (4-4-2) attained 29% accuracy for 4-4-2, 57% for 4-3-3, and 71% for 4-2-3-1. The 4-2-3-1 model ($R^2$= 0.824, F(15,160)=66.72, p<.001) explained 82.4% of the variance in Euclidean distances, with significant differences at 46–60s (coef =1.5435, p<.001), 31–45s (coef =1.4499,p< .001), and 16–30s (coef=1.2211, p<.001), indicating tactical adjustments before a goal.

The 4-4-2 model ($R^2$=0.786, F(15,160)=45.45, p<.001) accounted for 78.6% of the variance, with significant changes at 46–60s (coef = 1.4720, p < .001), 31–45s (coef=1.1379, p <.001), and 16–30s (coef = 0.8432, p =.001), reflecting structural shifts as the goal moment nears.

The 4-3-3 model ($R^2$=0.735, F(15,160) = 28.16, p < .001) explained 73.5% of the variance, with significant differences at 16–30s (coef = 1.7846, p < .001) and 31–45s (coef=1.3852, p<.001). The 46–60s interval (coef=0.4642, p=.124) was not statistically significant.

CONCLUSION: The main findings of this study are as follows: Firstly, teams are unable to maintain their initial formation patterns during the sequences leading to a goal. Secondly, even distinct tactical formations tend to converge into similar patterns at the moment of scoring. As a result, since different formations adopt similar structural patterns in goal-scoring processes, it cannot be concluded that a specific formation provides a positive or negative advantage in offensive play.

**IMPACT OF CHANGES IN SUBSTITUTION RULES ON ELITE FOOTBALL PLAYERS' PHYSICAL ACTIVITY AND TECHNICAL PERFORMANCE - ANALYSIS OF THE TOP 16 TEAMS AT THE 2022 FIFA WORLD CUP**

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INTRODUCTION: The modification of the five-substitution regulation marks a pivotal evolution in modern football, with tactical substitutions serving as critical interventions that significantly influence players performance. As a competitive sport, football is defined by periods of high-intensity, intermittent and sustained exertion, which necessitates that players repeatedly complete sprints, accelerate and decelerate. This also results in players accumulating fatigue with greater ease, which subsequently leads to a decline in performance during matches.

METHODS: To investigate the impact of player substitutions on match dynamics, this study examined 1,173 match observations from 329 players representing the top 16 teams during the 2022 FIFA World Cup Qatar. A comprehensive analysis was conducted on 10 physical and technical indicators across match statuses, positional roles, and player categories. The players included were divided into three groups: (1) entire match players (EMP) (n = 433); (2) players who were substituted (SP) (n = 370); and (3) replaced players (RP) (n = 370), and Cronbachs $\alpha$ = 0.999 and ICC = 0.997. The study did not require participant involvement or ethical approval due to the freely available and anonymized dataset.

RESULTS: The results show that defensive substitutions occurred more when leading by one goal (55.1%), while offensive substitutions occurred when trailing by one goal or in a draw (33.3% and 31.7%), and neutral substitutions occurred mainly in a draw (32.6%). SP have higher TD,HSRD,SPD,HSR and Sprints,Shots than EMP or RP($p<0.001$).The SP of forwards, midfielders, and defenders show better TD,HSR,and Sprints ($p<0.001$), compared to EMP or RP. EMP had significantly more passes ($p<0.001$) than SP and RP. Forwards and midfielders who played entire match contributed more shots($p<0.001$) than SP and RP. EMPs defensive performance in all positions ($p<0.001$) was better than SP or RP.

CONCLUSION: The primary objective of rotation is to mitigate fatigue or modify the tactical strategy of the match, thereby facilitating the attainment of the teams predetermined objectives. The implementation of high-intensity running is a crucial element in the generation of load during soccer matches. Consequently, coaches are required to rotate players in accordance with their physical condition in order to guarantee the competitive edge of the team. In the event of a deficit in score, the implementation of an offensive substitution will serve to augment the impact of the team and accelerate the pace of the match, thereby enhancing the probability of scoring.

The result emphasizes the strategic importance of substitution timing and player categorization. The empirical evidence provides coaches with actionable insights for optimizing substitution protocols and tailoring position-specific training regimens to enhance competitive outcomes. This research contributes to the evolving understanding of modern football dynamics under revised substitution regulations.

**QUANTIFYING AND COMPARING THE MATCH DEMANDS OF U17, U18, U23 AND 1ST TEAM SOCCER PLAYERS IN DIFFERENT PLAYING POSITIONS**

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INTRODUCTION: This study aimed to analyse the physical match and positional demands of youth and senior soccer players using GPS technology.

METHODS: Seventy-nine male outfield players from an English National League (5th tier) professional soccer club were included with GPS data obtained across the 2021–2022 and 2022–2023 seasons. Players were categorised into four age groups (U17, U18, U23, 1st team) and assigned to one of four positions (centre-back, full-back, central midfielder, forward). Data from 660 competitive match observations were analysed. GPS metrics included distance per minute (m/min), high-speed running per minute (HSR/m), sprint distance per minute (m/min), number of accelerations and decelerations per minute (n/min), and PlayerLoad (au). Linear mixed models (LMM) assessed differences across age groups and positions, with significance set at $p<0.05$.

RESULTS: Age group analysis revealed significant differences in sprint distance per minute ($p = 0.031$) and PlayerLoad ($p < 0.001$), with the 1st team covering greater sprint distances than U17s (1.9 vs. 1.1 m/min, $p=0.025$) and demonstrating higher PlayerLoad than U23s (458 vs 431 au). Positional analysis identified significant differences across all metrics ($p<0.001$). Central midfielders covered the greatest total distance (114.4 m/min), while forwards exhibited the highest sprint distance (2.5 m/min), high speed running (7.4 m/min), and number of accelerations and decelerations per minute (2.24 / min). The full-back position recorded the highest PlayerLoad (au).

CONCLUSION: This study highlights the positional and age-related physical demands in elite youth and senior soccer, reinforcing the need for tailored training strategies to ensure smooth transitions throughout academy settings to meet the heightened demands at 1st team level. The findings can inform load management, injury prevention, and player development programs in professional soccer.

**A SYSTEMATIC REVIEW OF SPACE CONTROL IN FOOTBALL**

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INTRODUCTION: In team sports, a team's ability to control key areas of the pitch and apply tactics to generate advantageous spatial team arrangements is crucial for success, as greater control is associated with better performance. However, various methodological approaches exist to analyse space control at the individual player or team level. This resulted in differing terminologies and interpretations of space in football, which hampers our understanding of how players and teams manage space during a match. The objectives of the review were to examine how the concept of 'space' is conceptualized, constructed and operationalised in high performance football, leading to the construction of a taxonomy with respect to the various analysis approaches and their associated findings.

METHODS: Systematic research of relevant English-language articles was performed on three databases (PubMed, IEEE Xplore and Web of Science), based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-analyses) guidelines. The keywords `football` and `soccer` were each paired with all possible combinations of the following keywords: 'space'; 'spatial'; 'region'; 'regions'; 'zone', and 'zones'. Articles were first screened using Rayyan and then independently assessed by two reviewers with the following exclusion criteria: 'no football', 'no 11 vs. 11', 'small-sided games', 'only youth', 'only event data', 'not original/primary work', 'only visualisation', 'only eSports/simulation', and 'no pitch/player/team assignment'. The study was pre-registered with the Open Science Framework (https://osf.io/6fxeb).

RESULTS: In total N = 33 full-text articles studying space control in elite football using positional data were included. The review highlights a notable lack of methodological consistency across studies. Inconsistencies were found with respect to varying terminologies, including different terms for the same construct, and various visualisation techniques. Similar terms were used for different constructs based on a variety of approaches varying from deterministic to probabilistic models. Few studies included any sort of validation procedures and overall study quality was low.

CONCLUSION: The research provides a comprehensive overview of the various approaches to delineating the spatial positions assigned to players on the football pitch. It highlights the similarities and differences in the methodological constructs of space metrics and motion models, as well as their interpretation across different contexts. The identified issues stem from the fact that the complexity of dynamic interactions is frequently disregarded and the transfer to practical applications is often not adequately reflected in a relevant manner. This suggests that enhancing models may be accomplished through the incorporation of machine learning, while concurrently advocating for the application-oriented integration of coaching expertise.

**RELATIONSHIPS BETWEEN EXTERNAL LOAD PARAMETERS AND MATCH OUTCOME IN PROFESSIONAL SOCCER PLAYERS**

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INTRODUCTION: Understanding soccer players' official match demands allows the training programme to be more carefully modulated. Certain characteristics such as the teams tactical disposition, the tactical attitude required by the coach and the course of the match can influence the soccer players motor load [1].

The influence of the playing position and contextual factors (e.g., home/away, opponent's standard positions, match period) on the match load has been a topic of particular attention [2] and their effects are well-reported [3]. So far, the literature has not sufficiently investigated whether the match result leads to changes in certain parameters of the players load. The aim of the study is to verify whether several parameters of the external load can be influenced by the match outcome (win, draw, loss).

METHODS: Thirty-six professional soccer players (age:25,3±4,6 years; height:181,1±3,5cm; weight:81,7±5,4kg) belonging to 4 different professional clubs, were randomly monitored during official matches. During the match, the players were monitored using global positioning system devices at 18.18 Hz (GPEXE® SYSTEM, EXELIO srl, Udine, Italy). Total distance covered (TD), average speed (AS), high speed running distance 14.4 – 19.8 Km/h (HSRD) , very high speed running distance 19.8 – 25.2 km/h (VHSRD), sprint running distance >25.2 km/h (SRD), maximum speed (MS), maximum acceleration >2,5 m/s2 (MA) and deceleration <-2,5 m/s2 (MD) were measured. In addition, the distance covered at different intensity of power has been analysed: low intensity power (LIP, <20.00 W/kg), high intensity power (HIP, 20.00 - 35.00 W/kg), very high intensity power (VHIP, 35.00 - 50.00 W/kg) and maximal intensity power (MIP, > 50 W/kg) [4].

The significance level has been set to $p<0.05$.

RESULTS: TD, AS, MS, MA, MD, LIP, HIP, VHIP and MIP haven't been influenced by the outcome of the competition. HSRD values have been significantly greater ($p<0.001$) in the matches drawn (2236,6±959,9 m) than ones won (1527,7±386,1 m) and lost (1586,7±577,8 m); VHSRD have been significantly greater ($p<0.001$) in the matches drawn (469,2±138,6 m) than ones won (341,1±137,4 m) and lost (344,1±100,8 m); SRD have been significantly greater ($p<0.001$) in the matches drawn (126,3±68,7 m) than ones won (67,8±53,1 m) and lost (54,7±43,6 m).

CONCLUSION: The data analysis describes a higher external load in official matches that had the result disputed until the end. Official matches have different loads in relation to their progress and outcome: the future line of research will be to design microcycles throughout the season, taking into account the external load of each match to improve the accuracy of training and recovery protocols [5].

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**ANTHROPOMETRICAL AND PERFORMANCE PROFILING OF FEMALE SOCCER PLAYERS IN THE BELGIAN FIRST DIVISION**

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INTRODUCTION: Despite the growing interest in female soccer, research on the anthropometrical and physical performance profiles of female players across playing positions and levels remains limited. This study provides a benchmark for the anthropometrical and physical (aerobic and anaerobic) performance profiles of Belgian first-division female soccer players, considering different playing positions and levels.

METHODS: A group of 100 female Belgian first division soccer players (age: 22.5 ± 3.8 yr, VO2peak: 50.3±4.6 mL·min-1·kg-1) completed a test battery consisting of an anthropometrical assessment (n = 99), a maximal incremental running test (~aerobic performance) (n=100), and several sprint and jump tests (~anaerobic performance) (n=99). Data was collected over seven different seasons (2015-2019 and 2021-2024). Positional differences (goalkeepers (GK), central defenders (CD), fullbacks (F), midfielders (M), wingers (W) and attackers (A)) and the impact of their playing level (national vs. international) were investigated.

RESULTS: Anthropometrics: CD were on average the tallest (1.72 ± 0.04 m; 95% CI 1.71-1.74) and GK the heaviest (71.2 ± 10.3 kg; 95% CI 65.7-76.7). Aerobic testing: Except for A, GK exhibited significantly lower first lactate threshold (LT1) values compared to D ($p=0.025$) and other positions ($p<0.001$). Similarly, their second lactate threshold (LT2) values were significantly lower than those of all other positions ($p<0.001$) with exception of A. GK also attained a lower maximal speed during the incremental test than CD ($p=0.002$), F, M and W ($p<0.001$). Additionally, GK demonstrated a significantly lower relative $VO_2$peak ($p < 0.05$) than F, W ($p<0.001$), and M ($p=0.008$). Anaerobic testing: GK scored lower for 10-m sprint than W ($p = 0.021$) and A ($p=0.042$). GK were also slower on the 5 x 10-m shuttle run (SHR) than W ($p=0.027$). The sum of skinfolds showed a strong inverse relationship with VO2peak ($r=-0.57$, $p<0.001$), LT1 ($r=-0.47$, $p <0.001$) and LT2 ($r=-0.55$, $p<0.001$).

International players (n=25) had a higher absolute VO2peak (3.17 ± 0.28 L·min-1 vs. 3.06 ± 0.27 L·min-1; $p=0.042$), higher fraction of VO2peak at which LT2 occurred (88.4 ± 3.8 % vs. 86.9 ± 3.2 %; $p=0.022$), faster SHR (12.42 ± 0.26 s vs. 12.60 ± 0.39 s; $p=0.03$), higher countermovement jump with the hands on the hips (CMJ-) (31.54 ± 3.85 cm vs. 29.23 ± 3.68 cm; $p=0.026$) and a higher countermovement jump with preparatory step (CMJstep) (39.60 ± 5.26 cm vs. 37.17 ± 4.28 cm; $p=0.049$) than national players (n=75).

CONCLUSION: This data provides insight into the physiological characteristics required of female soccer players in the Belgian first division, establishing a benchmark for future comparison across playing levels. However, this data also shows that there are no specific physiological profiles across playing positions, although international players tend to score higher on both aerobic and anaerobic parameters compared to national players.

## Conventional Print Poster Presentations

### CP-AP06 Sports Technology / Monitoring II

**EXAMINATION OF THE EffECT OF WEARING THERMAL TIGHTS ON IMMUNE RESPONSE**

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INTRODUCTION: For athletes, maintaining daily training can be essential. Physical stress disrupts normal physiological balance or homeostasis, including the immune system, especially during high-intensity exercise. Natural killer (NK) cells, a type of immune cell, are sensitive to exercise, and a decrease in NK cell activity contributes to immune system dysfunction. Therefore, maintaining high NK cell activity after exercise is a key factor in improving long-term performance. Recently, it has been reported that maintaining deep muscle temperature with a heat-retaining function after exercise can improve performance. The aim of this study was to investigate the acute effects of wearing thermoretentive tights after high-intensity exercise on immune function.

METHODS: Thirteen healthy adult males (21-29 years of age) participated in a randomized crossover study comparing conditions with and without heat-retaining tights (prototype of Thermal Charge®, Mizuno, Japan). The exercise protocol consisted of resistance training followed by high-intensity interval training (HIIT) on a bicycle ergometer. The effects on NK cell activity and heat shock protein 60 (HSP60) were assessed at baseline, 0, 30, and 150 minutes after exercise. A two-way ANOVA was performed, and when significant interactions were observed, trend analysis was performed for each group. A significance level of $p < 0.05$ was used.

RESULTS: All 13 participants completed the exercise. The control group showed a significant decrease in blood NK cell activity from baseline to 150 minutes after high-intensity exercise. In contrast, there was no decrease in NK cell activity from baseline to 150 minutes post-exercise when wearing thermoretentive tights. In addition, a significant increase in blood heat shock protein 60 concentration was observed only when wearing thermal-keeping tights.

CONCLUSION: Wearing thermal-keeping tights prevented the decline in serum NK cell activity at 150 minutes after high-intensity exercise and increased serum HSP60 levels after exercise. The thermoretentive garments used in this study have been shown to maintain both deep and superficial muscle temperature during exercise.

Thus, it is suggested that heat retention in deep muscles may have contributed to the suppression of immune decline.

**NEAR-INFRARED SPECTROSCOPY: HOW DOES EXERCISE INFLUENCE CALIBRATION AND MICROVASCULAR RESPONSIVE-NESS?**

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INTRODUCTION: The changes in deoxyhemoglobin ([HHb]) derived from near-infrared spectroscopy (NIRS) are commonly calibrated with an arterial occlusion (AO) to examine muscle oxygenation and microvascular responsiveness. However, exercise alters hemodynamic and metabolic responses, which could affect this calibration method. This study aimed to examine the influence of exercise on AO variables.

METHODS: Thirty-six endurance-trained males (28 ± 9 years, 75,9 ± 9,4 kg, 1,78 ± 0,08 m) completed a cardiopulmonary exercise testing (CPET) and a 5-km time-trial (TT) on an ergocycle. The NIRS device (PortaMon, Artinis Medical Systems BV, The Netherlands) was installed on the distal part of the right vastus lateralis muscle to record changes in muscle oxygen parameters during AO executed before and after each test. The resting baseline (30 sec), the AO amplitude (difference between the hyperemia spike and baseline) and the reperfusion slope of tissue oxygen saturation (% StO2, 10 sec post hyperemia spike) were evaluated. Student *t* tests were used to compare baseline, amplitude and reperfusion slope of [HHb] and TSI signals.

RESULTS: [HHb]baseline and [HHb]slope were similar pre- and post-CPET and between tests (CPET vs TT). [HHb]amplitude was higher post- vs pre-CPET ($p<0.001$) and post-TT vs post-CPET ($p<0.001$). Both CPET and TT increased TSIbaseline ($p=0.005$) and decreased TSIamplitude ($p=0.019$) and TSIslope ($p<0.001$). TT also decreased TSIslope ($p<0.001$). Finally, TSIbaseline was different between CPET and TT ($p=0.023$), but TSIamplitude and TSIslope were similar.

CONCLUSION: These results suggest that CPET and TT independently impacted maximal deoxygenation, highlighting the importance of performing an AO after every type of exercise to accurately calibrate [HHb]. Futhermore, exercise altered microvascular responsiveness, but with similar effect for CPET and TT.

**PREDICTION MODEL OF ENERGY METABOLISM IN CHEMICAL CORPS PERSONNEL WEARING NUCLEAR, BIOLOGICAL, AND CHEMICAL PROTECTIVE CLOTHING UNDER DIFFERENT OPERATIONAL LOADS**

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INTRODUCTION: Chemical Corps personnel wear nuclear, biological, and chemical (NBC) protective clothing along with 20 kg of equipment during operations, imposing significant physiological stress. NBC protective clothing restricts sweat evaporation and heat dissipation, increasing heat stress and metabolic burden (1). Heart rate is a widely used physiological indicator for workload prediction, while body composition factors such as body fat percentage (PBF) and body mass index (BMI) influence metabolic response (2,3). However, the extent to which these factors contribute to energy metabolism estimation remains unclear. This study aims to develop an optimized model for predicting metabolic equivalents (METs) based on physiological parameters.

METHODS: Twenty-five male military personnel (age: 25.32 ± 2.26 years; height: 170.42 ± 4.88 cm; weight: 64.9 ± 11.28 kg) participated. They performed treadmill walking/running at different loads (0 kg, 10 kg, and 20 kg) and speeds (4 km/h, 6 km/h, and 8 km/h) while wearing NBC protective clothing under controlled conditions (temperature: 25°C, humidity: 70%). METs were measured using a portable metabolic analyzer, and body composition was assessed prior to testing. Simple and multiple linear regression analyses were performed to determine the optimal METs prediction model.

RESULTS: Multiple regression analysis showed that the combination of HRRratio and PBF had the highest coefficient of determination ($R^2 = 0.867$, $p < 0.001$) for METs, with the model: METs = 4.116 + 0.939 × HRRratio − 0.051 × PBF. If PBF was unavailable, HRRratio and BMI provided a second-best model ($R^2 = 0.862$, $p < 0.001$):

METs = 5.179 + 9.370 × HRRratio − 0.088 × BMI. When no body composition data was available, HRRratio alone remained a strong predictor ($R^2 = 0.852$, $p < 0.001$):

METs = 3.243 + 9.322 × HRRratio.

CONCLUSION: This study developed a predictive model for energy metabolism in personnel wearing NBC protective clothing, confirming HRRratio as a reliable predictor of METs, with or without body composition parameters. The findings align with prior research on heart rate-based energy estimation and the physiological strain of protective gear (4,5). NBC protective clothing has been shown to increase core temperature by up to 11.2°C during moderate to heavy workloads, significantly elevating energy demands (1). Environmental conditions further exacerbate metabolic burden, emphasizing the need for context-specific models (6). While this model provides accurate estimations under controlled conditions, further validation in extreme environments is necessary. Future research should explore additional physiological markers to refine the model for broader operational use.

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**RESEARCH ON THE CHARACTERISTICS OF COMPETITION LOAD AMONG ELITE CHINESE FEMALE COLLEGE VOLLEYBALL PLAYERS**

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INTRODUCTION: This study quantifies the competition load characteristics of elite female college volleyball players from Nanjing Normal University from the perspectives of external and internal loads. The aim of the present study is to provide theoretical and practical foundations for the scientific training and preparation of college volleyball teams.

METHODS: The K-sport IMU motion monitoring system (K-AI Track, K-sport, Italy) and FirstBeat heart rate monitoring system (FirstBeat, Garmin, Finland) were used to collect data from 12 athletes during four matches of the 2024–2025 Jiangsu Provincial High-Level College Volleyball Championship. The K-sport IMU system collected metrics such as low, medium, and high-intensity training loads, movement frequency, and jumps. The Firstbeat system monitored average heart rate, maximum heart rate, minimum heart rate.

Data are presented as mean±standard deviation, with $P < 0.05$ considered statistically significant.

RESULTS: During matches, the teams average movement load was 747.7±26.7. By position: outside hitters averaged 876.1±32.8, middle blockers 553.4±25.3, setters 813.1±39.6, opposites 948.8±19.3, and liberos 763.8±28.1. There were no significant differences among outside hitters, setters, and opposites, whether for the entire match or individual sets. However, setters, opposites, and liberos showed an increasing trend in movement load per set.

In 0.2g ≤ Training Load Low ≤ 0.75g, no significant differences were observed except for middle blockers. Outside hitters, setters, and liberos showed higher intensity in the third set compared to the first two ($P < 0.05$). In 0.75g ≤ Training Load Medium ≤ 1.5g, no significant differences were found among outside hitters, middle blockers, and liberos, or between

setters and opposites. In Training Load High >1.5g, outside hitters, middle blockers, and opposites showed no significant differences, but significant differences were observed compared to setters and liberos ($P < 0.05$).

The teams average number of jumps was 13.4±0.1. By position: outside hitters averaged 9.3±0.2, middle blockers 13.3±0.6, setters 26.9±1.3 and opposites 19.5±0.4.

The teams average heart rate was 120.75±16.7 bpm, maximum heart rate was 201.3±5.8 bpm, and minimum heart rate was 66.3±10.3 bpm. Opposites and liberos had the highest average heart rates (137.3±15.6 bpm and 137.5±13.6bpm, respectively), followed by outside hitters and setters (120.9±11.4 bpm and 121.2±14.7 bpm). Middle blockers had the lowest average heart rate (107.9±10.7 bpm).

CONCLUSION: Volleyball players experience high competition loads, requiring medium-to-high-intensity movement and Confrontation ability.

Frequent changes in direction and acceleration during matches demand excellent speed and agility.

Heart rate loads are higher during intense rallies.

Increase the monitoring of daily training and Physiological and Biochemical indicatorstors.

Ensure that athletes physical conditioning during training camps meets or exceeds the demands of competition.

**DIFFERENCES IN MINIMUM VELOCITY THRESHOLD (MVT) AMONG INTERNATIONAL LEVEL YOUTH SPRINT KAYAK ATHLETES AND ITS ROLE IN E1RM PREDICTION**

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INTRODUCTION: The minimum velocity threshold (MVT) is one of the crucial metrics using velocity-based devices for prediction one repetition maximum (e1RM), from non-maximal loads. MVT is the mean concentric velocity (MCV) produced during the last successful repetition of a set and another way to acquire velocity for a 1RM (1). These velocities are afterwards also used for objective real-time monitoring, prescribing and adjustment of the training load and training intensity. We know, that for different exercises have different MVTs, but authors also have different recommendations for free-weight bench press 0.18 m/s-1 (2) and 0.17 m.s-1(4), which is most widely used. Therefore, the aim of this study was to examine differences of MVT in free-weight bench press (BP) exercise in national level youth kayak athletes and the accuracy of the estimation. This exercise was chosen because its use in strength and conditioning training of kayak athletes and can affect the sport performance in sprint kayak (5).

METHODS: 14 resistance trained athletes (5 females, 9 males; 14-20 years of age) with minimum of 2 years of strength training experience were recruited for this study. All subjects performed a one-repetition maximum test (1RM) on BP with measuring their MCVs using Tendo unit. Subjects trained for last year 3 times a week and were familiar with BP. The individual MVTs were compared with general recommended MVTs and the individual 1RMs were compared with e1RM.

RESULTS: MVTs of 1RMs on free-weight bench press varied widely in athletes from 0.12 m.s-1 to 0.32 m.s-1. The average of the MVTs in the group was 0.21 m.s-1, with SD=0.065 m.s-1. The mean value of 1RM was 54.6kg (SD=24.4) vs. e1RM 57.6 kg (SD=25.9). Even though the two-way mixed effect model with single measures ICC=0.98. In one example subject was 9.98% difference in 1RM vs e1RM (90kg vs 98.7kg).

CONCLUSION: We found high differences in BP MVTs in our athletes and differences of the average in the group compared to recommended (0.21 vs 0.17). So, we suggest that more precise would be to establish MVT for each athlete individually and use it later in testing and training. With these findings we would recommend restraining international level athletes from using standard MTVs. We even found that these standards for BP were mostly performed as smith machine bench press, which is much less common type of pressing oriented exercise, and less adequate due to lower attained velocities compare to free-weight BP. The standard MVT 0.17 m.s-1 (used in various velocity-based training devices) caused not only overestimations but also underestimations in 1RMs. In later we would recommend to app developers to add possibility of entering individual MVT for each exercise to precisely evaluate e1RM and use this kind of technology for training purposes.

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**EFFECTS OF NEOPRENE KNEE BRACE ON LOWER-LIMB BIOMECHANICS DURING SINGLE-LEG LANDINGS**

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INTRODUCTION: Single-leg landing places considerable stress on the knee joint, potentially leading to acute or chronic injuries—particularly of the anterior cruciate ligament (ACL) [1]. Although knee braces are often used to reduce injury risk [2], their effects on inverse dynamics (joint moments, ground reaction forces) during single-leg landing remain unclear.

This study compared knee angles, knee moments, and vertical ground reaction forces (GRF) between control (no brace) and knee brace conditions in healthy adults.

METHODS: Seven participants (4 males, age 23.8 ± 3.6 y; 3 females, age 23.7 ± 4.7 y), with no lower-limb injuries in the past six months, were recruited. Each performed single-leg landings from a 30 cm platform under two conditions: (1) Control (no brace) and (2) Knee brace (a neoprene sleeve with adjustable, nonelastic straps). Knee flexion angles and moments were recorded using a Vicon system (Vicon Motion Systems, Oxford, UK), and vertical ground reaction force was measured via an AMTI force platform (Advanced Mechanical Technology, Inc., Watertown, MA, USA). Data normality was evaluated (Shapiro–Wilk), and paired-samples t-tests ($p < .05$) compared the two conditions.

RESULTS: Following the landing protocol, no significant differences were observed between the Control and Knee brace conditions in knee angle or kinetic variables ($p > .05$). For instance, the mean knee angle was 63.30 ± 15.92° (Control) vs. 58.35 ± 19.39° (Brace), and peak positive X moments averaged 1575.16 ± 1115.70 vs. 1684.68 ± 1032.68, respectively (both $p > .05$). Similar results were found for negative X moments, Y moments, and peak vertical GRF, indicating that wearing a knee brace did not significantly alter the measured inverse dynamics parameters during single-leg landing.

CONCLUSION: Results showed no statistically significant effect of a standard neoprene knee brace on knee joint angles or kinetic parameters during single-leg landing in healthy adults. In a recent study [3], soft knee braces were found to provide only minor adjustments in lower-limb biomechanics for non-injured participants, supporting our finding that additional external support may not be essential in healthy populations. Meanwhile, another investigation [4] emphasized that compression-based brace designs had negligible impact on modulating landing forces and joint angles, suggesting that knee stability is primarily maintained by neuromuscular control rather than external bracing. In summary, a simple neoprene brace provides limited biomechanical benefit for healthy adults during single-leg landings. Future studies should use larger samples, varied landing tasks, and neuromuscular assessments to clarify protective or performance effects.

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**BRIDGING THE GAP: A CORRECTION FACTOR FOR VERTICAL JUMP PERFORMANCE ACROSS DEVICES**

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INTRODUCTION: In sports science, vertical jump height is a key performance metric. In low-resource settings, cost-effective tools like the My Jump 2 (MJ) app and the G-Vert (GV) sensor are widely used. However, measurement discrepancies affect reliability. This study aimed to cross-compare MJ and GV data. Enhancing reliability in remote performance monitoring ensures consistent data collection in different environments, such as during the Covid-19 Lockdown.

METHODS: Twenty-eight male adults (age 37.6 ± 8.83 y, $p < 0.001$; BMI 24.9 ± 3.31 kg/m2, $p < 0.001$) performed Squat Jumps (SJ), with data simultaneously collected via MJ and GV. The GV sensor was placed at L5, and jump execution was recorded via smartphone for MJ analysis. Statistical analyses included linear regression, intraclass correlation coefficients (ICC), and paired t-tests to assess relationships and determine adjustment factors.

RESULTS: The linear regression model found a strong correlation ($r = 0.75$, $p < 0.001$) between MJ and GV measurements, though GV overestimated jump height by an average of 12.02 ± 3.69 cm. To align MJ values with GV, a multiplication factor of 1.43 is recommended, while GV values should be adjusted by 0.71 to match MJ.

CONCLUSION: Discrepancies in vertical jump measurements between devices highlight the need for standardization in performance monitoring. The proposed correction factor allows for accurate data interpretation, particularly in remote training settings where device accessibility may vary. This approach is essential for maintaining consistent athlete evaluation and can aid in rehabilitation, strength assessment, and periodized training programs. This study provides a validated correction factor for comparing MJ and GV jump height measurements, enhancing cross-device reliability. The findings support broader applications in sports science, particularly in environments requiring remote assessments or multi-device monitoring. Future research should validate this correction factor across diverse populations and exercise conditions.

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**A QUALITATIVE STUDY ON DEVELOPING AN ATHLETE MONITORING SYSTEM FOR INJURY PREVENTION IN LONG TRACK SPEED SKATING**

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INTRODUCTION: Long-track ice speed skating (LTSK) is a physiologically demanding sport that requires careful training load management to optimise performance while preventing injuries. Athlete monitoring systems (AMS) can support this process by providing critical information to guide training and injury prevention decisions. However, using AMS for injury prevention presents challenges due to the context-dependent management of injuries. Therefore, this qualitative study explored how skaters and coaches perceive, report, and manage injury and their expectations of an AMS for this purpose. The findings aim to provide context-specific recommendations for developing an AMS in LTSK.

METHODS: This qualitative study utilised semi-structured interviews with 12 German Speed Skating Federation participants, eight skaters and four coaches. The data were analysed using thematic analysis.

RESULTS: Three main themes emerged. (1) Physical demands and limits – participants described "pushing their physical limits" as key in LTSK training, with skaters emphasising the challenge of recognising their limits for effective load management. Interviewees reported monitoring objective performance indicators (e.g., power output in cycling) and subjective feelings (e.g., lack of motivation) to assess fatigue. AMS potentially supports providing feedback on training intensity, guiding short-term adjustments, and identifying long-term trends.

(2) Understanding pain and injury – participants defined injuries as training-related physical complaints impacting subsequent sessions, with pain as the primary symptom. Pain was seen as a manageable aspect of training, distinguished from serious injury based on experiences. Individual pain assessments were used to decide on subsequent training adjustments, considering various characteristics and contextual factors.

(3) Reacting to Pain and Injury – more experienced skaters emphasised the importance of addressing symptoms early and proactively, highlighting the role of self-regulation. Participants reported adapting intensity, volume or exercises in response to pain and injury, opting for alternative or injury-specific exercises instead of complete rest to maintain fitness and minimise injury-specific load. They emphasised the importance of closely monitoring pain about these adaptations to evaluate their effectiveness and inform short-term adjustments for balanced training load management.

CONCLUSION: This study found balancing the training load with physical limits as challenging in LTSK. Pain, was seen as both manageable and inherent to training guiding training adjustments. Therefore, close pain monitoring is recommended to improve understanding of when and how to adapt training and evaluate the effectiveness of these changes, with training adaptations—rather than complete rest—being the preferred strategy for injury management. Additionally, monitoring fatigue may help skaters assess their physical limits when increasing training demands.

## Conventional Print Poster Presentations

### CP-AP11 Coaching III - Running and Biathlon

**COMPARISON OF DIFFERENT SPRINT TRAINING SESSIONS WITH ASSISTED RUNNING: EFFECTS ON PERFORMANCE AND KINEMATICS IN 30-METER SPRINTS**

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INTRODUCTION: Sprint training can be enhanced through assisted and resisted methods, which influence both sprint mechanics and overall performance. Assisted sprinting, typically involving towing mechanisms, has been studied using various towing forces, often providing constant full assistance. However, little is known about how adjusting these forces and setting specific speeds impact performance. Unlike full assistance, partial assistance reduces the towing force as the athlete approaches a certain speed, allowing for a more dynamic and adaptive sprinting experience. This method may require greater voluntary effort from the athlete, potentially leading to better training adaptations. Therefore, it was hypothesized that partial assistance sprinting would provide greater benefits compared to full assistance.

METHODS: This study compared two assisted sprint training methods: fully assisted sprinting with a constant 6 kg towing force and partially assisted sprinting, where assistance diminished once the athlete approached 0.5 m/s below their supra-maximal speed. Twenty-four male youth football players (age: 17.0 ± 1.9 years, body mass: 69.7 ± 9.9 kg, height: 1.80 ± 0.06 m) participated in the study during their offseason. Eight athletes completed the fully assisted training, eight underwent partial assistance training, and the remaining participants formed a control group.

The subjects were tested in both a 30-meter regular sprint and a 30-meter fully assisted sprint. The training program consisted of four 30-meter assisted sprints performed twice a week for a total of 10 sessions. A motorized device provided precise assistance loads, while sprint times were measured using the Witty Gate timing system. Maximal speed and 5-meter average speed were recorded by the towing device. Additionally, stride length, stride frequency, contact time, and flight time were analyzed using the OptoJump Next modular system.

RESULTS: Thirty-meter fully assisted sprint times significantly improved in both the fully and partially assisted groups ($p < 0.05$ for both). Additionally, contact times during both regular 30-meter sprinting and 30-meter fully assisted sprinting were significantly reduced ($p < 0.05$ for both). However, regular 30-meter sprint times remained unchanged.

CONCLUSION: Both fully and partially assisted sprint training methods effectively enhance 30-meter assisted sprint performance. Additionally, both methods led to a significant reduction in contact times, which may contribute to improved stride efficiency and sprint mechanics. However, longer training periods might be needed for a significant improvement in a regular 30-meter run. These results help coaches refine sprint training strategies, enabling them to adjust assistance techniques to better suit individual athletes.

**REGIONAL BIOIMPEDANCE PREDICTS PERFORMANCE DURING PERIODIZED TRAINING OF TRACK AND FIELD SPRINTERS**

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INTRODUCTION: Limited research has explored the relationship between variations in bioelectrical parameters during the full training season and the athletic performance of track and field sprinters of both genders.

METHODS: We collected longitudinal anthropometric and regional bioelectrical impedance vector analysis (BIVA) measurements of 12 female (age: 23.5 ±3.7) and 9 male (age: 23.9 ±5.2) sprinters, with >6 years experience and tier 3, for 9 months of periodization (T1, general conditioning; T2, specific conditioning; T3, pre-competition; T4, competition). Pearsons and Student's tests were used to evaluate the association with seasonal best (SB) time, maximal strength (flat bench, deadlift, squat), pre- vs. post- repeated-sprint training (4x4 of 80m sprints), and T1 to T4 progression. We also assessed how a specific nutritional plan (diet, n=4; non-diet, n=3 ) impacted performance and body composition. RESULTS: Between T4 and T1, independently of diet, we measured a median reduction of many skinfold (SF) sites, specifically the 7-site SF ( females , - 9.9%, P= 0.08 ; non-dieting males , -3.7%, P= 0.07 ), which was more marked in those athletes who followed the diet (7SF, -28.6%, P= 0.05 ). By combining the BIVA regional values, we developed a sprinter performance index (SPI) able to discriminate between top and low SB female groups (100m, P=0.003; 200m, P=0.04). SPI/h showed direct correlation with SB (r=-0.7, P=0.02 ), following seasonal fluctuations in performance and arm strength. Women SB significantly correlated with several indices of lean body mass, with an important decrease in leg impedance (Z) and leg phase angle (PhA), indicative of premature performance drop (T4-T3). Male sprinters who followed the diet prolonged their peak performance, along with an increase in SPI/h between T4-T3, and improved their SB (100m: -0.29s, P=0.03; 200m: -0.44s, n.s.). The non-diet group experienced a progressive decline in arm Z and leg reactance (Xc) after T2, and a drop in the leg PhA (T4-T3). Arm Xc was the only discriminant between faster (100m: average 10.75s; 200m: average 21.71s) and slower (100m: average 11.54 s; 200m: average 23.57s) male sprinters (28.7Ω vs. 26.9Ω, P=0.03 ), showing a correlation with SB (r=-0.6). Both females and males exhibited a reduction of parallel reactance (XcP) concomitant to reaching peak performance. For female athletes, the repeated-sprint test revealed a sharp decrease in leg PhA (-3.8%, P=0.04), increase in arm resistance ( R) and arm Xc (8.5% and 10%, respectively), and a significant rise in arm XcP (6.9%). Men only exhibited a certain drop in arm PhA (-2.7%, P=0.07) and arm Xc (-2.4%, P=0.03).

CONCLUSION: We formulated important regional BIVA criteria for coaches and nutritionists to plan macrocycles and mesocycles, especially for female athletes. Regional BIVA pinpointed essential physiological changes that would be masked if looking at whole body measurements only. Based on our data, arm Xc may explain most of the variation in performance, supporting the concept that arm fatigue and strength is a key factor in sprinting propulsion.

**BLOOD LACTATE AND GLUCOSE KINETICS FOLLOWING 800-M RUNNING ARE ASSOCIATED WITH EXERCISE PERFORMANCE**

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INTRODUCTION: Carbohydrate is an important energy source particularly during supramaximal exercise such as 800-m running event [1]. Blood lactate and glucose concentrations ([BLa] and [BGlu], respectively) have been widely accepted as good indicators of the usage of carbohydrates by muscles. Blood lactate kinetics indicators after high-intensity running reflect closely the lactate metabolic response implemented during exercise [2], and that of variables have been shown to be correlated with 800-m performance [3, 4]. However, these reported data were measured in the laboratory and the exercise duration was shorter than the 800-m event. It has also been shown that [BGlu] increases markedly after strenuous exercise (i.e. exercise-induced hyperglycemia) [5], but the relationship between high-intensity exercise and changes in [BGlu] has not been investigated. The aim of this study was to investigate the relationship between the variables in [BLa] and [BGlu] from the kinetics following 800-m trial and that of performance.

METHODS: In this study, 6 male well-trained middle-distance runners performed an 800-m time trial (800-m TT) on the outdoor track. [BLa] and [BGlu] were collected from the fingertip before and after the trial (i.e. the rest and recovery period, respectively). Using a biexponential time function, lactate exchange ability ($\gamma 1$), lactate removal ability ($\gamma 2$), and the quantity of lactate accumulated (QLaA), which can be interpreted as the amount of produced lactate during exercise, was calculated from individual blood lactate recovery data [2, 6]. The delta ($\Delta$) of [BGlu] was the difference between [BGlu] at rest and peak following the 800-m TT. The data are reported as mean ± standard deviation. Pearson correlation coefficients were used to determine the correlation between the variables (i.e. $\gamma 1$, $\gamma 2$, QLaA and $\Delta$[Glu]) and 800-m performance. Statistical significance was set at $p < 0.05$.

RESULTS: The time of 800-m TT was 119.14 ± 4.26 (sec). γ1, γ2, QLaA and Δ[BGlu] were 0.149 ± 0.08 (/min), 0.014 ± 0.08 (/min), 683.5 ± 131.68 (mmol) and 3.1 ± 0.9 (mmol/L), respectively. Whereas No significant correlations were detected between γ1, γ2 and 800-m TT (γ1: r = 0.46, ns; γ2: r = -0.51, ns), there is a significant relationship between QLaA and 800-m TT (r = -0.90, p < 0.05). In addition, Δ[BGlu] was strongly correlated with 800-m TT (r = -0.81; p < 0.05).

CONCLUSION: These results suggested that not only [BLa] but also [BGlu] after exercise could evaluate the supramaximal exercise performance, especially QLaA and Δ[BGlu] may be more highly associated with performance than other variables. The ability to mobilize more carbohydrates and produce more lactate may have a positive impact on 800-m running performance.

**COMPARING INFLUENCES OF SPIKES AND RUNNING SHOES ON LOWER EXTREMITY KINETICS AND SPRINT PERFORMANCE OF NOVICES**

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INTRODUCTION: Footwear is a critical factor influencing both sprint performance and injury incidence [1]. Despite evidence suggesting that injury rates increase with increasing training hours in spikes [2], there is a lack of studies quantifying this relationship. Additionally, it is not clear whether or not spikes actually enhance performance across different levels of sprinters. Specifically, novice sprinters may not benefit from wearing spikes to the same extent as experienced sprinters do, raising the question of whether they are worth wearing. Therefore, the purpose of this research is to investigate the effects of spikes versus running shoes on sprint performance and lower limb kinetics in novice sprinters.

METHODS: Eighteen novice sprinters completed six 60 m sprints, wearing either spikes or running shoes. Sprint times were measured using two pairs of double beam timing gates. Full-body kinematics were recorded using a motion capture suit and imported into the musculoskeletal model Myonardo®, which was used to estimate JCFs of the hip, knee, and ankle joints. All values were normalised to subjects body weight before being analysed through generalised linear mixed models.

RESULTS: Sprinting with spikes yielded significantly faster sprint times compared to running shoes. Results indicated a mean improvement of 1.7% in the 60 m sprint performances. Men benefited more from spikes (improvements of 2.7%) than women (improvements of 1.0%). When looking at the joint kinetics the peak knee JCFs were significantly higher when sprinting in spikes than in running shoes. This is consistent with reports of increasing injury incidence with increasing hours of training in spikes [2].

CONCLUSION: While the performance advantages of spikes were notable, novices should take into account the elevated loading associated with their use. Thus, it might be beneficial to implement their use progressively, allowing the musculoskeletal system sufficient time to adjust.

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**POLARIZED TRAINING FOR JUNIOR BIATHLETES, WISHFUL THINKING, OR COACH-INDUCED MISMATCH TO TRAINING PLAN COMPLIANCE?**

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INTRODUCTION: Biathlon is an endurance winter sport that combines cross-country skiing and rifle marksmanship. Previous research suggests that elite-level endurance athletes typically follow a polarized training intensity distribution (TID) model ([1]). However, more recently, Burnley et al. suggested that polarized distributions are typically seen only in the prescription of session goals [2]. The actual TID executed by athletes is more likely to be a pyramidal distribution. Nevertheless, discrepancies between coach training prescription and athlete execution can lead to maladaptation of training.

Therefore, this study aimed to determine if there were any discrepancies in planned (PLAN), self-reported (REP), and executed (EXE) training intensity distribution in junior biathletes.

METHODS: Thirty junior biathletes (16 men, 14 women) were monitored over 13 months of biathlon training involving skiing and roller skiing. Training was PLAN by a coach and REP in an online diary using a 5-zone model (z1-z5) from the Swedish Biathlon Federation [3], based on each athletes maximum HR. Athletes wore heart rate monitors (Polar H10, Polar Electro OY, Finland) and GNSS devices (Vector S7, Catapult Sports, Australia) during sessions. EXE data were analyzed from when the athlete started moving to when they stopped, with heart rate and GNSS data co-analyzed in Matlab (Mathworks, Natick, U.S.). HR data were allocated to minutes in intensity zones, including a zone for data below z1 (z0) < 55% HRmax. Data representation was as a percentage of total training time. A non-parametric Friedman test detected differences in training conditions, and paired t-tests compared REP and EXE for z0. Significance was set at $p<0.05$.

RESULTS: In total, n=241 sessions were analyzed. Average session duration was 96±20, 92±22, and 95±24 min for PLAN, REP, and EXE, respectively. Significant differences were found between session duration on PLAN vs. REP and PLAN vs. EXE (p=.007 and p=.024, respectively). Mean zone distribution differed between PLAN and EXE in all five intensities (z1= 90±19%, 45±22% respectively, p<.001; z2= 3±13%, 33±17% respectively, p<.001; z3=1±6%, 8±9% respectively, p<.001;

z4=4±11%, 5±9% respectively, p<.001; z5=1±5%, 2±4% respectively, p<.001). Z0 accounted for 2±7% and 9±5% for REP and EXE, respectively (p<.001).

CONCLUSION: This works novel finding was that biathlon coaches plan endurance training polarized, favoring z1 training with a low distribution of z3, while the HR response reveals that training is pyramidally performed. This suggests that junior biathletes struggle to maintain HR within a single intensity zone while performing different training modalities on varied terrain. A second finding was that adolescent biathletes perform a substantial part of their training with an HR response lower than what is considered beneficial for training adaptations while still being summarized in the total training volume.

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**DIFFERENCES IN PERFORMANCE AND PHYSIOLOGICAL VARIABLES BETWEEN ROLLER-SKIING WITH AND WITHOUT RIFLE DURING A SIMULATED BIATHLON COMPETITION.**

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INTRODUCTION: Biathlon combines cross country skiing and rifle marksmanship, and the athletes need to carry the rifle (mass >3.5 kg) on their back during skiing. Previous research in laboratory settings have shown that physiological variables, i.e. heart rate (HR), oxygen uptake (VO2), ventilation (VE), breathing frequency (BF), respiratory exchange ratio (RER) and blood lactate concentration (BLa) increases when roller-skiing with rifle (WR) at submaximal workloads compared to roller-skiing without rifle (NR) (1, 2). Roller-skiing performance is also shown to decrease for WR compared to NR during laboratory testing (1). The aim of the study was to investigate the effect of rifle carriage on performance and physiological variables during a simulated biathlon roller-skiing sprint in the field.

METHODS: 20 well-trained tier 3 (3) biathletes (10 women, 10 men; age 22±3 years) completed two biathlon roller-skiing sprints (women 3×2km; men 3×2.5km) in the field, one WR and one NR in a randomized order, separated by 30 minutes of active rest. After each lap, the athlete stopped for 30–45 s (normal shooting time) for measurement of BLa and rating of perceived exertion (RPE, 6–20). Respiratory variables and HR were measured throughout the sprints. A two-way repeated measurements ANOVA (two conditions (WR/NR) × three laps) was used to compare performance and physiological variables between conditions. During the stops, WR and NR was compared using paired samples t-test. Wilcoxon Signed Rank test was used if data was non-normally distributed. Data are presented as mean±SD, except for RPE (presented as median (IQR)).

RESULTS: Mean roller-skiing speed for the race was 0.20 m/s slower for WR compared to NR (5.5±0.5 vs. 5.7±0.5 m/s, p<0.001). The time loss during WR was 13.5±14.6, 12.2±8.7 and 16.9±9.6 s for laps 1, 2, and 3, respectively. No difference between WR and NR in mean HR, VO2, VE, BF, RER or BLa was found for any of the skiing laps (all p>0.05). However, RPE, mean VO2, VE and BF during the second stop (simulating standing shooting) was higher for WR compared to NR (RPE 18 (1) vs 17 (1), p = 0.008; VO2 40±5 vs 37±4 ml/kg/min, p=0.006; VE 99±23 vs 92±18 L/min, p=0.031; BF 52±6 vs. 48±4 breaths/min, p=0.005) with no difference in the duration of the stop (p>0.05).

CONCLUSION: Unlike previous laboratory studies, this field-based study demonstrates that respiratory variables, HR and BLa were similar for WR and NR during roller-skiing, despite the higher skiing speed for NR during all the three laps. However, respiratory variables and RPE were higher during the second stop for WR, which may impact shooting performance. To replicate competition demands, biathletes are advised to carry their rifle during high-intensity training sessions that include shooting.

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## Conventional Print Poster Presentations

### CP-AP14 Coaching and Training in Youth Athletes

**THE IMPACT OF FOOTBALL COACHES FEEDBACK ON PSYCHOLOGICAL VARIABLES AMONG YOUNG FOOTBALL PLAYERS – AN INTERVENTION STUDY**

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INTRODUCTION: The purpose of this study was to examine how feedback from the coach influences young football players´ experience of well-being, mastery, pleasure, satisfaction, development, joy, and motivation.

METHODS: The study used an intervention with a crossover experimental approach, where 95 boys that participated in sports clubs and specialization in football classes, participated in the same organized training session with the same coach in every session – one without feedback and one with feedback from the coach, answering a questionnaire after

each training session. Wilcoxon nonparametric tests were used to examine differences between the training session without and the session with feedback among players at the two groups at each variable.

RESULTS: Analyzing all players, the results showed that when feedback was given, it led to a significant increase in mastery, the experience of being seen by the coach, and motivation, compared to the same training session when they did not receive feedback. Furthermore, analyzing only players who participated in sports studies with a specialization in football, the results showed that giving feedback led to a significant increase in well-being, pleasure, satisfaction, and development. Finally, analyzing only players who participated in sports teams and did not specialize in football in sports programs, showed that when feedback was given, it led to a significant increase in the experience of development, the experience of being noticed by the coach, and motivation, compared to the same training session when they did not receive feedback.

CONCLUSION: The findings suggest that football coaches' feedback has a positive outcome for several psychological factors of young players, and especially players that participate in football classes at school experience positive outcomes from coaches' feedback. The findings of the study highlight the importance of football coaches' feedback.

**PHYSICAL SUPERIORITY IN FOOTBALL. AN ANALYSIS OF THE SYSTEMATIC DEVELOPMENT OF CONDITIONAL ABILITIES AND THEIR CHALLENGES IN AUSTRIAS FOOTBALL YOUTH ACADEMIES**

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INTRODUCTION: This study analyzes the systematic development of physical abilities in Austrian youth football. It highlights the use of training methods and resources as well as the challenges that influence the transition from youth to professional levels. The results provide valuable insights into the prioritization of conditional abilities and identify technical and organizational barriers that could hinder the development of future national players.

METHODS: Through a quantitative survey conducted among all 15 sports science heads responsible for the Austrian football academies certified by the Austrian Football Association (as of February 2024), both the significance and the organizational aspects of implementing strength, speed, and endurance training in training operations were queried. A total of 60% of all distributed questionnaires were included in the actual analysis (9 out of 15 sports science directors).

The same survey was also sent to the heads of sports science at the newly established youth performance centers (NLZ) for the 2023/24 season. However, due to the low response rate (22.2%), they were excluded from further analyses due to the lack of representativeness.

RESULTS: The results showed, among other things, a very high or high acceptance and prioritization of strength and speed training in the weekly training operations, but less priority was given to inclusive endurance training. An negative opinion of the sports science directors was detected regarding the permeability between youth and professional levels. The greatest performance differentiating factor between academy players and players from the professional level was identified as technical and tactical skills, which could also explain the below-average permeability in the clubs.

CONCLUSION: The results of the present study highlight the strengths of the Austrian academy system in

physical preparation, but also reveal weaknesses that could hinder the development of future national players. To enhance the permeability and quality of youth training, the following measures should be prioritized:

1. Optimization of training scheduling: Coordination of morning strength training and football training on the same day

2. Promotion of running technique: Early and structured integration of running technique sessions for ages 10–14.

3. Focus on aerobic endurance: Increased integration of aerobic training session

4. Systematics integration of youth and professional divisions

5. Personnel and infrastructure resources: Strengthening scientific and medical departments through targeted investments

**RESEARCH ON JUNIOR COACHING IN SPEED SKATING COMPETITION**

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INTRODUCTION: Various athlete development programs have been announced for the coaching of junior athletes, and their importance has been highlighted by being implemented in many countries and competitions. In speed skating, the strong countries of the Netherlands and Canada have established their own athlete development programs (1) (2), which indicate training hours and goals according to the age of the athletes. Development programs for speed skating have also been proposed in Japan, but it is unclear what kind of coaching coaches actually provide. Therefore, the purpose of this study was to clarify the actual situation of coaching junior speed skaters in Japan and to help improve Japans competitive performance.

METHODS: A questionnaire survey was conducted targeting coaches involved in speed skating teams for elementary, junior high, and high school students in each prefecture, asking about the purpose of coaching and the importance of onice training content.

RESULTS: Comparisons between the three groups were made by dividing the instructors into the three counties of elementary school students, junior high school students, and high school students according to the target group of instruction.

When looking at the goals of the three groups by subject of instruction, significant differences were found in items such as "enjoying skating" (p=0.016), "competing in international competitions" (p<0.001), and "self-development through skating" (p=0.002).

Importance of ice training, the items that showed significant differences were "course positioning" (p=0.005).

CONCLUSION: Coaching objectives were generally consistent with the indicators of strong countries in all age groups. However, elementary school students tended to seek "winning the competition" more than junior high school students, indicating that the objectives of elementary school coaches need to be carefully monitored to avoid placing excessive emphasis on competition.

Regarding the importance of ice training, a study on the track and speed of middle and long distance events in international competitions reported that the track position increases the skating distance and also affects the record (3). This is thought to be the result of strategic skating instruction being given to high school students who are becoming increasingly specialized. Given the above, in order to improve Japans competitiveness, it is necessary to provide clear indicators for coaching methods and seek a common understanding of future directions.

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**THE EFFECT OF BIOLOGICAL AGE ON SELECTED COMPONENTS OF GAME PERFORMANCE IN YOUTH FOOTBALL PLAYERS**

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INTRODUCTION: Biological maturation significantly impacts the physical performance of youth soccer players. This study aimed to investigate the influence of biological age on selected performance factors—including anthropometric characteristics, speed, agility, explosive power, and football-specific skills—among players at different stages of maturation.

METHODS: A total of 72 youth soccer players (aged 11–15) were divided into three groups based on their biological age, as determined by the TW-3 method using a DXA hand scan: accelerated (AKC, n = 10), on-time (ONT, n = 45), and delayed (DEL, n = 17). Eighteen variables were collected for each participant, including decimal age, biological age, height, weight, body fat percentage, sprint times (over 10 m and 20 m), agility tests (Illinois and DBF agility), jump performance (CMJ jump height and CMJ_Fpeak), football-specific skills (LPST passing and DBF dribbling tests), and coach evaluations of game and training performance. One-way ANOVAs with Bonferroni-adjusted LSD post-hoc comparisons were used to identify group differences. Additionally, Pearson and Spearman correlation analyses were conducted to explore the relationships among the variables.

RESULTS: While chronological age did not differ significantly between groups, the AKC group demonstrated a significantly higher biological age (15.49 ± 0.93 years) compared to the ONT (13.15 ± 1.19 years) and DEL groups (11.64 ± 1.02 years; $p < 0.001$, $\eta^2_p = 0.52$). In addition, AKC athletes were taller and heavier, with lower body fat percentages than their counterparts ($p < 0.001$). Performance assessments revealed that the AKC group achieved faster sprint times over 10 m and 20 m ($p < 0.001$) and superior agility in both the Illinois ($p = 0.003$) and DBF agility tests ($p = 0.007$). Moreover, AKC athletes demonstrated greater countermovement jump height and peak force ($p < 0.001$), although no significant differences were found when peak force was normalized by body weight. No group differences were observed in football-specific skills (LPST, DBF dribbling), endurance tests, or head coach evaluations.

Biological age was very strongly positively correlated with key anthropometric measures, including body height ($r = 0.850$, $p < 0.001$) and body weight ($r = 0.876$, $p < 0.001$), and significantly negatively correlated with body fat percentage ($r = -0.598$, $p < 0.001$), indicating that higher biological maturity was associated with a leaner body composition. In performance tests, higher biological age was linked to faster sprint times over 10 m ($r = -0.440$, $p < 0.001$) and 20 m ($r = -0.550$, $p < 0.001$), as well as better performance in the Illinois agility test ($r = -0.596$, $p < 0.001$). Additionally, biological age was positively correlated with countermovement jump performance, as indicated by associations with CMJ jump height ($r = 0.587$, $p < 0.001$) and peak force ($r = 0.835$, $p < 0.001$). Furthermore, higher body fat percentage was significantly associated with poorer performance in sprint and jump tests (e.g., $r = 0.520$ with 10 m sprint time and $r = -0.631$ with CMJ jump height; $p < 0.001$). Game and training performance ratings provided by the head coach were also strongly interrelated ($r = 0.941$, $p < 0.001$)

CONCLUSION: The findings indicate that biological maturation is a critical determinant of physical performance in youth football players. Players with accelerated maturation not only exhibit favorable anthropometric characteristics but also demonstrate enhanced speed, agility, and explosive power. These results underscore the importance of considering biological age in training programs and talent identification processes. Tailoring training to account for maturational differences may optimize performance development and enhance long-term athletic potential.

**EXTERNAL TRAINING LOAD AND RATING OF PERCEIVED EXERTION COMPARISON BETWEEN TENNIS DRILLS IN ELITE JUNIOR TENNIS PLAYERS**

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INTRODUCTION: Professional and elite junior tennis players' competitions are often closely scheduled, leaving coaches with limited time to focus on developing technical, tactical, and physical skills. As a result, coaches tend to prioritize integrated on-court training sessions where technical and tactical training, along with match-specific conditioning, can coincide. To ensure players receive the most specific training load relative to the match, monitoring both the external and internal training loads of individual training exercises is necessary. Therefore, our study aimed to compare the external training load of various tennis drills with the rating of perceived exertion (RPE) in elite junior tennis players.

METHODS: Sixteen junior male tennis players (age: 16.0 ± 1.1 years; height: 179.2 ± 9.9 cm; mass: 67.0 ± 10.4 kg) from the same club participated in the study, performing seven types of tennis drills. To determine the external training load, seven parameters were measured in relative values using portable micro-sensors (Catapult Vector S7, Catapult Sports, Melbourne, Australia) at a sampling frequency of 10 Hz for the GNSS and 100 Hz for the tri-axial accelerometers. We also assessed the players' RPE using Borgs CR-10 scale after each drill. Differences between the tennis drills were analyzed using the nonparametric Kruskall-Wallis test with planned Bonferroni correction for post-hoc analyses. The significance level was set at $p < 0.05$.

RESULTS: There was a significant main effect for seven load parameters with the post-hoc analyses revealing difference in the Player Load/min variable between the 2-on-1 open and 2-on-1 net play ($U = 46.000$; $Z = -3.091$; $p = 0.002$; $r = 0.77$), as well as between the Recovery/Defensive and Accuracy ($U = 53.000$; $Z = -2.827$; $p = 0.005$; $r = 0.71$) drills. In the IMA Acceleration High/min variable, a significant difference was also found between the 2-on-1 open and 2-on-1 net play ($U = 35.500$; $Z = -3.487$; $p < 0.001$; $r = 0.87$), and between the Recovery/Defensive and Accuracy ($U = 24.000$; $Z = -3.920$; $p < 0.001$; $r = 0.98$) exercises. Additionally, there was a significant difference in the RPE between the 2-on-1 open and 2-on-1 net play ($U = 53.000$; $Z = -2.897$; $p = 0.004$; $r = 0.72$), and between the Open pattern and Closed technical ($U = 10.500$; $Z = -4.585$; $p < 0.001$; $r = 1.15$) tennis drills.

CONCLUSION: Overall, the results indicate that the defensive situation and shot accuracy types of tennis exercises are the most intense in terms of external training load, as the players performed more accelerations during these drills. In terms of RPE, the closed drills with coach feeding were found to be the most intense. Based on the load values of the tennis drill types obtained here, coaches can more objectively periodize the players preparation for a specific tournament.

**IDENTIFICATION OF KEY PERFORMANCE INDICATORS TO DEVELOP A PERFORMANCE DIAGNOSTICS FRAMEWORK FOR BREAKING**

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INTRODUCTION: With breaking entering the Olympic stage, training science has increasingly focused on its physiological and biomechanical aspects. While most studies address injury prevalence, research on key performance indicators remains limited. This study assessed anthropometric and performance-relevant characteristics across different performance levels in German breakers, using a comprehensive diagnostic approach to identify key performance indicators for developing a performance testing framework.

METHODS: A total of 74 breaking athletes (females: n= 21; males: n= 53 males) participated. Anthropometric measures included height (standing/seated), body mass, limb lengths, age, and breaking experience. Performance tests comprised countermovement jump (CMJ), drop jump (DJ), grip strength, isometric mid-thigh pull (IMTP), pull-ups, T-agility test, and Y-Balance test (YBT). Based on national qualification status, athletes were categorized as elite (females: n= 6; males: n= 7), youth (females: n= 10; males: n= 29), or recreational (females: n= 5; males: n= 16).

RESULTS: Due to the non-normal data distribution, a Kruskal-Wallis test was used for group comparisons, considering sex differences. Elite breakers had significantly more breaking experience than youth (13.2 ± 5.0 yrs vs. 8.5 ± 4.8 yrs; $p = 0.013$) and recreational athletes (8.4 ± 4.4 yrs; $p = 0.025$). They were also shorter than recreational athletes (167.6 ± 6.2 cm vs. 173.7 ± 10.0 cm; $p = 0.041$) and had a lower seated height (88.6 ± 3.4 cm vs. 91.7 ± 6.1 cm; $p = 0.04$). No significant differences were observed in body mass, limb lengths, CMJ, IMTP, T-agility test, pull-ups and grip strength. However, elite breakers showed significantly shorter ground contact time in the drop jump (179.5 ± 29.7 ms) than youth athletes (251.8 ± 88.4 ms; $p = 0.03$), though the difference was not significant compared to recreational athletes (225.8 ± 70.4 ms). Sex-specific differences in balance were identified in males ($p = 0.049$) but not in females: elite male breakers performed significantly better compared to youth and recreational breakers in YBT upper extremity and lower extremity (right leg).

CONCLUSION: Our findings suggest that elite breakers of both sexes primarily differ from their less experienced counterparts in training history, anthropometric characteristics, and in performance during reactive jumps, while YBT performance differed in males only. However, most of the applied conventional athletic tests did not identify differences between groups, indicating that those may have limited validity in capturing the specific demands of breaking. Unlike traditional sports, breaking integrates physiological performance with artistic expression, requiring complex movement patterns, creativity, and rhythmic coordination. Given the lack of training science concepts for this competitive sport and a dance genre, future research should focus on developing breaking-specific diagnostic tools that integrate both physiological and artistic performance factors.

Conventional Print Poster Presentations

CP-AP19 Power and Strength II

**THE EFFECT OF ACUTE MULTIPLE SET COMPLEX TRAINING WITH DIFFERENT INTENSITIES ON JUMP PERFORMANCE IN TRAINED WOMEN**

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INTRODUCTION: Contrast training (CT) involves resistance exercises of maximal or high intensity before performing a lighter resistance plyometric movement with similar biomechanical properties. The aim of this study was to investigate the effect of different intensities of acute multiset CT on jump performance in trained women

METHODS: Fourteen volunteer woman athletes (age= 25.2± 5.2 years) with a regular menstrual cycle (26.1± 1.8 days) and experience in strength and plyometric training (3.79± 1.57 years) were randomised to 2 different intensities (90% 1RM - 65% 1RM) at the same time of day (15:30-17:00 h), with 48 hours interval, during the late follicular phase of their menstrual cycle (days 7-12). CT was performed in three sets, consisting of three repetitions of back squat exercise at the specified intensity, followed by three Counter Movement Jump (CMJ) as an explosive exercise. Participants performed 2 CMJ before CT, and the acute effect of 2 different intensities of CT on jump performance was assessed with CMJ tests repeated at the 1 st and 3 st minutes after 3 sets of CT. Data were analysed using a 2x3 (intensity x time) repeated measures two-way ANOVA

RESULTS: ANOVA analysis showed that the effect of intensity ($F(1,13) = 3.230$, $p=0.096$, $\eta 2 = 0.199$) and the interaction between intensity and time ($F(2,12) = 1.088$, $p=0.344$, $\eta 2 = 0.077$) were not statistically significant. However, the effect of time on jump performance was statistically significant ($F(2,12) = 4.638$, $p=0.024$, $\eta 2 = 0.263$). The jump height was lower than the reference value at 1 min after the CT ($p=0.027$), whereas at 3 rd mins, it was similar with the reference value ($p=0.282$)

CONCLUSION: The study found no significant difference in the jump performance of woman athletes after CT, regardless of the intensity

**IMPACT OF EXHAUSTIVE EXERCISE WITH A HIGH ECCENTRIC COMPONENT ON STRENGTH, SPRINT PERFORMANCE, AND MUSCLE PAIN IN YOUNG MEN AND WOMEN**

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INTRODUCTION: Muscle fatigue and soreness often occur after high-intensity exercise, particularly when eccentric contractions are involved. Women (W) show lower fatigability in low-intensity isometric tasks, but this advantage fades at higher intensities. In dynamic contractions, W fatigue less than men (M), yet may experience greater power loss in high-load eccentric tasks. Pedalling cadence influences muscle fiber recruitment, yet its impact on performance and fatigue across sexes remains unclear. W may exhibit less muscle pain and recover faster due to oestrogen effects. This study examines sex-based differences in muscle strength, pain perception and sprinting capacity across different cadences during recovery before and after a fatiguing protocol with a strong eccentric component (FP). We hypothesise that M will experience greater muscle pain, while W will exhibit a reduced loss in strength and sprint performance.

METHODS: Eighteen young active participants (9M/9W) completed a familiarisation and DXA evaluation. Pre-testing included 1RM (bench press (BP) & squat (SQ)), sprint capacity test (SpC) (6x6s sprints, 24s recovery at 80 and 110rpm) and two 30sWingate (WG) with 20s occlusion in between, 5 min between tests. The automated constant leg pressure device (CLPD) and a visual analogue scale assessed pain. The FP included 5 sets of BP (105% 1RM, eccentric-only) & SQ to failure (5 sets: 80-60% 1RM),120 drop jumps, and repeated cycling sprints. Post-testing was performed 24h (pain and strength) and 48h (pain, strength and SpC) after FP.

RESULTS: Muscle pain increased at 24-48h post-exercise, more in W than M, particularly in chest and legs ($p<.05$). In both sexes 1RM-strength declined (SQ: 16.3% at 24h, 12.1% at 48h; BP: 22.7% at 24h, 18.8% at 48h). M had higher baseline PPO and MPO (+11 and 9.8%) in Watts/kg-leg lean mass (W/kg-LLM) during the SpC than W ($p<.05$). At 48h, PPO (7.2%) and MPO (5.7%) were reduced ($p>0.05$), regardless of sex. At baseline, PPO during WG1 was higher in men ($p=.047$), with a performance loss of 42% in WG2 ($P<.001$). At 48h, PPO in WG1 was decreased by 2.5% in M and 9.4% in W, while in WG2, it increased 9.2% in M and decreased 2.1% in W. This led to a PPO drop only in W (6.7%, Time×Sex interaction $P=.072$). This trend disappeared when adjusting for baseline fitness (1RM/LLM, PPO/LLM, MPO/LLM) as covariates. Higher pedalling cadence (110rpm) resulted in superior MPO compared to 80rpm (~6.2%, $p=.006$).

CONCLUSION: Both sexes showed significant declines in strength and SpC after a FP, with W reporting greater muscle pain and a larger WG performance loss, likely due to a lower anaerobic capacity per unit of muscle at baseline. Higher cadence allowed for a greater MPO pre- and post- FP. These findings suggest that sex-specific muscle traits influence recovery patterns, warranting further research into underlying physiological mechanisms.

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**GREATER TRAINING LOADS DO NOT EQUATE TO SUPERIOR PERFORMANCE: RETHINKING WORKLOAD AND ADAPTATION IN RODENT MODELS**

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INTRODUCTION: Despite the well-established use of progressive training overload (PTO) and total load (TL), training monitoring and other training principles are often overlooked in animal model research, creating a gap in understanding their potential impact on performance outcomes and translational effects. This study investigates whether greater training loads equate to superior performance while also considering training monitoring metrics such as Training Monotony (TM) and internal TL.

METHODS: 70-day-old male Sprague-Dawley rats were assigned to 3 groups: Sedentary (SED, n=10), Continuous Training (CTR, n=13), or Interval Training (ITR, n=9). All animals underwent a 1-week treadmill familiarization. CTR and ITR trained 3x/week for 4 weeks. External TL was set at 34,200 arbitrary units (AU) for CTR and 16,950 AU for ITR. PTO was applied biweekly with a 22% and 18% AU increment for CTR and 15% and 13% AU increment for ITR. Running sessions: CTR—40 min at low-intensity; ITR—18 min (3 cycles of 2-min moderate-intensity + 4-min low-intensity recovery). Performance was assessed post-familiarization (week 0), at week 2, and at week 4, using external work (EW), calculated in Joules [2]. Training monitoring was conducted via lactate-based TRIMP (TRIMPLac) for internal TL at weeks 1 and 3. TM remained constant at 1.24 AU in both training groups [3]. The statistical analysis was performed using a mixed linear model to assess time and group effects on EW and TRIMPLac. The time×group interaction was explored via post hoc comparisons (Bonferroni correction). The effect size was estimated using Cohen's d. Statistical significance was set at $p<0.05$.

RESULTS: CTR and ITR groups improved EW compared to the baseline and the SED group. A significant main effect of time was observed (B=12.84, 95% CI: 9.21–16.47, $p<0.001$); indicating an overall enhancement in performance. Post hoc comparisons confirmed significant improvements in performance for CTR (Δ=23.6%, $p<0.001$) and ITR (Δ=19.8%, $p<0.001$) from baseline to post-intervention. The effect size for training was large (CTR: d=1.74; ITR: d=1.61), reinforcing the efficacy of the interventions. No significant EW difference was found between CTR and ITR (Δ=3.8%, $p=0.289$), despite external TL in CTR being more than double that of ITR. While TM remained equivalent across groups, TRIMPLac did not differ between CTR and ITR at week 1; however, at week 3, CTR exhibited significantly higher TRIMPLac than ITR ($p<0.001$).

CONCLUSION: Higher training loads do not necessarily translate into superior performance outcomes. Training adaptations in rodent models are not solely determined by absolute external TL, and might be influenced by additional physiological and methodological factors such as TM and TRIMPLac. These implications highlight the relevance of our research and its potential to shape future studies in the field.

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**EFFECTS OF DIFFERENT INTER-SET REST DURATIONS ON MUSCLE TONE, STIFFNESS, AND RELAXATION TIME IN ISOINERTIAL BICEPS CURL EXERCISE: A PRELIMINARY STUDY**

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INTRODUCTION: Rests interval between resistance training sets is fundamental for performance and recovery. This area of research was already explored for traditional resistance training methods, however its impact on muscle mechanical properties, like tone, stiffness, and relaxation time, still needs more investigation in isoinertial training. The aim of this preliminary study is to investigate how different inter-set rest durations, 60 seconds and 120 seconds, influence these mechanical parameters, e.g. muscle tone, stiffness and relaxation, in an isoinertial biceps curl exercise.

METHODS: A total of 24 physically active males, aged between 18 and 30, were enrolled in this study and randomly assigned to two groups, each performing three sets of ten maximal effort repetitions of isoinertial biceps curls. One group rested for 60 second between set, while the other rested for 120 seconds between sets. Muscle mechanical properties, tone, stiffness, and relaxation time, were assessed with the MyotonPro device (Myoton AS, Tallinn, Estonia) at four time points: baseline (T0), after the first set (T1), after the second set (T2), and after the third set (T3). The statistical analysis was performed using Python (v. 3.11) and a two-way repeated measures ANOVA with the Tukey HSD post-hoc test was used to analyze the differences between groups.

RESULTS: The two-way ANOVA revealed that the group factor had a significant effect on stiffness ($p = 0.004$) ,and relaxation ($p = 0.005$), while muscle tone was not significant ($p = 0.179$). The Tukey HSD post-hoc tests revealed that stiffness was significantly higher in the 60 sec group compared to the 120 sec group ($p = 0.003$), and relaxation time was significantly lower in the 60 sec group compared to the 120 sec group ($p = 0.004$).

CONCLUSION: This preliminary study indicate that 60 seconds inter-set rest durations may lead to increased muscle stiffness and reduced relaxation time compared to 120 seconds rest periods during isoinertial biceps curl training. These findings suggest potential differences in the response of the mechanical properties of the muscle regarding the rest time between sets; however, they should be interpreted with caution considering the small sample size. Further researches with larger cohorts and additional physiological assessments are needed to confirm these effects and better understand the implications for isoinertial training optimization.

**EFFECTS OF DYNAMIC OR STATIC STRETCHING PERFORMED BEFORE RESISTANCE TRAINING ON TRAINING PERFORMANCE AND STRENGTH GAINS ACROSS 8 WEEKS IN UNTRAINED MEN**

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INTRODUCTION: Stretching exercises are often performed before resistance exercise (RE). While static stretching (SS) has been shown to temporarily reduce muscle performance, a recent study suggests that neither SS nor dynamic stretching (DS) performed before RE impairs strength gains in untrained young men (1). Other studies also reported similar strength gains regardless of pre-exercise stretching (2,3). However, no study has examined the chronic effects of SS and DS before RE using a within-between subjects' design. This approach allows for direct comparisons while reducing inter-individual variability, such as genetic and neuromuscular differences. Additionally, the impact of SS and DS on training performance throughout a training period remains unclear, which could help explain the chronic effects of stretching before RE. Thus, it was investigated the chronic effects of DS and SS performed before resistance training on training performance and strength gains over 8 weeks in untrained young men.

METHODS: Twenty-six untrained young men (21.4±2.4 yrs, 72.7±14.9 kg, 179±1 cm) were randomly assigned to one of three groups using a unilateral crossover design: (1) Control group (no training), (2) SS group (n=13), where one leg performed 80 s of SS before RE, and (3) DS group (n=13), where one leg performed 80 s of DS before RE. In both SS and DS groups, the contralateral leg served as a control (no stretching before RE). The RT protocol consisted of 4 sets of 8-12 repetition maximum (RM) knee flexion exercises, performed twice per week for 8 weeks, with at least 48 h between sessions. Unilateral knee flexor maximal isometric strength (MIS) was measured pre- and post-training. Training volume (repetitions × load) was recorded in sessions 1, 8, and 16. The control group was used to estimate the Minimal Detectable Change (MDC) for MIS measurements (8.3 kg). MIS data were analyzed using ANCOVA (group × leg) with pre-training values as covariates, and training load was analyzed using a three-way repeated measures ANOVA (group × leg × session) with Tukey's post hoc test ($p<0.05$).

RESULTS: A significant leg × group interaction ($p=0.043$) showed a higher training volume in the DS leg (1397 [1595; 1199] kg) compared to its control leg (1296 [1073; 1520] kg, $p=0.047$), with no other differences ($p>0.05$). Strength gains exceeded the MDC for both SS and DS groups, but no significant group × leg ($p=0.93$), group ($p=0.19$), or leg effect ($p=0.64$) was found for MIS.

CONCLUSION: Performing 80 s of either SS or DS before resistance training sessions did not affect training-induced muscle strength adaptations in untrained young men, despite a small increase in training volume in the DS group.

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**FACTORS INFLUENCING STRENGTH AND HYPERTROPHY IN TRAINED COHORTS: A RETROSPECTIVE AND EXPLORATORY ANALYSIS**

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INTRODUCTION: Determining the resistance-training (RT) variables associated with muscle strength and hypertrophy gains in trained cohorts has challenged the Exercise Science field. Several literature appraisals have been published on the topic, but the large variability between and within RT protocols and muscle strength and hypertrophy assessments hinders the precision of the estimates. A retrospective analysis of multiple studies from the same research group may provide clearer insights into RT-induced strength and hypertrophy gains due to greater standardization in training and assessment procedures. This study conducted secondary statistical analyses of randomized controlled trials (RCTs) to identify key RT variables influencing these adaptations

METHODS: This retrospective study encompassed muscle strength and hypertrophy data from five published RCTs (1,2,3,4,5) and one unpublished study. One hundred seventy-six resistance-trained individuals (146 males and 30 females; 23.7 ± 4.1 years, 4.44 ± 3.06 years of training experience) were analyzed. The following variables from each study were used to determine their impact on muscle strength and hypertrophy gains after RT interventions: one-repetition maximum (1RM): body mass (BM) ratio (1RM:BM) at baseline (2.11 ± 0.54 a.u.), training duration (TD) (9.96 ± 2.00 weeks), pre-intervention weekly set number (PSN) (16.09 ± 8.03 weeks), weekly set number performed during the study (SPS) (19.17 ± 9.40), and total number of sets performed during the study (TSS) (199.7 ± 116.8). Data were obtained from two distinct laboratories using different devices. Then, data were transformed into standard units (i.e., z-values) using each assessments mean and standard deviation. Therefore, the estimates should be interpreted based on standard deviation units (SDUs) from the mean. Linear mixed models were used to determine the variables impacting muscle strength and hypertrophy gains, with variables modeled as continuous variables. The Minimal Detectable Change (MDC) of standard units was calculated using the standard formula $MDC = 1.96 \times SEM \times \sqrt{2}$.

RESULTS: Muscle Strength: The 1RM:BM ratio at baseline (0.58 SDUs, $p < 0.001$) and PSN (0.02 SDUs, $p = 0.03$) were significant. However, only the 1RM:BM estimate surpassed the MDC (0.20 SDUs). Muscle Hypertrophy: TD (-0.39 SDUs, $p = 0.046$), TSS (0.01 SDUs, $p = 0.035$) were significant. Nevertheless, only the TD surpassed the MDC (0.21 SDUs).

CONCLUSION: While some parameters were statistically significant, the estimates did not surpass the MDC, indicating that their effects may not be practically meaningful. Notably, the 1RM:BM ratio at baseline exceeded the MDC for strength gains, suggesting its potential relevance in trained individuals. Additionally, the negative estimate for TD exceeded the MDC for muscle size, suggesting a potential diminishing return.

**EFFECT OF FLYWHEEL SQUAT TRAINING LOAD MAGNITUDE ON SPRINT, AGILITY, AND JUMP PERFORMANCE ADAPTATIONS**

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INTRODUCTION: Neuromuscular adaptations are known to be velocity-specific [1]. However, research confirming this assumption for flywheel (FW) resistance training is limited. The specificity of FW loading complicates its quantification. The force-velocity-power (FvP) profiling method has been previously suggested as a way to individually determine the magnitude of FW load [2]. Therefore, the aim of our study was to evaluate differences in adaptations in sprinting, agility, and jumping performance following FW squat resistance training under low and high loading conditions, as well as to assess delayed onset muscle soreness (DOMS), fatigue, and well-being responses over time.

METHODS: Physical education students were randomly assigned to two training groups and a control group. The training groups engaged in 8 weeks of FW squat resistance training, 2-3 times per week. Load magnitudes for training groups were defined based on FvP profiles obtained during FW squats prior to the intervention. The low-load group (LL; n = 16) trained at the peak power FW-load, while the high-load group (HL; n = 18) used a load corresponding to 70% of peak power FW-load condition. The control group (n = 13) did not undergo any training. Pre- and post-intervention FW squat mechanical variables were assessed at peak power and 70% peak power FW-load magnitudes for both groups to assess load specific training adaptations. Additionally, various physical performance tests were conducted, including sprints with 5-, 10-, 20-, and 30-meter split times, agility T-test, and squat jump (SJ), counter-movement jump (CMJ), and drop jump (DJ). Before each session, participants reported leg muscle DOMS, fatigue, and well-being.

RESULTS: Paired samples t-test showed that both training groups improved significantly in most FW squat-related mechanical variables, including concentric and eccentric force, velocity, and power across both peak power load and 70% peak power load testing conditions. Both training groups demonstrated enhanced CMJ and agility performance, while SJ improved only in the HL group, and DJ and 10-m sprint time only in the LL group. DOMS (from 3.6 to 1.6) and overall fatigue (from 4.2 to 2.2) decreased while reported well-being increased (from 8.1 to 9.4) from the first to the last session. Analysis of covariance revealed no differences in adaptations over time between the two training groups ($p > 0.05$).

CONCLUSION: FW squat resistance training proved to be an effective modality for enhancing both concentric and eccentric leg strength and power during squatting. Additionally, it led to improvements in SJ, CMJ, DJ, agility, and sprint acceleration performance in athlete students. Interestingly, the FW training load did not affect discomfort, and no load-specific adaptations were observed. These findings suggest that similar performance enhancements can be expected regardless of the selected FW load following 22 sessions of FW squat resistance training.

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**SLEEP DURATION DOES NOT AFFECT RESISTANCE TRAINING-INDUCED STRENGTH GAINS**

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INTRODUCTION: It is advocated that sleep duration may affect resistance training-induced strength gains. Theoretically, short-sleepers (i.e., <360 min per night) should have lower strength gains than regular-sleepers ( > 360 min per night). On the other hand, evidence suggests that a higher training volume (i.e., number of sets) may mitigate the negative effects of a short sleeping pattern on strength gains. Thus, our study aimed to determine if total sleep time, number of awake periods during the night, and differences in RT volume may affect RT-induced strength gains.

METHODS: Twenty-five untrained college students (20 females and 5 males) volunteered to participate in the study (mean ± standard deviation [SD]—age: 20.0 ± 2.0 years, body mass: 61.6 ± 18.9 kg). Total sleep time (TST) and wake after sleep onset (WASO) were assessed over seven days at pre-training via wrist-worn actigraphy. The one-repetition maximum (1RM) load was assessed using a leg extension pin-loaded machine (Body-Solid; DLEC-SF, Forest Park, IL) at pre- and post-training by researchers blinded to sleep patterns. Classification of participants into short- and regular-sleepers was performed non-randomly at post-training for blinding purposes (i.e., a non-randomized controlled trial). Participants' lower limbs were randomly assigned to low- and high-RT volume conditions (1 set vs. 3 sets per exercise [leg press and knee extension], respectively—i.e., within-subject design) and trained for eight weeks, twice a week, under the supervision of researchers blinded to sleep patterns. General linear models were used to compare changes in muscle strength from pre- to post-training and delta change in muscle strength between the low- and high-RT volume limbs.

RESULTS: Means and SD for TST and WASO were 442.0±63.4 min and 32.3±2.32 times per night, respectively. As our sample had only 3 short and 22 regular sleepers, TST and WASO were modeled as covariates instead of a fixed effect. Covariates TST and WASO did not change the interpretation of our findings, and they were removed from the statistical models. Both the lower-volume and the high-volume limbs presented significant increase in the 1RM values from pre- to post-training (Low volume: Pre: 75.20±23.47 and Post: 91.43±27.98 kg: p=0.038; High volume: Pre: 74.80±22.57 and Post: 94.29±26.57 kg: p=0.01, respectively). The comparison of the delta changes in muscle strength between the low- and high-volume limbs showed no difference between short- and regular-sleepers (p=0.32).

CONCLUSION: College students with no previous experience in RT demonstrate sleep patterns that do not appear to affect RT-induced strength gains. Additionally, a higher training volume does not seem to have positive effects on maximum strength for this cohort.

## Conventional Print Poster Presentations

### CP-AP22 Basketball

**LANE AGILITY TEST DISCRIMINATES CHANGE-OF-DIRECTION SPEED BETWEEN PLAYING STANDARDS AND POSITIONS IN BASKETBALL PLAYERS**

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INTRODUCTION: Although the Lane Agility Test (LAT) has been widely used for assessing change-of-direction speed in basketball, its ability to evaluate and discriminate players competing at different standards and positions is unknown [1]. The aim of this study was to compare change-of-direction speed in male basketball players according to playing standards and positions determined using the LAT.

METHODS: This study adopted a cross-sectional, descriptive research design, where data collected from highly trained adolescent basketball players (n = 53; age: 17.3 ± 1.0 years; height: 185.0 ± 7.8 cm; body mass: 78.3 ± 10.7 kg) and participants in the 2024 NBA Draft Combine (n = 77; age: 21.4 ± 1.6 years; height: 198.9 ± 8.7 cm; body mass: 96.2 ± 9.9 kg) were grouped and compared based on playing standards and positions (backcourt: n = 54; age: 19.1 ± 2.5 years; height: 184.9 ± 7.0 cm; body mass: 79.4 ± 10.1 kg; frontcourt: n = 76; age: 20.1 ± 2.4 years; height: 199.1 ± 9.0 cm; body mass: 95.7 ± 11.4 kg). Generalized linear model was performed on the LAT values, while using playing standard and position as predictors.

RESULTS: According to the generalized linear model, both predictors, playing standard (p = 0.046, Wald x2 = 3.977) and playing position (p = 0.001, Wald x2 = 10.783), had a significant main effect on the time in the LAT. Data collected at the NBA Draft Combine (compared to highly trained adolescents) and from backcourt positions (compared to frontcourt) accounted for -0.389 seconds (95% CI: -0.682 to -0.097) and -0.533 seconds (95% CI: -0.860 to -0.206) faster LAT times, respectively.

CONCLUSION: Our findings suggest basketball researchers and practitioners may use the LAT to confidently assess and discriminate change-of-direction speed between male players competing at different standards and positions.

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**INTERNAL TRAINING LOAD IN COLLEGIATE WOMEN'S BASKETBALL: DESCRIPTIVE ANALYSIS OF THE EFFECT OF A CONGESTED TWO-WEEK MICROCYCLE**

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INTRODUCTION: Basketball requires high-intensity efforts across various parameters. Collegiate seasons often expose players to congested schedules with multiple games per week. Internal training load (ITL) reflects physiological stress experienced by the players during practices and games (1). Investigating the impact of differing game schedules such as a 3-game week vs. 2-game week could provide insight on variation of ITL. ITL distribution between practice and games could further assist planning to optimize players' readiness for games (1). While external training load has been studied well, we are unaware of research on ITL using modified summated heart rate zones (SHRZ) in collegiate womens basketball. SHRZ quantifies ITL by accounting for time spent at different heart rate intensities (2). Our aim was to examine how a congested two-week microcycle affects ITL distribution between practices and games and the overall weekly demands in collegiate women's basketball.

METHODS: A two-week microcycle with three games and three practices in week 1 (W1), and two games and four practices in week 2 (W2) was monitored. Players who played ≥ 10 live minutes in each game of the microcycle were included. Four players with mean age 22.75±0.5 years and mean height 180.97±8.89 cm met the criteria. Catapult S7 sensors (indoor mode) and Openfield Console 3.13.0 captured heart rates which were exported in 1-minute epochs into Microsoft

Excel. SHRZ involves calculating heart rate bands in 2.5% increments of maximum heart rate (HRmax) (starting from 50% HRmax), assigning each band a weighting factor which was multiplied by the time spent in that band and finally summed to get absolute SHRZ (aSHRZ) in arbitrary units (AU) (2). HRmax for each player was the maximum heart rate observed from preseason to the end of the microcycle. We identified that 7 observations were missing for 3 players. The mean of the data from the remaining days in the microcycle was used for imputation. Descriptive statistics were calculated using Jamovi 2.6.17.

RESULTS: The mean aSHRZ for W1 (3-game week) was 247±110 AU and W2 (2-game week) was 217±86 AU. W1 practices averaged 185±47.2 AU and games averaged 308±121 AU. W2 had practices averaging at 201±69.7 and games at 297±83.1 AU. The total aSHRZ for W1 was 106% of W2. Practices and games were 37.5% and 62.5% of the total aSHRZ in W1. In W2, practices were 57.52% whereas games were at 42.48% of the total aSHRZ.

CONCLUSION: Our study found a slightly higher overall ITL during the 3-game week compared to the 2-game week consistent with previous literature (1). While games had a higher mean aSHRZ than practices in both weeks we observed that the practices in the 2-game week exhibited a higher total aSHRZ than the games. This suggests that strategic scheduling could be implemented to manage ITL, recovery and may improve performance.

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**CHANGE OF DIRECTION SPEED, SPEED AND CHANGE OF DIRECTION DEFICIT VARIATIONS IN YOUNG BASKETBALL PLAYERS: SEX AND MATURATION COMPARISON**

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INTRODUCTION: Change of direction speed (CODS) which has a very important role in basketball performance, is a complex and multidirectional skill that involves planned decelerations and accelerations in different directions1. On the other hand, change of direction deficit (CODD) is the additional time that one directional change requires when compared to pure linear sprint over an equivalent distance1. It is also known that for young athletes both sex and maturation are two important factors that affect performance variables throughout growth2. Hence the purpose of this study was to determine CODS, speed and CODD variations in young basketball players according to sex and maturation.

METHODS: A total of 181 young basketball players (Females: n=97, Males: n=84) with at least two years of basketball experience constituted the sample of this study. Participants were classified into three groups based on their biological maturation levels determined by their distance from the peak height velocity (PHV) periods as pre-PHV (n=59), circa-PHV (n=46) and post-PHV (n=76). Each participant performed two Y-drill tests (planned) for determination of CODS to both left and right sides and two 10-m sprint tests for determination of speed in random order. CODD was calculated as the difference between best COD performance and 10-m sprint time. To determine the variations in CODS, speed and CODD according to sex and maturation a 2x3 (sex x maturation) two-way ANOVA was applied with Scheffe's post hoc analysis.

RESULTS: Results indicated significant sex (p=.000) and maturation effect (p=.000) with no significant sex x maturation interaction (p=.159) in CODS. Males had faster COD than females and post-PHV was the fastest compared to the other maturation groups. Similarly, in 10-m speed there was significant sex (p=.000) and maturation (p=.000) effect, while sex x maturation interaction was not significant (p=.425). Again males were faster than females and post-PHV group was the fastest compared to other groups. Finally, in CODD no significant sex and maturation effects were found together with sex x maturation interaction (p>.05).

CONCLUSION: The findings of this study indicated that sex and biological maturation resulted in significant variations in CODS and speed, whereas these two variables did not affect CODD.

1Nimphius et al 2016, 2Giuriato et al 2021

**EFFECTS OF KETTLEBELL TRAINING VS. PLYOMETRIC TRAINING ON JUMPING PERFORMANCE IN VOLLEYBALL AND BASKETBALL ATHLETES**

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INTRODUCTION: Kettlebell training is a well-established method to increase strength and power and appears to be a promising approach for improving jumping performance in athletes across various sports such as basketball or volleyball. However, there are no studies investigating the effectiveness of kettlebell training compared to conventional plyometric jump training in experienced basketball and volleyball athletes.

METHODS: Forty-nine volleyball and basketball athletes (age: 23 ± 5.2 years) with a minimum of 1 year of training experience, were assigned to one of three groups: a control group (CtrG), a kettlebell training group (KbG), and a plyometric training group (PlyG). Over a 6-week intervention period, KbG and PlyG trained twice per week for 25 minutes under supervision of a coach, with a minimum of 48 hours of rest between sessions. The CtrG was instructed to adhere to their habitual training schedule throughout the intervention period. All participants attended a pre- and post-test. During the test sessions, vertical jump height was assessed using the countermovement jump (CMJ), squat jump (SJ), and drop jump (DJ). Additionally, the reactive strength index (RSI) was determined for the DJ, and maximal force was measured in the

mid-thigh pull (MTP). All tests were conducted on a dual force plate and analyzed via TEMPLO™ software (Contemplas, Kempten, Germany).

RESULTS: Thirty-eight participants completed the study (CtrG: N = 12, KbG: N = 16, PlyG: N = 10). The KbG showed significant improvements in vertical jump height, with increases of 3.9% in the CMJ (p = .039), 9.5% in the SJ (p = .001), and an 11.1% in the DJ (p = .002). The RSI improved significantly by 13.3% (p = .002) and maximal force in the MTP by 9.9% (p = .002) in the KbG. In the PlyG, maximal force in the MTP improved significantly by 14.6% (p = .002). No significant differences were found between pre- and post-test results within the CtrG for any outcome.

CONCLUSION: This study indicated that even as little as 6 weeks of kettlebell training could significantly improve measures of jumping performance and strength in experienced volleyball and basketball athletes. While both plyometric and kettlebell training aimed to develop the ability to rapidly apply force, the improvements in kettlebell training could have benefited from the novelty of the training stimulus, providing additional adaptive potential. In conclusion, kettlebell training could be a valuable alternative to plyometric training, potentially reducing monotony and altering the mechanical stress on joints, tendons, and ligaments through exercise variation, making it an accessible and convenient training method for strength and conditioning professionals.

**HIGH-RISK MOVEMENT LEADING TO ANKLE SPRAIN INJURY IN CONTACT TEAM SPORTS: A SYSTEMATIC REVIEW OF VIDEO ANALYSIS STUDIES**

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INTRODUCTION: Ankle sprains count among the most common musculoskeletal injuries, particularly affecting athletes in team sports. Although a plethora of studies have investigated epidemiological aspects, preventive measures, and rehabilitative treatments, the movements leading to injury have not yet been identified. Video-based analyses of injuries sustained during match play enable the extraction of specific data on situational variables. This systematic review summarized the prevalence of different movement patterns performed during the moment of ankle sprain injury in contact team sport athletes.

METHODS: A systematic literature search was conducted using PubMed, Web of Science, SPOLIT, and Google Scholar. We included video analysis studies investigating the movement patterns performed by contact team sport athletes sustaining an ankle sprain. Risk of bias was assessed by means of the QA-SIVAS scale. Meta-analysis of prevalence was used to pool the proportions of the following movement patterns: landing, change of direction (COD), running, shuffle, and step/lunge.

RESULTS: The literature search returned seven eligible studies, collectively examining a total of 534 injuries (480 males, 54 females). Risk of bias was low to moderate, with an average QA-SIVAS score of 71% (range: 50 to 83%). Direct injuries (65%, 95% CI 54-76%, p<.001, I2=80%) were more frequent than indirect (22%, 95% CI 14-31%, p=.01, I2=69%), and non-contact ankle sprain injuries (15%, 95% CI 10-22%, p=.01, I2=63%). The most frequent movement pattern during injury was landing (32%, 95% CI 21-45%, p<.001, I2=86%), followed by running (24%, 95% CI 13-36%, p<.001, I2=82%), step/lunge (19%, 95% CI 5-38%, p<.001, I2=95), COD (6%, 95% CI 2-10%, p=.08, I2=55%) and shuffle (3%, 95% CI 0-10%, p<.001, I2=79%).

CONCLUSION: Jump landing and running are the main high-risk movements associated with ankle sprain injuries. Although most traumas are caused by direct physical contact, athletes, coaches, and therapists should be aware of this finding when designing exercise programs. Additional research investigating specific populations (e.g., recreational vs. professional athletes, youth vs. adult athletes, males vs. females) or sports (e.g., team vs. individual) is warranted.

**DYNAMIC POSTURAL STABILITY STRATEGIES IN FEMALE ATHLETES DURING CONSECUTIVE LATERAL LANDINGS WITH DUAL-TASK**

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INTRODUCTION: Anterior cruciate ligament (ACL) injury is one of the most common sports injuries. Movements such as directional changes, jumping, and landing increase the risk of ACL injuries [1]. Dual-task interventions may interfere with landing strategies, potentially elevating the risk of injury. In complex sports environments, athletes must perform rapid movements while maintaining postural stability, often simultaneously engaging in multiple tasks such as running, passing, and dribbling, which reflect the demands of dynamic balance and dual-task performance [2]. Therefore, designing movement tasks that closely mimic real sports scenarios can provide deeper insights into dynamic postural stability strategies and injury mechanisms during lateral landings. This study aims to investigate athletes dynamic postural stability strategies using continuous lateral jumping combined with a dual-task.

METHODS: The study recruited eight healthy female collegiate athletes. Participants performed four consecutive single-leg lateral jumps, with the jump distance set at 140% of hip width. For the dual-task condition, participants held a wireless handgrip dynamometer with their dominant hand, maintaining 30% of their maximal grip strength. In the non-dual-task, the handgrip dynamometer was not used. Data from the final landing and the subsequent three seconds were analyzed. The primary analyses focused on postural stability parameters and joint kinematics. A paired-sample t-test was used to compare postural stability indicators between the dual-task (DT) and non-dual-task (NDT).

RESULTS: This study revealed that during landing, the hip abduction angle (p = .021) and knee varus angular velocity (p = .001) were significantly lower in the DT condition compared to the NDT. Furthermore, the medial-lateral stability index (MLSI)(p = .003) and hip adduction angular velocity at the lowest squat position (p = .033) were significantly higher in the DT than NDT.

CONCLUSION: The results of this study indicate that under the DT, the MLSI index increased, hip abduction showed less angle at initial landing, and hip adduction angular velocity was greater at the lowest squat position. This study found that athletes exhibited poorer dynamic stability and movement control under DT, increasing their risk of lower limb injuries [3]. Moreover, the slower knee varus angular velocity may represent a compensatory landing strategy in response to the reduced hip abduction angle [1]. In summary, DT may affect athletes landing strategies and lower limb control [4]. Future training programs could incorporate DT exercises to enhance postural stability and athletic performance while reducing the risk of lower limb injuries.

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**PHYSICAL DEMANDS ON ELITE SPANISH MALE AND FEMALE FOOTBALL REFEREES DURING COMPETITION**

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INTRODUCTION: In football, professional referees represent the highest authority during a match. They must move in all directions on the field to ensure optimal positioning and the enforcement of the laws of the game (Weston et al., 2012). Football is a team sport that requires a high level of physical fitness (Castagna et al., 2007), involving continuous accelerations, decelerations, changes of direction, and other high-intensity actions performed by professional football players (Oliva-Lozano et al., 2021).

Previous studies on professional football referees have shown significant gender differences, particularly in higher speed thresholds. Female referees generally exhibited lower aerobic fitness levels and performance compared to their male counterparts.

The objective of this research was to analyze and compare the physical demands of professional male and female field referees during official matches in terms of distance covered and speed.

METHODS: The study sample consisted of 17 female referees (age: 29.05 ± 5.24 years; height: 163.88 ± 6.77 cm; weight: 54.03 ± 5.19 kg) and 19 male referees (age: 38.25 ± 4.14 years; height: 182.1 ± 4.73 cm; weight: 74.63 ± 5.89 kg), all of Spanish nationality, officiating in the Spanish Womens First Division. Male referees trained an average of five sessions per week, while female referees trained four sessions (including strength, endurance, and speed exercises). They typically officiated one midweek match and another on the weekend. As an inclusion criterion, referees had to be free of injuries.

Data were collected from 409 matches during the 2020-2021 season (male matches: 223; female matches: 186). Matches took place in different football stadiums with similar dimensions according to FIFA requirements (110x70 meters). The physical demands of female referees were monitored using WIMU PROTM (RealTrack System SL, Almería, Spain). All devices were activated 30 minutes before data collection to acquire satellite signals and synchronize the GPS clock with the atomic clock of the satellite.

Referees performed a standardized 15-minute warm-up before the match. However, these data were excluded, and only the data collected during the first and second halves were considered for analysis.

RESULTS: Female referees showed significantly lower values than male referees in total distance covered (-451.11 m; ES = 0.56; $p < 0.05$), explosive distance (-102.92 m; ES = 0.42; $p < 0.05$), high-speed breaking distance (-55.29 m; ES = 0.57; $p < 0.05$), total sprints (-4.96 actions; ES = 1.08; $p < 0.05$), sprint distance (-112.35 m; ES = 1.16; $p < 0.05$), high-speed running actions (-10.25 actions; $p < 0.05$), high-speed running distance (-206.58 m; ES = 1.01; $p < 0.05$), and maximum speed (-2.24 km/h; ES = 1.00; $p < 0.05$).

CONCLUSION: The main finding was that Spanish male referees in mens football matches experienced higher physical demands than female referees in womens football matches in terms of both distance covered and speed.

## Conventional Print Poster Presentations

### CP-AP26 Running

**EFFECTS OF DAYTIME ENDURANCE EXERCISE UNDER HOT ENVIRONMENT ON SLEEP IN ENDURANCE ATHLETES**

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INTRODUCTION: Athletes are often required to perform intensive training sessions under hot environment. Exercise under hot environment increases physiological stress due to elevated core temperature and dehydration (Silva et al. 2019). Therefore, recovery process becomes more important following the exercise under hot environment. Although several types of the post-exercise recovery strategies are proposed, sleep is indispensable to promote recovery of exercise capacity (John et al. 2017). While the effects of exercise on sleep have been well documented, how endurance exercise

under hot environment affects sleep quality remains unclear. The aim of the present study was to clarify the effect of endurance exercise under hot environment on sleep quality, nocturnal body temperature and autonomic nerve activity.

METHODS: Ten endurance male athletes (20±1years, 169.8±5.7cm, 61.2±7.3kg, VO2max 56.1±4.9ml/kg/min) performed 60 min of endurance exercise at two different conditions, (1) hot condition (HOT : 35°C,50%RH), (2) control condition (CON : 20°C,50%RH). After completing the exercise, sleep variables (evaluated by EEG), skin temperature and heart rate variability (HRV) were measured during sleep.

RESULTS: Total sleep time (TST), sleep efficiency (SE) and time of slow wave sleep (N3) were significantly greater in HOT (TST: 411.3±15.6; SE: 97.1±3.7%; N3: 107.7± 31.0 min) compared with CON (TST: 389.8±34.6; SE: 92.3±8.1%; N3: 93.6±20.6 min, $p<0.05$ for each variable). The changes in skin temperature during initial 180 min after the sleep onset did not differ significantly between conditions. When comparing autonomic nerve activity parameters (evaluated by HRV) during sleep, no significant differences were observed between conditions for HF, LF/HF, SDNN, RMSSD, or pNN50 during sleep. However, NN50 was significantly lower in the HOT (127.5±39.2) compared with CON (138.0±30.4, $p<0.05$) .

CONCLUSION: Our findings indicate that endurance exercise under hot environment improved sleep quality compared with the same exercise under thermoneutral environment in endurance athletes. However, changes in body temperature and autonomic nerve activity during sleep did not account for improved sleep quality following the exercise under hot environment.

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**PHYSIOLOGICAL DIFFERENCES DURING AN INCREMENTAL TREADMILL TEST ACCORDING TO THE PERFORMANCE LEVEL IN LONG-DISTANCE RUNNERS**

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INTRODUCTION: Performance in long-distance events is influenced by several key physiological factors, including maximum oxygen uptake ($VO_2$max), running economy (RE), and the percentage of $VO_2$max at which the aerobic and anaerobic thresholds occurred [1]. Previous studies found differences in aspects such as the percentage of $VO_2$max where lactate threshold occurs between different level runners [2]. Therefore, this intervention aimed to analyze physiological differences between performance levels to better understand their influences on key performance parameters in long-distance runners.

METHODS: Thirty-four male and 22 female runners were categorized into two groups based on the 50th percentile of WA scores from 5 km to half-marathon events. Group 1 included runners with 965.18 ± 67.14 points for females and 933.06 ± 40.82 points for males. Group 2 averaged 652.55 ± 134.15 points for females and 737.41 ± 109.88 points for males.

A maximal graded exercise test on a treadmill (HP Cosmos Pulsar, Germany) was performed, starting at 10 km·h$^{-1}$ for females and 12 km·h$^{-1}$ for males, increasing by 1 km·h$^{-1}$ per minute until exhaustion and at 1% of inclination. Respiratory variables were measured with a gas analyzer (CPX Ultima MedGraphics, United States), and heart rate (HR) was recorded using a Polar H10 monitor. Ventilatory thresholds (VT1, VT2), $VO_2$max, and maximal aerobic speed (MAS) were determined. Independent t-tests were conducted separately for males and females to compare performance groups.

RESULTS: At the VT1, significant differences between groups were found in speed ($p<0.001$), %MAS where VT1 occurs ($p=0.019$), HR ($p=0.01$), and RPE ($p=0.016$) for male participants. In contrast, for female participants, there were only significant differences between groups in the speed ($p=0.008$).

At the VT2, significant differences between groups were observed in speed ($p=0.022$) and HR ($p=0.03$) for male participants. For female participants, there were significant differences in speed ($p<0.001$) and $VO_2$ (ml/kg/min) ($p=0.018$).

CONCLUSION: Male and female runners with higher performance levels demonstrated higher absolute speeds at both VT1 and VT2, as well as a higher %MAS where VT1 occurs only in male runners. Additionally, HR and RPE were significantly higher in males with a higher performance level, which may be attributed to their ability to sustain greater relative intensity over the same duration. These findings highlight the importance of stratifying athletes by performance level when analyzing physiological responses.

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**NEUROMUSCULAR FACTORS IN TRAIL RUNNING: A SYSTEMATIC SCOPING REVIEW.**

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INTRODUCTION: Trail running has emerged as a growing trend in endurance sports and has seen significant professionalization among many athletes (1). As with other endurance sports, neuromuscular factors play a crucial role in performance (2). However, most reviews in the scientific literature address physiological topics and injuries, leaving a gap in the knowledge regarding neuromuscular factors. Therefore, the purpose of this scoping review was to identify which neuromuscular factors have been studied, the types of interventions that have been conducted, and the populations that have been analyzed.

METHODS: A systematic search was conducted on PubMed, Web of Science, and Dimensions databases composing "trail running" AND "strength" OR "resistance" OR "neuromuscular" OR "lower limb" as keywords. Two reviewers screened the articles for eligibility according to the inclusion criteria. The articles that did not include trail athletes were excluded and PEDro scale was used to check article's quality.

RESULTS: Eighty-four records were retrieved during an initial search with a total of 38 finally included. Most of the studies had a pre-post design (44.73%), followed by cross-over studies (26.31%), comparative (10.53%), correlational (10.53%), and longitudinal case studies (7.89%). The main topic was to analyze the effect of different trail running distances, slopes, and sex on neuromuscular fatigue. Maximal voluntary and evoked contractions of lower limb muscles were measured in most of the studies (73.68%). Electromyography (21.05%), leg stiffness (15.79%), jump performance (13.16%), muscle soreness questionnaires (10.53%), and levels of creatine kinase (5.26%) were also evaluated. Moreover, fewer than half of the studies included female participants, and while some focused on amateur or high-level/elite athletes, the majority involved well-trained and experienced individuals.

CONCLUSION: The effects of trail running fatigue on neuromuscular factors have been widely studied across different distances, sexes, and athletic levels. Similarly, the impact of neuromuscular and biomechanical factors on performance, although to a lesser extent, has also been examined. However, there is a lack of knowledge regarding the impact of strength training on trail running performance, as well as a general need for further research involving female populations.

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**CONTINUOUS AND INTERMITTENT RUNNING CAUSE SIMILAR IMPAIRMENTS IN MAXIMUM FORCE-GENERATING CAPACITY BUT DIFFER IN CENTRAL, PERIPHERAL, AND PERCEIVED FATIGABILITY OVER A SIX-HOUR RECOVERY PERIOD**

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INTRODUCTION: Fatigue is known to be task-dependent, with exercise characteristics determining the dynamics of central and peripheral mechanisms, as well as magnitude of perceived fatigability [1,2]. In locomotor efforts, fatigue processes related to exercise intensity and training type have been extensively studied [3,4], likely due to their key role in conditioning and rehabilitation routines. However, despite its widespread practice, the task dependency of fatigue during running remains a rather under-researched topic. Therefore, this study aimed to provide a comprehensive evaluation of knee-extensor neuromuscular function and perceived fatigability following distinct running exercises at well-defined levels of metabolic stress.

METHODS: Twelve recreationally trained runners ($VO_2$max: 52.2 ± 6.9 mL/kg/min, training volume: 23.3 ± 6.5 km/week) completed a 8.1 ± 0.6 km run under three different conditions: (i) continuously for 40 minutes at a velocity corresponding to the respiratory compensation point (vRCP; CONT100%RCP), intermittently at (ii) 30% above vRCP (HIIT130%RCP; 10 × 3-min intervals), and (iii) 50% above vRCP (HIIT150%RCP). Voluntary and evoked knee-extensor contractions were assessed before and up to six hours after exercise to quantify mechanisms of fatigue. Additionally, ratings of global fatigue, leg pain, and mood state were recorded.

RESULTS: Peak force and voluntary activation of the knee extensors remained reduced for at least six hours after exercise (main effects of time $p<0.01$), while contractile function was impaired for up to two hours (main effects of time, $p = 0.01$). Greater impairments in the central nervous systems ability to transmit electrical signals to the vastus lateralis (i.e., reductions in RMSVL/M-waveamp) were observed after CONT100%RCP compared to both HIIT130%RCP and HIIT150%RCP (main effects of time $p = 0.03$). In contrast, greater impairments in contractile function (i.e., reductions in potentiated peak force evoked by the single stimulus) were observed after HIIT150%RCP compared to CONT100%RCP (main effect of training type, $p < 0.05$). Additionally, leg pain, perceived fatigue, and mood disturbance were significantly greater after HIIT150%RCP compared to CONT100%RCP (main effects of training type, $p < 0.05$).

CONCLUSION: Our findings highlight the task dependency of fatigue in running, demonstrating that six hours post-exercise, a continuous run at a velocity corresponding to the respiratory compensation point primarily impaired central

nervous system muscle activation capacity, whereas a high-intensity interval run at 50% above vRCP led to greater impairments in contractile function and perceived fatigability.

1. Hunter (2018) 2. Iannetta et al. (2022) 3. Brownstein et al. (2021) 4. Thomas et al. (2018)

**COMPARISON OF THE LOWER LIMB MUSCLE ACTIVITY DURING A DOWNHILL RUN AND THE SUBSEQUENT MUSCLE DAMAGE IN TRAIL VERSUS ROAD RUNNERS.**

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INTRODUCTION: Downhill running (DR) sections, a common component of off-road racing, can lead to exercise-induced muscle damage (EIMD) due to the greater eccentric work of some lower limb muscles. Repeated exposure to eccentric work is known to reduce or prevent EIMD. Running patterns may change during prolonged DR but the relationship between these adaptations and the EIMD has not been fully understood. Therefore, this study aimed to compare the running patterns during a 30min DR test and the magnitude of EIMD between trail and road runners.

METHODS: Recreational male trail runners (TR; n=22; 23.8 ± 3.7 yrs) and road runners (RR; n=21; 30.5 ± 8.8 yrs) underwent a treadmill VO2max test to determine their maximal aerobic speed (MAS). They then performed a 30min DR protocol at 90% MAS (-15% gradient). Spatiotemporal parameters (using a 3D motion system) were measured during DR, coupled with surface electromyography recordings. Plasma creatine kinase (CK) and delayed-onset muscle soreness (DOMS) were measured before, 24h and 48h after DR. Squat jump (SJ) performance was assessed before, immediately and 24h after exercise.

RESULTS: The VO2max values of the TR and RR groups were 55.9 ± 5.3 and 52.5 ± 6 mlO2/min.kg, respectively. The increase in plasma CK activity was significantly higher in RR group at 24h (1306 ± 630 UI/l) and 48h (852 ± 553 UI/l) post-exercise compared to TR group (772 ± 540 UI/l; 382 ± 151 UI/l; respectively). Similarly, the RR experienced higher muscle soreness of the knee extensors at 24 and 48h post-exercise (5 ± 2.4 and 4.5 ± 2.2 a.u) than the TR (3.6 ± 2.3; 3.7 ± 2.4 a.u). SJ performance decreased immediately and 24h after DR only in the RR group (-8.7 ± 7.6 and -7.3 ± 5.4%). While no significant differences in stride frequency, swing and stance times were found between groups, the duration of the stance phase significantly increased from the beginning to the end of the run (2.3 ± 4.2%). Muscle activity of lower limbs did not differ between groups but significant changes were found over time. Muscle activity increased for the biceps femoris, rectus femoris, vastus lateralis and medialis during the stance phase whereas the gastrocnemius lateralis and medialis showed a decreased activation from the start to the end of DR.

CONCLUSION: As expected, the RR showed greater changes in EIMD indirect markers than the TR after DR but no difference in muscle activity was found between groups. Further correlation analysis between running patterns and subsequent EIMD may help to better understand the relationship between these parameters.

**THE REPRODUCIBILITY OF SKIN THERMAL RADIATION VARIATIONS DURING REPEATED CONTINUOUS AND INTERMITTED RUNNING EXERCISE MEASURED WITH AI-ASSISTED INFRARED THERMOGRAPHY**

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INTRODUCTION: AI-assisted Infrared Thermography allows automatic time-series analysis of skin thermal radiation (Tsr) non-invasively and contact-free during exercise. Tsr variations during exercise are closely related to acute physiological response [1]. However, the reproducibility of Tsr variation during repeated exercise has not been sufficiently investigated. Hence, this study investigated the reproducibility of Tsr variations both within and between individuals across continuous and intermittent running bouts in endurance-trained individuals.

METHODS: Eleven young endurance-trained individuals (24.8±2.4 years; maximal oxygen uptake: 50.5±6.8 mL/min/kg; Physical Activity-Rating ≥ 6) completed three running protocols with a duration of 46 minutes each. The similar average external load was based on individual anaerobic threshold (IAT) measured via lactate measurement during cardiopulmonary exercise testing. Each session consisted of a warm-up (10 min), followed by either 36 min of continuous (T1), continuous-intermittent (T2), or intermittent-continuous (T3) running. A high-resolution thermal camera, positioned perpendicular to the lower leg, captured images at 30 Hz. Deep neural network-based segmentation was applied to objectively perform reproducible region of interest extraction and Tsr time-series analysis. The relative consistency of measurements within and between individuals was analyzed by two-way mixed-effects intra-class correlation analysis and the differences between exercise sessions were tested with repeated measures analysis of variance (rmANOVA; significance level: $p < .05$).

RESULTS: The interindividual intra-class correlation analysis revealed good consistency for the relative Tsr variations for all three exercise bouts (ICC = 0.75-0.76) comparable to oxygen consumption (ICC: 0.64-0.77) and heart rate (ICC: 0.65-0.76). The intraindividual reproducibility showed good to excellent consistency (ICC ≥ 0.75) for warm-up, intermittent-phase, and recovery, again comparable to oxygen consumption and heart rate. Additionally, there were no significant differences for the relative Tsr between the three running sessions at any time point according to the results of the rmANOVA [$F(1.77,17.74) = 3.352$, $p = 0.056$].

CONCLUSION: The study results indicate that time-series of Tsr variations during running are reproducible for endurance-trained individuals. Furthermore, the intraindividual comparison showed promising results regarding consistency in Tsr variation independent of day, daytime, and preload. These exploratory findings advance the field considering analysis and design of studies investigating thermography to detect individual cardiovascular and thermoregulatory long-term adaptation.

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**PHYSIOLOGICAL RESPONSES AND PERCEIVED EXERTION OF THREE HIGH-INTENSITY INTERVAL TRAINING PROTOCOLS IN LONG-DISTANCE RUNNERS.**

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INTRODUCTION: HIIT is commonly used in the training regimens of long-distance athletes. However, there is a wide variety of training protocols exist, each with different load components (volume, intensity, rest duration, etc.). Furthermore, there is a notable scarcity of well-controlled studies, leaving many unanswered questions regarding the most effective training types for optimizing specific adaptations in endurance athletes. This study aims to analyze and compare the acute responses of oxygen consumption (Vo2/kg), heart rate (HR) and Rating of Perceived Exertion (RPE) in three HIIT protocols with different interval durations.

METHODS: A study involved 20 highly trained adult long-distance athletes (10 men and 10 women), comparing gas exchange (MetaMax 3B Cortex), HR (Polar H10), and RPE (Borg Scale 1-10) across three different HIIT protocols: 1200m (long), 400m (medium), and 100m (short). All protocols were equated for volume (6000m), and rest time was standardized to a work/rest ratio of 1:1. The running intensity prescribed for all athletes was the maximum they could maintain throughout all repetitions. The study aimed to simulate a real-world training scenario on an official 400-meter track using portable equipment. Data were analyzed using RStudio. Two Linear Mixed Models (LMMs) were applied: one with VO2/kg and another with HR as dependent variables. Fixed effects included protocol and time (within-subjects design), with random effects were structured to account for variability in protocol effects across individual subjects. Pairwise comparisons and $R^2$ values were calculated for both models. RPE was assessed via the Kruskal-Wallis test, supplemented by post hoc Dunn tests for pairwise comparisons.

RESULTS: The results indicate that the protocols have distinct effects on VO2/kg and HR. The models revealed significant differences in VO2/kg between protocols: medium (-5.68 vs long, $p < 0.001$) and short (-7.45 vs long, $p < 0.001$), with no significant difference between medium and short ($p = 0.44$). Fixed effects, including time and protocol, accounted for $R^2 = 0.095$, while random effects explained $R^2 = 0.385$. Similar effects were observed for HR; however, no significant differences were found between the protocols when directly compared. The Kruskal-Wallis test showed significant differences ($\chi^2 = 8.9575$, $p = 0.011$) in RPE across the three protocols, primarily between the short and long protocols, with the former perceived as less strenuous by the subjects.

CONCLUSION: Based on the findings, the long interval protocol results in significantly higher VO2/kg values during the running phases compared to the medium and short protocols, with no significant differences between the latter two. In terms of perceived exertion, the short interval protocol elicited the lowest ratings. The study underscores the importance of performing intervals lasting between 3 and 5 minutes to stimulate athletes for a longer period in zones close to VO2max.

**ACUTE RESPONSES TO TWO INDIVIDUALIZED AEROBIC INTERVAL TRAINING PROTOCOLS WITH DIFFERENT INTENSITY OF EFFORT BASED ON A PREVIOUS RUNNING TEST**

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INTRODUCTION: Aerobic interval training (AIT) consists of repeated bouts of high-intensity exercise (i.e., work intervals longer than 60 s) interspersed with pauses (i.e., rest intervals), allowing for a greater accumulation of exercise volume at a targeted intensity (i.e., above 90% of $VO_2$max) within a single training session (Sánchez-Otero et al., 2022; Varela-Sanz et al., 2023). Scientific evidence traditionally recommends work intervals lasting 2–3 minutes, performed at maximal aerobic speed (MAS), with a work-to-rest ratio (w:r) of 1:1 and a total accumulated exercise volume of at least 15 minutes to develop aerobic power (Sánchez-Otero et al., 2022; Varela-Sanz et al., 2023). To our knowledge, no studies have explored individualized interval durations based on a time-to-exhaustion running test (Tlim) at MAS. This study aimed to examine the acute responses to two individualized AIT protocols with different intensities of effort based on the individual Tlim.

METHODS: Ten Sports Science students completed a maximal running test to determine MAS and $VO_2$max. After 72 hours, 20–30 m maximal sprinting speed was assessed. Participants Tlim at MAS was then determined. After 72 hours, they randomly performed two AIT sessions at MAS, each accumulating 15 minutes but differing in intensity of effort based on Tlim: AIT30 (work intervals lasting 30% of Tlim) and AIT75 (work intervals lasting 75% of Tlim). A 30-m sprint force-velocity profile was recorded before (pre) and after (post) both AIT sessions. Rating of perceived exertion (RPE) was recorded after each work interval and for the entire session. Heart rate (HR) was monitored throughout all sessions.

RESULTS: Exercise tolerance during work intervals was higher in AIT30 than in AIT75. RPE and HR for the entire session were similar between both AIT sessions. Sprinting speed performance differed between pre- and post-measurements, indicating a post-activation performance enhancement (PAPE) response following the AIT protocols.

CONCLUSION: AIT protocols performed at MAS with a w:r of 1:1, but differing in intensity of effort based on individual Tlim, provide an effective approach for prescribing individualized training loads. Both shorter and longer work intervals appear to be well tolerated when total exercise volume is equated. Interval length partially modulates acute responses to AIT. Future longitudinal studies are needed to optimize dose-response relationships and maximize adaptations in both the short and long term.

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**EFFECTS OF A BODY-MASS SUPPORT SYSTEM ON SPATIOTEMPORAL PARAMETERS DURING (SUPRA-)MAXIMAL TREADMILL SPRINTING**

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INTRODUCTION: Maximum sprinting speed (MSS) is constrained by the ability to generate sufficient mass-specific vertical forces within short ground contact times(tc), leading to an inverse relationship between tc and sprinting speed [1]. 'Assisted' sprinting has been proposed as a promising method to increase MSS, with traditional methods relying on horizontal towing forces. Conversely, body-mass support systems (BMSS) offer a unique 'vertical assistance' approach,that reduce vertical force demands during stance [2]. While BMSS has been explored in low-speed running, its effects on maximal and supramaximal sprinting remain poorly understood. Therefore, this study examined the impact of a novel BMSS on spatiotemporal parameters during high-speed treadmill sprinting.

METHODS: Seven male (100m PR: 10.84 ± 0.56s) and 11 female (100m PR: 12.49 ± 0.70 s) trained sprinters participated. The study consisted of two testing sessions separated by 72 hours. During the first visit, athletes performed three maximal 70 m sprints on an indoor athletic track. MSS, defined as the highest velocity over two consecutive steps, was measured via a laser device. During the second visit, athletes completed two treadmill sprints for each of the three conditions in the following order: a) unassisted at 100% MSS (FREE), b) assisted at 100% MSS (ASSIST) c) assisted at 105% MSS (ASSIST-SUPRA). A motorized treadmill was accelerated within 5 s to the individually selected velocity and this velocity was maintained for a period of 3 s (peak velocity phase) before decelerating. Vertical assistance, corresponding to a 10% reduction in body mass during upright standing, was applied using a custom-built BMSS (LEVER UP, Lever Movement, Boulder, USA). Spatiotemporal parameters - including step length (SL), step frequency (SF), tc, and flight time (ta) - were measured via photoelectric cells during the peak velocity phase. A one-way RM ANOVA was conducted to assess differences between the three conditions, followed by Bonferroni-corrected post-hoc tests.

RESULTS: Multivariate analysis revealed statistically significant differences across conditions for all spatiotemporal parameters ($p < 0.001$) with large effect sizes (part. eta2 = [0.14, 0.89]). In ASSIST-SUPRA, participants exhibited significantly greater SL ($p < 0.01$) and SF ($p < 0.001$), alongside reduced tc ($p < 0.001$) while ta remained unchanged compared to FREE and ASSIST. No significant differences in SL and SF were observed between FREE and ASSIST. However, ASSIST altered step time distribution, reducing tc ($p < 0.001$) and increasing ta ($p < 0.01$).

CONCLUSION: Unlike horizontal towing devices, which primarily increase velocity by lengthening SL through extended ta [3], this study observed a combination of supramaximal speed and reduced tc. These findings highlight the potential advantages of BMSS as a training tool to possibly enhance MSS, warranting further investigation in applied sprint training.

(1) Clark et al., 2022

(2) Kratky et al., 2016

(3) Gleadhill et al., 2024

Conventional Print Poster Presentations

CP-AP28 HIIT, Agility and Fatigue

**HEART RATE VARIABILITY (DFA A1) AS A FATIGUE MARKER: DIFFERENTIAL RESPONSES TO LIGHT, MODERATE, AND HIGH-INTENSITY TRAINING WITH MATCHED WORKLOADS**

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INTRODUCTION: Training improves performance through progressive overload, delicately balancing stress and recovery. Hence, an objective fatigue-recovery marker would gravely benefit athletes seeking to sustainably improve performance. Interestingly, a non-linear heart rate variability (HRV) index (DFA a1) holds promise as a marker of exercise intensity as well as one's physiological status of fatigue during endurance training. Specifically, DFA a1 has gained attention for its potential to demarcate intensity thresholds as it's value decreases with increasing intensity and hereby correlates with aerobic and anaerobic thresholds. Moreover, it could be applied to monitor fatigue as it shows suppressed values during prolonged exercises. However, responsiveness of DFA a1 to training sessions of different intensities with identical workload remains unexplored.

METHODS: Eighteen participants (18-35yrs, BMI<25, ≥5h endurance training/week) performed three training sessions (light, moderate, high-intensity) separated by at least one week. Training sessions were matched for workload (joules) by adapting training time, calculated using the formula $E=P\times\Delta t$. The high-intensity training was done first and determined the duration of the light and moderate training. The order of the light and moderate training was randomized and was performed as a continuous training at the first and second lactate threshold (i.e LT1 and LT2) power, respectively, based on the subject's individual maximal incremental exercise test results. The initial high-intensity training followed a 10x1-minute high-intensity interval protocol at 110% $VO_2$max power alternated with 1 minute rest at 80% LT1 power. Each training started and ended with a standardized 10-min warming-up (WU) and 10-min cooling-down (CD) at LT1 power. Mean DFA a1 and HR were calculated during the final two minutes of WU and CD to assess intensity-specific physiological changes.

RESULTS: Mean differences in DFA a1 and HR (beats/min) values between the last two minutes of WU vs. CD were 0.051 (±0.160), p=0.66 and 6.50 (±3.67) beats/min, p=0.27 for light-intensity, 0.285 (±0.140), p=0.006 and 8.28 (±3.48) beats/min, p=0.14 for moderate-intensity, and 0.321 (±0.222), p=0.009 and 9.39 (±5.71) beats/min, p=0.11 for HIIT. Repeated measures ANOVA of DFA a1 during WU vs. CD revealed significant differences for light vs. moderate (0.234, p<0.001) and light vs. HIIT (0.269, p<0.001). However, no significant difference was observed for moderate vs. HIIT (0.035, p=0.486). Importantly, HR values obtained during WU vs. CD were not significantly different across training intensities, indicating that DFA a1 seems to be a more sensitive marker of acute fatigue.

CONCLUSION: The responsiveness of DFA a1 to training intensity, especially compared to unchanged HR values, highlights its potential as a sensitive marker of fatigue. This responsiveness suggests DFA a1 could serve as a practical tool for monitoring physiological stress and personalizing exercise and recovery programs.

**EFFECTS OF BREATHING HYPEROXIC GAS DURING HIGH-INTENSITY INTERVAL EXERCISE ON POST-EXERCISE MRNA RESPONSES IN EQUINE SKELETAL MUSCLE**

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INTRODUCTION: High-intensity interval training (HIIT) in hyperoxia is proposed to enhance exercise performance and aerobic capacity, but its potential efficacy and underlying mechanisms remain unclear. Therefore, the aim of this study was to determine the effect of breathing hyperoxic gas during HIIT on post-exercise mRNA responses in equine skeletal muscle.

METHODS: In a randomized crossover study design, seven trained Thoroughbred horses (3 geldings and 4 mares) performed four work-matched treadmill exercise protocols: 1) moderate-intensity continuous exercise in normoxia (fraction of inspired oxygen [FIO2] = 0.21, 6 min at 70% VO2max; N-MICT), 2) high-intensity interval exercise in normoxia (FIO2 = 0.21, 6 × 30 s at 100% VO2max with 30 s recovery; N-HIIT), 3) moderate-intensity continuous exercise in hyperoxia (FIO2 = 0.30, 6 min at 70% VO2max; H-MICT), and 4) high-intensity interval exercise in hyperoxia (FIO2 = 0.30, 6 × 30 s at 100% VO2max with 30 s recovery; H-HIIT). Arterial blood samples were collected during exercise to measure blood gases and plasma lactate concentrations. Biopsy samples from the middle gluteal muscle were collected pre-exercise and 4 hours post-exercise for real-time PCR analysis of gene expression. Data are expressed as mean ± standard error (SE), and the effects of time, protocol and their interaction (time x protocol) were analyzed using mixed models ($P < 0.05$).

RESULTS: At the end of exercise, arterial O2 saturation (SaO2) was higher in H-MICT (95.6 ± 0.1%), H-HIIT (95.1 ± 0.2%) and N-MICT (92.4 ± 0.7%) compared to N-HIIT (86.5 ± 1.6%) ($P < 0.001$). Plasma lactate concentrations were higher in N-HIIT (23.6 ± 2.6 mmol/L) and H-HIIT (19.5 ± 2.6 mmol/L) compared to N-MICT (9.5 ± 2.1 mmol/L) and H-MICT (12.0 ± 2.5 mmol/L) ($P = 0.001$). After 4 hours of exercise, HIF-1α mRNA increased 4.6-fold in N-HIIT ($P= 0.046$), VEGF mRNA increased 2.0-fold in H-HIIT ($P = 0.032$), and HSP70 mRNA increased 6.2-fold in N-HIIT ($P = 0.001$) and 2.9-fold in H-HIIT ($P = 0.036$). PGC-1α mRNA increased by 4.2- to 5.4-fold ($P < 0.001$ to $P = 0.0033$), and PDK4 mRNA increased by 7.9- to 10.1-fold ($P < 0.001$ to $P = 0.019$) in all groups.

CONCLUSION: Plasma lactate concentration was unaffected by FIO2, whereas SaO2 was maintained during HIIT when breathing hyperoxic gas. These results suggest that H-HIIT can enhance whole-body O2 delivery to skeletal muscle, which may reduce cellular adaptation to hypoxia but enhance angiogenic responses. However, H-HIIT had no additional effects on heat shock response, mitochondrial biogenesis, or lipid metabolism compared to N-HIIT.

**RELIABILITY AND VALIDITY OF THE ILLINOIS AGILITY TEST AND THE T-AGILITY TEST AMONG CHINESE CHILDREN**

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INTRODUCTION: Agility is an individual's ability to maintain and control body posture while running and changing direction quickly[1]. During childhood, routine play activities often involve speed, twists, and turns, making this period particularly sensitive for agility development[2]. The Illinois Agility Test and the T-Agility Test have been validated in adults and athletes[3], yet their reliability and validity in Chinese children remain underexplored. This study aims to evaluate the test–retest reliability and validity of the Illinois Agility Test and the T-Agility Test in Chinese children.

METHODS: For test–retest reliability, 90 participants (41 males and 49 females; age: 11.6 ± 0.6 years; height: 148.3 ± 7.9 cm; weight: 43.1 ± 12.6 kg; BMI: 19.4 ± 4.6) completed the Illinois and T-Agility Tests twice, with a two-week interval between assessments. To assess validity, 189 participants (86 males and 103 females; age: 11.6 ± 0.5 years; height: 148.9 ± 7.7 cm; weight: 42.4 ± 11.3 kg; BMI: 18.9 ± 4.0) were evaluated using both agility tests alongside the 20-meter dash and the standing long jump (SLJ). Data were analyzed using Spearman correlation. Significance was set at $p<0.05$.

RESULTS: The intraclass correlation coefficient (ICC) for test–retest reliability of the Illinois Agility Test was 0.778 ($p < 0.001$), while the ICC for the T-Agility Test was 0.771 ($p < 0.001$). For validity, the Spearman correlation coefficients between the 20-meter dash and the Illinois and T-Agility Tests were 0.540 ($p < 0.001$) and 0.581 ($p < 0.001$), respectively. The Spearman correlation coefficients between the SLJ and the Illinois and T-Agility Tests were -0.611 ($p < 0.001$) and -0.537 ($p < 0.001$), respectively.

CONCLUSION: This study demonstrates that both the Illinois Agility Test and the T-Agility Test are reliable and valid measures of agility in children. Among Chinese children, the Illinois Agility Test exhibits superior reliability and validity compared to the T-Agility Test.

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**THE EVIDENCE-BASED FORCE VECTOR THEORY OF TRAINING SPECIFICITY**

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INTRODUCTION: The force-vector theory of training specificity indicates that the similarity between movement patterns and force-vector specificity of training exercises and the target movement will likely result in the greatest transfer of the practiced skills and physical abilities to the intended sports skill performance [1]. Thus, performing training exercises predominantly in the plane in which the target motor performance task is also executed is more effective compared with training during which training exercises and the target movements are done in different planes of movement [2]. Therefore, compared to vertical jump, the horizontal jump may be shown greater correlations with horizontal movements (e.g., sprint and change of direction).

METHODS: Thirty-six male college players well-trained background were recruited in this study. All subjects performed 30 m sprint, 505 COD, CMJ, and sprint bounding for three trials in random order. The 2-3 min rest interval was allowed between trials and 5 m interval between tests. For the CMJ test, participants rapidly moved down to the knee joint angle of 90° and then immediately and vertically jump as high as they can, the jump height was assessed using force platform. For the sprint bounding test, participants started with a 5 m sprint and completed a 5-step forward jump, the jump distance was measured using a tape. For the 30 m sprint test, two pairs of time gate were placed at the 0 m and 30 m line, respectively, and participants started behind 30 cm of the 0 m line with the two-point position. For 505 COD, the time gate was placed at the 10 m line, the participants started with a two-point position 30 cm behind the 0 m line, and immediately sprint back to the 10 m line after reached the 15 m line. The correlation analysis was examined using Pearson's (parametric data) or Spearman's (non-parametric data) correlations.

RESULTS: The CMJ height, 30m sprint time, sprint bounding distance, and CODD were normally distributed ($p > 0.05$). The CMJ height was significantly correlated ($p<0.05$) with 30 m sprint time, CODD and sprint bounding distance, with moderate magnitude of correlations (30m: $r = 0.34$; CODD: $r = 0.31$; sprint bounding distance: $r = 0.38$). Significant correlations were also observed between sprint bounding distance and 30 m sprint time ($r= 0.54$) and CODD ($r = 0.62$), with large magnitude of correction.

CONCLUSION: Compared to vertical jump height, the sprint bounding jump distance showed greater correlations with horizontal movement performance, thus supporting the force-vector theory of training specificity.

**THE EFFECTS OF LADDER DRILLS AND HURDLE JUMPS ON AGILITY AMONG CHINESE CHILDREN : A RANDOMIZED CONTROL TRIAL**

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INTRODUCTION: Agility is a crucial component of physical fitness that enables children to maintain and control correct body positioning while responding to multidirectional speed and changes in movement direction[1]. Childhood is a critical period for developing agility, which involves speed, twists, and rapid directional changes[2]. However, despite its importance, the effects of different training methods on agility in children have not been thoroughly investigated[3].Therefore, this study aimed to examine the effects of ladder drill (LD) and hurdle jump (HJ) training on agility performance among Chinese children.

METHODS: A total of 99 participants (39 males and 60 females; age: 11.44 ± 0.57 years; height: 148.35 ± 7.28 cm; weight: 42.26 ± 12.31 kg; BMI: 18.99 ± 4.56) were randomly assigned to one of three groups: the ladder drill (LD) group (n = 33), the hurdle jump (HJ) group (n = 33), and the control (C) group (n = 33). The LD and HJ groups underwent six weeks of training, performing their respective exercises three times per week. In contrast, the control group attended regular physical education classes three times per week without participating in ladder drills or hurdle jump exercises. Agility performance was assessed using T-Test and the Illinois Agility Test the before and after the intervention. Data were analyzed using one-way ANOVA and paired t-tests.Significance was set at $p < 0.05$.

RESULTS: After six weeks of agility training, significant improvements in agility performance were observed in both the LD and HJ groups. In the T-Agility Test, the HJ group demonstrated the largest improvement (12.33% improvement; pre-test: 15.32 s, post-test: 13.43 s, $t = 9.13$, $p < 0.001$), followed by the LD group (6.66% improvement; pre-test: 14.87 s, post-test: 13.88 s, $t = 7.27$, $p < 0.001$). The control group exhibited only a moderate improvement (3.86% improvement; pre-test: 14.75 s, post-test: 14.18 s, $t = 3.18$, $p < 0.01$). Similarly, for the Illinois Agility Test, the HJ group exhibited the greatest improvement (6.67% improvement; pre-test: 22.35 s, post-test: 20.86 s, $t = 8.64$, $p < 0.001$), followed by the LD group (4.52% improvement; pre-test: 22.53 s, post-test: 21.50 s, $t = 4.52$, $p < 0.001$), while the control group showed no significant change (2.97% improvement; pre-test: 22.22 s, post-test: 21.56 s, $t = 1.44$, $p = 0.08$).

CONCLUSION: Both ladder drill and hurdle jump training significantly enhanced agility in Chinese children. However, hurdle jump training proved to be more effective in improving agility compared to ladder drills. These findings suggest that hurdle jump exercises should be considered a more efficient method for agility development in children.

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**THE EFFECT OF APPROACH MOMENTUM ON HORIZONTAL DECELERATION PERFORMANCE**

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INTRODUCTION: Deceleration is fundamental to multi-directional team sports match play performance (2-3) and thereby the need to assess the horizontal deceleration ability of athletes to provide insights into training programs and player development. Notably, the objective of horizontal deceleration is to reduce the bodies momentum, which is determined by approach velocity and body mass. Theoretically, an athlete attempting to decelerate from a greater approach momentum may require a longer duration and distance over which to stop, to reduce their horizontal velocity to zero, compared to lower approach momentums. This is likely on account of a greater number of foot contacts required to generate sufficient braking impulse to reduce the horizontal momentum. However, this hypothesis has not been examined in previous studies.

METHODS: Eighty male university athletes were recruited in the present study. During the acceleration-deceleration test, all participants were instructed to reduce the horizontal velocity to zero as quickly as possible following a 15 m linear sprint. Following deceleration, all participants were required to backpedal to the deceleration line to determine the ending position of deceleration. All participants were instructed not to decelerate until passing the 15 m line, and the 15 m completion time of any trial that was 5 % greater than the individual best sprint time was discarded, and subsequently another trial was performed following 2-3 min recovery. The completion time of the 15 m sprint was recorded using the aforementioned timing gates and the velocity-time-distance profile was collected using a radar device, which was positioned 5 m behind the starting line with a height of 90 cm and sampling at 47 Hz. Three successful trials were collected for each participant. The instantaneous deceleration during the deceleration phase was determined using the following Equation (linear adjacent method): Deceleration (m/s2) = (Vf -Vi) / (Tf -Ti) . The correlative analyses were examined using Pearson's (parametric data) or Spearman's (non-parametric data) correlations. Within-session reliability was examined using intraclass correlation coefficients (ICC) and coefficients of variation (CV %).

RESULTS: Mean and peak deceleration had very high agreement between consecutive trials (ICC = 0.79-0.88), while time to stop showed poor reliability. Lower peak approach momentum was significantly and moderately correlated with greater mean deceleration ($\rho = -0.354$, $p = 0.001$) and greater peak deceleration ($\rho = -0.323$, $p = 0.001$).

CONCLUSION: Horizontal deceleration performance is determined by the magnitude of approach momentum; thus, caution is advised when classifying players as faster or slower deceleration performers, as direct comparisons using mean/peak deceleration may lead to erroneous conclusions regarding deceleration ability.

**ASSOCIATION BETWEEN CHANGES IN SELF-REPORTED QUESTIONNAIRES AND COUNTERMOVEMENT JUMP PERFORMANCE FOLLOWING A FATIGUING AEROBIC PROTOCOL**

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INTRODUCTION: Athletes' self-report measures (ASRM) are commonly used as indicators of fatigue status and training predisposition [1]; however, the sensibility of these questionnaires to detect changes in performance and fatigue status has not yet been investigated. This study aims to explore if ASRMs are sensitive to changes in fatigue status and if they can be used to predict changes in performance after an exhaustive aerobic exercise.

METHODS: Nine healthy adults (6 females, 24.7±2.7 yrs and 3 males, 28.7±2.6 yrs [mean±SD]) performed 9 testing sessions: i) a maximal incremental test to determine peak power output (POpeak); ii) eight identical testing sessions consisting of ASRM (total quality of recovery questionnaires on 6 to 20 [TQR6-20] and 0 to 10 [TQR0-10], 8-item short recovery and stress scale [SRSS], and an adapted 0 [not ready] to 10 [completely ready to perform physical exercise] readiness scale [RS] [2]) followed by three counter-movement jumps (CMJ), both performed before and after a constant-load exercise to task-failure at 70% of POpeak. For each individual, Spearmans correlation coefficients (ρ) were calculated to assess the correlation between the changes (i.e., the differences [Δ] between pre and post exercise values) of all ASRM and CMJ performance indicators (i.e., best jump height and peak power [3]). Then, one-sample t-tests or the Kolmogorov-Smirnov tests were used to assess if the individual ρ between the several ΔASRM and ΔCMJ were different from 0. α was set at 5%.

RESULTS: ΔSRSS items (i.e., mental performance capability, emotional balance, overall recovery, muscular stress, lack of activation, and negative emotional state), ΔTQR6-20, and ΔRS were not associated (i.e., ρ not significantly different from 0) with ΔCMJ jump height. However, the correlations between ΔSRSS of two items (i.e., physical performance capability [ρ=0.027±0.372; p=0.065] and overall stress [ρ=-0.299±0.433; p=0.072]), ΔTQR0-10 (ρ=0.101±0.372; p=0.088), and ΔRS (ρ=0.280±0.439; p=0.092) and CMJ jump height showed a trend towards significance (i.e., p<0.1). Likewise, ΔSRSS items and ΔTQR (0-10 and 6-20) were not associated with ΔCMJ peak power; however, the ΔRS (ρ=0.281±0.351) was associated (p=0.043) with ΔCMJ peak power.

CONCLUSION: In conclusion, most of the commonly used indicators of readiness and fatigue were not associated with CMJ jump height and peak power, and solely RS correlated with CMJ peak power. This points out the potential superiority of a simple and specific readiness scale in predicting neuromuscular fatigue-related performance changes compared to non-specific physical or mental fatigue ASRMs.

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**EFFECTS OF COMPRESSION SLEEVES ON MUSCLE FATIGUE FOLLOWING ECCENTRIC CONTRACTION**

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INTRODUCTION: Compression garments are widely used in sports to reduce fatigue and improve performance. Previous research suggests that external compression during exercise may reduce muscle stress [1] and fatigue [2] and improve exercise performance. Although a few reports have examined the fatigue-reducing effects of external compression on muscle strength, or performed frequency analysis using electromyography, the effects of external compression on exercise-induced muscle fatigue remain unclear. Therefore, in this study, we aimed to investigate the effects of compression garments on post-exercise muscle fatigue, focusing on eccentric contractions, where muscles experience high mechanical stress.

METHODS: This study included six healthy young male subjects. A compression sleeve was worn by the study participants covering the entire lower leg during exercise. Maximum voluntary contraction (MVC) torque and mean power frequency (MPF) were measured before and after exercise. The assessment included five sets of 10 maximal eccentric ankle plantar flexion exercises performed in a seated position with 80° hip and 0° knee flexion using a dynamometer (Biodex system 4), with a 30-second rest period between sets. After recording measurements on one leg, the same procedure was conducted on the contralateral leg following a 15-minute recovery period. Rates of change in MVC torque and MPF were calculated by dividing the difference between pre- and post-task measurements by the pre-task value. A repeated-measures two-way ANOVA was conducted to assess both MVC torque and MPF, with compression garment use status (with or without compression) and time as factors. Each change in rate was analyzed using a paired t-test, with statistical significance set at $p = 0.05$.

RESULTS: The time factor showed a significant effect on MVC torque ($p < 0.05$), but no significant effect of the compression garment use status or the time × compression garment use interaction was observed. In contrast, a significant effect of compression garment use status on MPF ($p < 0.05$) was noted, but no significant effect of time or time × compression garment use interaction was observed. The change in rate of MVC torque was significantly lower among participants wearing the sleeve than those not wearing it (wearing: - 7.55%, not wearing: - 15.95%, $p < 0.05$). Additionally, the change

in rate of MPF was significantly lower among those wearing the sleeve compared to those not wearing it (wearing: + 1.20%, not wearing: - 7.62%, $p < 0.05$).

CONCLUSION: External compression of the lower leg reduced neuromuscular fatigue during eccentric contractions, as indicated by the lower change in rates of MVC torque and MPF. These findings suggest that compression sleeves can help maintain muscle performance during activities involving eccentric contractions, particularly in the lower extremities

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**EVALUATING FAST STRETCH-SHORTENING CYCLE FATIGUE USING A NOVEL 30-SECOND REPEATED JUMP TEST**

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INTRODUCTION: Rebound jumping performance is widely used to assess fast stretch shortening cycle (FSSC) mechanics in athletes, as it plays a crucial role in sprinting, jumping and changing direction [1]. Athletes' FSSC capacity is often referred to as reactive strength (RS). While practitioners typically evaluate maximal FSSC and RS capacity using short duration tests with fewer than 10 ground contacts [2], tests with higher number of ground contacts provide an opportunity to assess both maximal FSSC and the impact of fatigue on FSSC. This approach may more accurately reflect the demands of sporting activities. This study aims to investigate changes in FSSC performance during a continuous 30 second rebound jumping test.

METHODS: Thirty elite male soccer players (21.10 ± 1.61 years; height 181.01 ± 6.45 cm) completed a 30-second repeated jumping trial (30RJT). Participants were instructed to jump maximally while minimising ground contact time (CT) and maximising jump height (JH). Three-dimensional force data were collected at 2000 Hz using four floor-integrated force plates (AMTI BP400600, Massachusetts). Performance was evaluated using the Reactive Strength Index (RSI), calculated as JH divided by CT, along with peak force (PF) and time to peak force (TTPF) during the first and last 10 jumps of the test. A one-sample t-test was used to determine whether the relative changes in performance metrics were significantly different from zero.

RESULTS: Participants completed 46±3 jumps during the test. For the first 10 jumps, averages for RSI, JH and CT were 1.70±0.12, 27.91±1.62cm, and 166.70±8.04ms respectively. Average ground contact time ranged from 127.6ms to 222.3ms for the first 10 jumps, and 138.7ms to 229.9ms for the last 10. Comparisons between the first and last 10 jumps showed a drop of 13.80±8.66% for the RSI ($p<0.001$), increase in CT of 4.82±3.74% ($p<0.001$), and drop in JH of 8.11±7.49% ($p<0.001$). Investigating the force traces in more detail, PF dropped by 6.91±5.46% ($p<0.001$), while the change in TTPF was not significant (increase of 1.21±12.38%, $p=0.601$).

CONCLUSION: The 30 second jump induced fatigue, evidenced by significant decreases in RSI, JH and PF. Despite the fatigue, participants were able to sustain CTs under 250ms, ensuring we tested the FSSC. Changes in RSI were predominantly due to changes in JH. Changes in TTPF were highly variable between participants and should not be used to assess fatigue in RS and FSSC performance.

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## Conventional Print Poster Presentations

### CP-AP31 Training and Testing III - Mixed

**EVALUATING WALKING SPEED AND HEART RATE RESPONSE AS INDICATORS OF ASSESSMENT QUALITY OF THE SIX MINUTE WALKING TEST**

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INTRODUCTION: The six minute walking test (6MWT) is a cost-effective and easy to administer submaximal test used to evaluate functional capacity and estimate aerobic fitness in both clinical and healthy populations [1]. However, because it is self-paced, test intensity can vary significantly between individuals, ranging from moderate to vigorous, potentially affecting the reliability of the maximum walking distance achieved during the test [2][3]. This variation raises concerns about whether test outcomes accurately reflect an individuals functional capacity in a healthy population or are largely influenced by motivation. This study aimed to evaluate whether walking speed and heart rate measures can help assess the quality of each individuals test results by identifying the impact of motivation on performance.

METHODS: Seventy overweight participants (84.1±11.9 kg; 170.6±9.0 cm; BMI: 28.8±2.3 kg/m²) performed the 6MWT on a 20 m indoor track. Participants were instructed to walk as fast as possible to cover the greatest distance in six minutes.

Time updates were provided every minute without additional encouragement. HR was recorded using a Polar H10 chest strap, and lap counts and time were tracked with a Polar Pacer Pro watch. Pearson correlation was used to analyze the relationship between average relative HR expressed as a percentage of predicted max HR (220 – age) and maximum walking distance. Hierarchical agglomerative clustering using Wards minimum variance linkage method and Euclidean distance was applied to classify participants based on their average walking speed and average relative HR. Group comparisons were conducted using ANOVA or the Kruskal-Wallis test, depending on normality (Shapiro-Wilk test), with appropriate post hoc tests applied when significant differences were detected.

RESULTS: A moderate positive correlation was observed between average relative HR and maximum walking distance (r=0.36, p=0.002). Based on average walking speed and average relative HR, four distinct clusters were identified: Slow-LowHR (n=11), and Slow-ModerateHR (n=19), Fast-ModerateHR (n=9), Fast-HighHR (n=31). Significant differences in average walking speed were observed between all groups except Slow-LowHR (1.66±0.09 m/s) and Slow-ModerateHR (1.74±0.12 m/s) as well as Fast-ModerateHR (2.01±0.09 m/s) and Fast-HighHR (1.93±0.15 m/s). Average relative HR differed significantly between all groups (Slow-LowHR: 64.2±2.4 %HRmax, Slow-ModerateHR: 74.4±3.4 %HRmax, Fast-ModerateHR: 70.7±5.0 %HRmax, Fast-HighHR: 84.4±3.6 %HRmax), except between Slow-ModerateHR and Fast-ModerateHR.

CONCLUSION: In the 6MWT, evaluating the interaction between walking speed and heart rate response can support interpretation and help identify individuals whose slow pace and low HR may indicate low motivation, suggesting that their results could be unreliable and a repeat assessment may be needed.

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**LONGITUDINAL MONITORING OF INTERNAL LOAD IN AN ELITE ATHLETE: A SINGLE-CASE STUDY TOWARDS THE PARIS OLYMPIC GAMES**

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INTRODUCTION: Monitoring training load is essential for understanding individual responses to training, managing fatigue, optimizing recovery, and minimizing the risk of nonfunctional overreaching and injury. Training load is typically classified into internal load (IL) and external load (EL) (1). Despite the importance of these monitoring methods, standardized methods for longitudinal evaluation remain limited. This study aimed to explore an effective condition assessment framework for optimizing elite athlete performance using a single-case experimental design (SCED) in preparation for the Paris Olympic Games.

METHODS: A single elite athlete was monitored over one year, tracking daily sleep parameters, lowest heart rate (HR), and heart rate variability (HRV), which were measured using the OURA Ring (Ōura Health, Oulu, Finland). Subjective data, including subjective fatigue and training load indicators such as session rating of perceived exertion (sRPE), calculated as training time x RPE, were collected via AthletesPort developed by JISS, while both subjective and objective data were managed using a centralized tool (2). Preparedness was estimated using a fitness-fatigue mathematical model incorporating sRPE (3). Tau-U was employed to compare various indices during the training and tapering phases. Effect sizes (ES) were classified as follows: 0.80–1.00 (very large change), 0.60–0.80 (large change), 0.20–0.60 (moderate change), and 0.00–0.20 (small change) (4). The Bayesian hierarchical piecewise regression model (BHPRM) with AR1 was employed to assess athlete-specific indicators and evaluate daily condition fluctuations in the year before the Paris Olympic Games.

RESULTS: A comparison of changes in resting HRV between the training and tapering phases of hypoxic training at 2,000 m, conducted three times a year, showed that resting HRV increased significantly from the first training to the tapering phase (ES = 0.71), with moderate increases in the second (ES = 0.27) and third (ES = 0.43). Based on BHPRM estimation, preparedness, calculated using a 5-day moving average, differed significantly between the training and tapering phases within the three weeks before each race (level difference: 0.26 [95% CI: 0.09 – 0.41], slope difference: 0.09 [95% CI: 0.03 – 0.16]). Both the level and slope improved during tapering, with significant between-race variability in the training phase slope (0.05, [ 95% CI: 0.02 – 0.10]).

CONCLUSION: Monitoring daily IL demonstrated its potential for assessing training adaptation and competition readiness in elite athletes. Furthermore, the results of the present study suggested that IL data collection and SCED-based statistical analysis may be useful for tracking intra-individual conditions in athletes.

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**THE EFFECTS OF VISUAL BLUR ON GAIT ALTERATIONS: ADAPTIVE AND COMPENSATORY MECHANISMS IN ATHLETES**

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INTRODUCTION: Refractive error is one of the most prevalent eye disorders worldwide, occurring when light fails to focus accurately on the retina, thereby reducing visual clarity [1]. The visual system plays a vital role in dynamic tasks, and visual

blur can significantly impair athletic performance. Despite the importance of vision in sports, few studies in sports biomechanics have explored how blurred vision affects motor tasks. This study aims to address this gap by examining lower limb joint kinematics and foot plantar pressure characteristics during slow running under varying degrees of refractive error.

METHODS: This study recruited 5 male collegiate athletes. Blurred vision was induced by wearing lenses with different diopters (D) to simulate three visual conditions: myopia (-3D), full correction (0D), and hyperopia (+3D). Participants performed a 15-second slow run at a speed of 6 km/h. The gait parameters, lower limb joint angles, and foot plantar pressure during the stance and swing phases were analyzed. One-way ANOVA repeated measures was used to compare kinematic and kinetic differences among the three visual conditions.

RESULTS: The results revealed no significant differences in foot plantar pressure, gait parameters, or joint angles among the visual conditions. However, descriptive statistics revealed some noteworthy trends. Full-foot pressure during the stance phase showed higher in the -3D and +3D conditions compared to 0D. Specifically, midfoot and heel pressures were higher in both the -3D and +3D conditions compared to 0D, with midfoot pressure increasing by 3.29% (-3D) and 5.05% (+3D), and heel pressure increasing by 12.53% (-3D) and 11.8% (+3D), respectively. During the swing phase, participants exhibited greater hip and knee flexion and increased ankle abduction in the -3D and +3D conditions. Additionally, gait analysis showed that the -3D condition demonstrated a wider step width compared to the other two conditions.

CONCLUSION: The findings suggest that blurred vision reduces athletes environmental perception, prompting them to adopt more stable gait strategies, such as increased hip and knee flexion and greater ankle abduction during the swing phase to improve swing foot safety and center of mass adjustment. Moreover, blurred vision (-3D and +3D) resulted in increased midfoot and heel pressures during the stance phase. Under the -3D condition, athletes compensated by increasing step width, thereby enhancing balance support [2]. Although these compensatory strategies help mitigate the effects of visual blur on motor control, they may also increase the mechanical load on the hip and knee joints, which potentially affecting gait patterns and athletic performance over time. Therefore, it is recommended to fully correct refractive errors to ensure clear visual feedback and reduce the need for compensatory gait adjustments.

**THE EFFECTS OF DIFFERENT ATHLETIC TAPES ON DYNAMIC POSTURAL CONTROL AND JOINT MOVEMENT PATTERNS DURING DUAL TASKS LANDING TASKS**

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INTRODUCTION: Lateral ankle sprains are the most common lower limb injury and influence athletes in the long term. Athletic taping plays a role in providing reinjury. In addition to conventional rigid white tape, a novel taping material known as dynamic tape offers high elasticity. Nonetheless, its efficacy in safeguarding the ankle joint remains unexamined. To investigate the benefits of different taping methods on dynamic posture stability at drop jump tasks during divided attention.

METHODS: Recruited thirty male college-level Class A athletes and divided them into CAI and healthy groups based on the Cumberland Ankle Instability Tool (CAIT). The test item is a drop jump test and a divided attention task using different athletic taping methods. The taping methods involve no tape, dynamic tape, and white athletic tape. Used motion capture and force plates were collect during the landing. Statistical analysis was using two-way mixed design ANOVA.

RESULTS: The intervention of this study found that AT and DT effectively reduced ankle plantarflexion. Moreover, DT is beneficial in reducing the center of pressure (CoP) sway area during the landing phase for athletes with ankle instability.

CONCLUSION: The study found that athletes with CAI face ongoing risks of sprains due to biomechanical issues like reduced dorsiflexion and excessive plantarflexion. This leads to altered joint energy absorption and increased knee joint stress. CAI athletes also show impaired postural stability with greater sway areas of CoP and center of mass, heightening the risk of injury. Taping interventions (AT and DT) effectively reduce ankle plantarflexion, with DT showing additional benefits like improved ankle range of motion and enhanced dynamic postural stability, crucial for injury prevention in CAI athletes.

**RELATIONSHIP BETWEEN ULTRASOUND IMAGING AND STANDARD APPROACHES IN ASSESSING DIAPHRAGM FUNCTIONALITY**

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INTRODUCTION: Diaphragm is the primary inspiratory muscle involved in quiet and deep breathing. Like other skeletal muscles, it undergoes functional and structural adaptations in response to training procedures or diseases. The former can be comprehensively evaluated through the integration of different measurements, including spirometry, maximal inspiratory and expiratory pressure (MIP and MEP, respectively) and maximal voluntary ventilation (MVV). An additional indicator of diaphragm functionality can be obtained by ultrasound imaging (US) by quantifying the amplitude of diaphragm excursion during voluntary breathing. US can also provide evaluations of structural adaptations. Neuromuscular evaluations further complement functional assessments by measuring the compound motor action potential (CMAP) of the diaphragm during phrenic nerve stimulation (PNS). The relationship between US-derived measurements and functional or structural indicators has been scarcely investigated. Moreover, no studies have assessed the feasibility of US meas-

urement during PNS. Therefore, this study aims to explore correlations between US and pulmonary function variables and to evaluate the feasibility of a combined US and PNS technique for the assessment of diaphragmatic function.

METHODS: Twenty-seven healthy students (17 male; age: 23±5 yr; body mass: 72±11 kg; stature: 1.7±0.1 m, mean ± standard deviation, SD) participated to the study. Pulmonary function was assessed via Forced vital capacity (FVC), vital capacity (VC), MVV, MIP and MEP. The amplitude of diaphragm excursion was evaluated through US during voluntary deep breathing (AmpDB) and PNS (AmpPNS). Simultaneously, CMAP was recorded. A Pearson's product moment correlation coefficient determined the correlation between US-derived variables and CMAP and with the outcomes of the standard pulmonary test.

RESULTS: AmpDB correlated with MVV ($r=0.45$; $p<0.05$) and MIP ($r=0.38$; $p=0.048$). AmpPNS showed a slight correlation with only CMAP ($r = 0.37$; $p=0.05$) while its correlations with FVC and VC were near to significant values ($p=0.07$ and $p=0.08$, respectively).

CONCLUSION: US imaging proved to be a convincing indicator to evaluate diaphragm function changes. Moreover, the simultaneous acquisition of US and PNS proved novel insights into the mechanical counterpart of the diaphragm electrical excitation.

**VASCULAR AND CARDIORESPIRATORY ADAPTATIONS TO A 4-WEEK BLOOD FLOW RESTRICTED COUPLED WITH HIGH-INTENSITY INTERVAL TRAINING (HIIT) PROGRAM**

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INTRODUCTION: Blood Flow Restriction (BFR) interventions using occlusion pressures between 40-80% of individual limb occlusion pressure (LOP) have been shown to improve cardiovascular function and maximal oxygen uptake (VO2max) [1] more effectively than training without BFR. Additionally, HIIT has been promoted as a time efficient method for increasing VO2max [2]. The aim of the present study was to examine the effect of 4-weeks of HIIT cycling under localized BFR on submaximal and maximal cardiorespiratory and vascular responses.

METHODS: Twenty-five participants (11 females, 16 males; 19±7 yo; 175±8 cm; 67±8 kg) were randomly assigned into one of the three groups: (G1) HIIT+20 mmHg of blood occlusion (SHAM), (G2) HIIT+40% LOP, and (G3) HIIT+60% LOP. The training program lasted 4-weeks, with 4 to 7 cycling bouts of 90s HIIT+BFR performed at 90% of VO2max, interspersed with 2 min unoccluded recovery. During all training intervals, both thighs were occluded. Pre- and post- training intervention, participants completed an incremental step to volitional exhaustion for determination of VO2max, Gas Exchange Threshold (GET), Respiratory Compensation Point (RCP), Qmax and Tissue Saturation Index (TSI). Additionally, they completed a pre- and post- submaximal cycling trial of 10 min at baseline (BL; i.e., 50W for females, 100W for men), 6 min at moderate (MOD=BL+50% (GET – BL)), 10 min at BL, and 6 min at heavy (HEV=GET+20% (RCP – GET)) intensities.

RESULTS: Maximal aerobic power (MAP) improved significantly across all groups ($p<.001$; $\eta^2=0.11$) but not for VO2max among any of the groups ($p>0.05$). A significant rightward shift of GET ($p<0.001$) and RCP ($p<0.001$) against workload were observed but with no differences among any of the groups. Qmax ($p=0.13$, $r=-0.335$) and TSImax ($p=0.54$) remained unchanged after the training period. All groups showed a sub-maximal heart rate response ($p<0.001$) only in the BL, but with no differences among any of the groups. G3 exhibited a reduced VO2 and VCO2 in both MOD bouts ($p<0.001$). In HEV, a lower VO2 ($p=0.004$) was observed with no differences across all groups.

CONCLUSION: While all groups showed increased MAP, 4 weeks of BFR+HIIT did not enhance maximal cardiovascular adaptations, suggesting peripheral adaptations highlighted by delayed GET and RCP. Submaximal results indicate HIIT+60% LOP may be more efficient probably due to increased blood pooling and metabolite accumulation. A longer BFR training might demonstrate benefits for maximal cardiovascular and cardiorespiratory adaptations, highlighting the potential of combining HIIT+BFR.

1. Patterson et al. (2019) 2. Astorino et al. (2012)

**A NOVEL EQUATION FOR PREDICTING WALKING-INDUCED ENERGY CONSUMPTION IN MALE COLLEGE STUDENTS**

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INTRODUCTION: As health awareness continues to rise among college students, walking has emerged as a popular form of exercise due to its simplicity, cost-effectiveness, and efficiency in promoting fitness. Accurate measurement of walking energy expenditure (EE) is crucial in ensuring exercise safety and optimizing health outcomes. However, traditional methods for assessing EE, which often rely on complex and expensive equipment, pose significant barriers to widespread and timely public assessment. This study aims to develop a convenient and precise method for estimating walking EE among Chinese male college students, utilizing straightforward parameters to predict consumption across various speeds. This will provide college students with a practical self-monitoring tool, promoting scientifically-based fitness practices.

METHODS: 60 healthy male Chinese college students (21.12±1.28 years) were recruited for this study. Under rigorously controlled conditions, including the testing environment, workload, rest intervals, and dietary intake, a crossover experimental design was adopted. Participants were engaged in 30-minute treadmill walking exercises at inclinations of 0°, with speeds of 4.8 km/h, 6.4 km/h, and 8.1 km/h. A 7-day washout period was imposed between each speed test to ensure the absence of residual effects. EE was measured through respiratory gas analysis utilizing a MetaLyzer 3B ana-

lyzer (Germany) and heart rate monitoring with a Polar device (Finland). Subsequently, partial correlation analysis and multiple regression were performed on the collected data to formulate a regression equation linking EE with pertinent physical parameters. To further validate the equations precision, an identical experimental protocol was applied to an additional cohort of 20 healthy male college students. Their measured data were rigorously compared with the predicted values derived from the regression equation, using a paired t-test.

RESULTS: EE per minute during 30-minute walking was significantly correlated with walking pace and heart rate ($P<0.01$), and moderate correlations with BMI, height, and body weight ($P<0.05$). Stepwise multiple regression analysis yielded an EE prediction model: EE (kcal/min) = -8.453 + 1.030 × pace (km/h) - 0.023 × BMI (kg/m²) + 0.032 × heart rate (bpm) + 0.080 × body weight (kg). There were no significant differences between the predicted values of the formula and the measurements of the external validation sample at the three walking speeds (P4.8=0.255, P6.4=0.470, P8.1=0.353).

CONCLUSION: This study developed a precise EE prediction model for male college students during walking, incorporating four readily measurable parameters: walking speed, BMI, heart rate, and body weight. The validated formula provides a reliable and practical tool for quantifying walking-related EE in this population.

**MOTOR CONTROL, COGNITION, AND HORMONAL LEVEL DURING THE MENSTRUATION PHASE IN HIGHLY TRAINED FEMALE ATHLETES**

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INTRODUCTION: Around 50% of female athletes use hormonal contraception (Martin et al., 2018). However, it is currently unknown if fluctuations in sex hormones either during the normal menstrual cycle (NMC) or during combined oral contraceptive intake (COC) influence motor or cognitive performance in female athletes.

METHODS: Therefore, we tested 22 trained female athletes 3 times: 14 with NMC (tested during the early follicular phase vs. follicular phase vs. luteal phase) and 8 with COC (tested during no hormonal intake vs 1st week of intake vs 3rd week of intake). Estradiol (E2) and testosterone (T) levels were assessed, as well as cognitive performance (tests on spatial cognition, memory, and reaction times) and motor performance (countermovement jump and grip test).

RESULTS: Motor and cognitive performances were stable across the menstrual cycle for both groups of participants (ps > .05). A group effect was found for some performances (higher grip strength for the COC group; greater memory span for the COC group, ps < .05). No correlations were found between neither hormonal concentration in E2 or T and motor or cognitive performance, nor between the variation in hormonal concentration and performance (ps > .05).

CONCLUSION: As previously described in the literature (Smith et al., 2024), there is no obvious variations in either motor or cognitive performance across the menstrual cycle in trained athletes. Moreover, fluctuations of E2 and T, which are supposed to impact performance, are not related to the performance of highly trained athletes. More studies are necessary to understand if a high dose of training might overcome the usual impact of sex hormones on performance.

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**ASSOCIATION BETWEEN MAXIMAL LOWER BODY STRENGTH AND BALANCE PERFORMANCE IN GRASSROOTS SPORTS ATHLETES**

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INTRODUCTION: Postural balance plays a crucial role in minimizing injury risk during both daily life and sports activities, with research showing that individuals who exhibit greater postural sway are more prone to injuries [1]. Maintaining balance requires significant neuromuscular contributions from the trunk, hip, ankle, and foot, as the neuromuscular system must execute rapid and coordinated minor adjustments in muscular activity to preserve balance [2,3]. Previous studies have demonstrated a link between ankle and hip strength and balance performance [1,2,3]. This study aimed to evaluate the association between lower body maximal strength, balance performance, and asymmetries.

METHODS: Twenty grassroots sports athletes (mean±SD; 71.3±12.5 kg; 175.2±7.9 cm; BMI: 23.2±3.4 kg/m^2) participated in a cross-sectional study. The test protocol included the isometric mid-thigh pull (IMTP), seated isometric plantarflexion (PF), and a single-leg balance test, which were performed on force plate (Musclelab, Ergotest Innovation AS, Norway). All assessments were performed unilaterally on both sides with three trials conducted per test. Maximal force was obtained from the strength tests, with the best trial selected for further analysis. Center of pressure (CoP) displacement as the primary variable, was obtained from single-leg balance test. Average CoP displacement values across the three trials were

used for further analysis. Statistical analyses included Pearson or Spearman correlation coefficients depending on normality (Shapiro-Wilk test), to evaluate the relationship between strength and balance variables. The Wilcoxon signed-rank test, followed by Bonferroni correction, was used to detect significant differences in asymmetry magnitude across tests. Cohen's Kappa coefficient was used to assess agreement in asymmetry direction between tests.

RESULTS: There were no significant correlations between single-leg balance test variables and IMTP or PF ($p>0.05$). IMTP asymmetry magnitude is significantly lower than asymmetry calculated from single-leg balance test variables area, mean CoP length and SD CoP length ($p=0.003$). Single-leg balance test variables have poor to moderate (Kappa=-0.10–0.60), and poor to fair (Kappa=-0.10–0.29) agreement levels with IMTP and PF, respectively, determining direction of asymmetry.

CONCLUSION: Maximal isometric strength of the hip, knee extensors, and plantarflexors was not associated with balance performance, suggesting that maximal strength may not be a key factor in maintaining balance. However, single-leg balance asymmetry more closely aligns with the direction of hip and knee extensor strength asymmetry.

References:

1. Trajkovic et al. (2021) 2. Tao et al. (2020) 3. Tapanya et al. (2023)

## Conventional Print Poster Presentations

### CP-BM02 Motor Learning and Motor Control I

**IDENTIFYING EARLY LEARNING STAGES IN THREE-BALL CASCADE JUGGLING**

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INTRODUCTION: Motor skill learning is an individual process. Individual constraints such as body size and prior experiences contribute to motor performances as well as the progress of skill learning. Early identification of the result of these constraints allows adaptive guidance at an early stage. 3-ball cascade juggling is a complex yet attainable novel task to study motor learning . Prior research has often observed different progress rates among learners reflecting different stages of juggling development. Different functions have been used to model long-term learning performance. This study examined athletes from different sports backgrounds learning 3-ball cascade juggling and categorized them into different learning stages based on different models.

METHODS: 16 college athletes with no prior experience with 3-ball juggling, 8 each from open- (O) and closed-skill (C) sports, participated in learning to do so. After a brief instruction session and the pre-test(PRE), participants practiced 15 min 3-ball juggling for 4 days, followed by a post-test(POST) on day 5. Based on the POST performance of 6 catches or more, participants were identified as in progression (P) or beginning (B) stages. The accelerated exponential (AEXP) and linear function (LN) fit the daily average catches of 4 practice days. The 2-way mixed-design ANOVA was used to examine differences in PRE-POST performance between O and C, as well as differences in R^2 between AEXP and LN within P and B. Additional independent t-tests were performed to compare the rate of change of AEXP and LN between P and B.

RESULTS: For the number of successful catches, no significant differences were observed between the PRE and POST ($p = .20$), between O and C ($p = .26$), or in their interaction ($p = .27$). However, in the analysis of model fit, a significant interaction was found between function type and learning stages ($p < .05$). Post-hoc analysis indicated that AEXP R^2 value (0.98) were significantly higher than LN (0.85, $p = .002$) for P. No significant difference was observed between AEXP and LN in B. The rate of change was significantly higher for both the AEXP ($p = .03$) and LN ($p = .002$) for P compared to B.

CONCLUSION: The results suggest that sports background did not contribute significantly to learning to 3-ball juggling in 4 days. The P group demonstrated rapid improvement, with the AEXP providing a better fit for their performance curves. The B group did not show significant differences in model fit between AEXP and LN, and their rates of change were significantly lower than that of the P group, indicating a slower progression over the practice. This suggests that the B group may require additional instructional support. The findings indicate that early-stage learning 3-ball juggling can be categorized based on the average number of successful catches, and the model-fitting results further support this classification.

**ECRONY: AN INNOVATIVE MOTOR LEARNING TOOL FOR TEACHING THE BIOMECHANICS OF WALKING**

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INTRODUCTION: Walking is a fundamental motor pattern that integrates complex biomechanical and neurological systems, whose efficiency is crucial for the development of advanced motor gestures such as running and its variations in sports and physical activities. Although it may seem like a simple coordination task, walking is, in fact, a multifaceted and systemic process that requires a deep biomechanical understanding to be effectively taught and optimized. This study aims to present and analyze eCrony, an innovative educational tool based on the Sincrony educational framework, designed to support students in sports science in comprehending human walking.

METHODS: eCrony innovatively emphasizes proprioceptive and kinesthetic awareness as primary tools for motor comprehension. Using an experimental approach that differentiates between the causes and visible effects of movement, it

equips learners with the knowledge needed to enhance their correction and teaching abilities. The tool, structured into four didactically progressive levels, introduces the concept of the "vacuum" as a theoretical framework to understand the influence of external forces like gravity and inertia on visible motor gestures. eCrony also guides students through the activation sequence of the main muscle groups involved in walking, using interactive modules, video demonstrations, and practical exercises. These combine proprioceptive feedback with theoretical knowledge. Additionally, this tool introduces advanced biomechanical concepts, such as the Grocco model (2008), which defines the basic segmental unit of movement as consisting of two joint segments and one motor muscle.

RESULTS: The educational path provided by eCrony aims to stimulate learning by developing advanced observational skills essential for identifying errors and inefficiencies in motor gestures, particularly walking. The eCrony prototype transforms the traditional study of the gait cycle into an in-depth theoretical and practical analysis of walking as a transitional foundation for more advanced motor activities, such as running and jumping, which are fundamental to many sports.

CONCLUSION: The expected outcomes from using this digital tool include improved observation and correction skills in walking for future sports science educators. Furthermore, eCrony, with its apparent simplicity, incorporates several innovative principles for motor education that could inspire new possibilities for teaching movement.

**BACKWARDS WALKING IN A THERAPEUTIC CONTEXT: A SCOPINGREVIEW**

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INTRODUCTION: Walking is used by physical therapists as both a technique for rehabilitation and as a measure of success to treat a number of conditions and diseases. The ability to walk in multiple directions including backward is an imperative for activities of daily living and survival. Retro walking is not simply the reverse of forward walking and with the changes in the direction there are changes to the joint kinematics occurring at the ankle, knee, and hip. The main aim of the study was to determine the therapeutic benefits of backward walking and provide guidelines for physical therapists.

METHODS: The research design used was a scoping review. The sources of the scoping review included both randomised and non-randomised controlled trials which utilised "retro walking and/or backward walking". The search of published literature was completed using databases. The sources of the research were published before 1 November 2024 which utilised backward walking in a physical rehabilitation context. The studies included in the literature review included adults (above 18 years old) both male and female. The articles that met the inclusion criteria were analysed by means of the data extraction form. From the articles that were analysed, the results were drawn up. Six articles were included and analysed to address the research question.

RESULTS: A total of six studies met the inclusion criteria and were subsequently analyzed. Two of these studies specifically investigated the effects of backward walking interventions on patients diagnosed with knee osteoarthritis, assessing parameters such as pain reduction, joint function, and biomechanical adaptations. Three studies focused on the application of retro walking as a rehabilitative strategy for individuals recovering from stroke, examining its impact on gait mechanics, balance restoration, and neuromuscular activation. The remaining study explored the influence of retro walking on individuals with general and abdominal obesity, evaluating changes in body composition and metabolic parameters.

CONCLUSION: Backward walking is a valuable rehabilitative tool in physical therapy, offering significant therapeutic benefits for individuals physical rehabilitation for neuromuscular skeletal, neurological and chronic conditions. Backward walking is utilized to restore functional mobility, enhance proprioception, and improve neuromuscular control in individuals with neuromuscular skeletal conditions such as knee osteoarthritis. Additionally, it plays a critical role in neurological rehabilitation, aiding stroke survivors by promoting balance, gait symmetry, and lower limb coordination. Its application in chronic disease management, particularly in individuals with obesity in reduction in waist circumference further highlights its role in improving functional capacity and overall physical health. Backward walking is a cost effective, easy to administer tool that should be utilized in conjunction to traditional therapy.

**EVALUATING THE IMPACT OF PASSIVE EXOSKELETON ON MAXIMAL ISOMETRIC STRENGTH, PERCEIVED WORKLOAD AND COMFORT IN MANUAL MATERIAL HANDLING**

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INTRODUCTION: Work-related musculoskeletal disorders (WMSDs) are the most common work-related health problem in the European Union, with an increasing trend from 27 EU countries (Eurostat data) between 2007 and 2020 (from 54.2% to 60.1%). In recent years, exoskeletons have been developed to aid manual workers, wearable devices that stabilize and support the locomotor system of the human body. Studies have tested the effectiveness of passive back-support exoskeletons during simulated load-handling tasks (Schmalz et al., 2022), but the effect on maximal strength has not yet been investigated under standardized conditions. The aim of this study was to determine whether the use of a passive exoskeleton supporting the lower body can improve the user physical performance during a maximal strength isometric lifting task. Additionally, we sought to investigate the comfort and wearability of the device.

METHODS: The exoskeleton used for this study was the Paexo Back model produced by Ottobock SE & Co. KGaA (Duderstadt, Germany), designed to aid in lifting by supporting the lower back. 34 healthy male workers (age: 30 ± 11 years old) participated in this study. Stature and weight were measured and handgrip strength was tested on the dominant side. Each participant performed general and specific warm-up, afterward, they performed three trials of isometric

maximal deadlift pulls with and without wearing the exoskeleton, in a randomized order, with 90 seconds of rest between each attempt. Then, the participants completed a questionnaire on the wearability and comfort of the exoskeleton prepared for this study.

RESULTS: The mean strength performance without using the exoskeleton was 135.5 ± 31.2 kg, and 144.9 ± 32.1 kg with the device, with a mean difference between the two conditions (Δ exo) of 9.4 ± 16.5 kg. The range for Δ exo was -27.9-55.1 kg. The paired t-test revealed a significant difference between the two conditions (t-score = 3.3246, p-value = 0.0022, fig. 4), with an effect size of 0.56 (95% confidence interval of 0.20-0.92). There was a weak correlation between Δ exo and stature (Pearson's r = 0.35, p-value = 0.045). From the comfort questionnaire, strength support was the highest scored item, while dressing autonomy received the lowest scores.

CONCLUSION: The exoskeleton was effective in improving isometric strength and was perceived as providing good support, although wearability remains a barrier.

**THE EFFECT OF OBSTACLE APPEARANCE TIMING ON DECELERATION BEHAVIOR DURING WALKING**

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INTRODUCTION: Sudden deceleration during change of direction (CoD) may increase the risk of non-contact anterior cruciate ligament (ACL) injury. Sudden CoD is typically experienced when athletes are required to avoid obstacles, such as opponents, in team sports. Although studies have focused on risk-elevated lower limb kinematics and kinetics during unanticipated CoD, it is still unknown whether the timing of obstacle appearance affects the deceleration behavior during subsequent CoD. This lab-controlled study aimed to investigate whether the timing of obstacle appearance during walking affects the distribution of deceleration amount in the subsequent first and second steps.

METHODS: Fourteen healthy adults were asked to walk on the 5.5 m platform at 100 bpm cadence. If the visual obstacle (black circle with a 25-cm radius) appeared on the platform in front of them, they were instructed to change their walking direction toward left or right to avoid the obstacle. The positions of the torso marker cluster and the toe markers were collected (360 Hz). 80 trials with obstacle appearance and 20 trials without obstacle appearance were performed randomly to avoid anticipation of obstacle appearance. In the obstacle appearance trials, a custom MATLAB script was used to control the timing of the obstacle appearance so that it appeared randomly and evenly from the beginning to the end of the swing phase. The timing of obstacle appearance was quantified as the percentage of the swing phase from toe-off (0%) to heel contact (HC, 100%). The negative peaks of torso marker cluster's acceleration at the first and the second HC after obstacle appearance were analyzed. The percentage of the first HC deceleration (%1stHCD) relative to the sum of the first and the second HC deceleration was calculated as an outcome measure of deceleration behavior. In addition, the body momentum at the obstacle appearance (BM@ob) was calculated as the torso marker cluster velocity times the participants body mass. Both %1stHCD and BM@ob were grouped into five bins at every 20% interval in the timing of the obstacle appearance, and a Mann-Whitney U test was conducted between these timing groups.

RESULTS: 1022 trials were included. %1stHCD was smaller when the obstacle appeared in the earliest (0—20%) or the latest (80—100%) swing phase compared to the middle (20—80%) swing phase. When the obstacle appeared in the latest (80—100%) swing phase, BM@ob became the greatest among all swing phases. All p-values were < .005.

CONCLUSION: When an obstacle appeared in the latest swing phase, the %1stHCD was smaller despite the greatest body momentum. This suggests that the latest obstacle appearance did not allow sufficient preparation time for the subsequent stance limb (the first HC) to decelerate body velocity effectively, resulting in a reduced %1stHCD. Insufficient preparation time for sudden deceleration could also increase the load on the second stance limb, consequently leading to improper deceleration function on the first limb.

**RELATIONSHIP BETWEEN PERCEPTION THRESHOLD OF LEFT-RIGHT SPEED DIFFERENCES AND LOCOMOTOR ADAPTATION IN SPLIT-BELT TREADMILL WALKING**

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INTRODUCTION: Humans can adjust their walking patterns in response to various environments. A split-belt treadmill has been utilized to study locomotor adaptation. When healthy individuals are exposed to a perturbation where the walking speeds differ between the right and left legs, their walking patterns become asymmetrical but gradually approach symmetry over several minutes1). For locomotor adaptation, the perception of left-right speed differences is considered important to recognize asymmetric movements as errors and correct them2). However, the relationship between the ability to perceive left-right speed differences and the ability to modify asymmetric movement during walking remains unclear. Therefore, this study aimed to investigate the relationship between changes in walking patterns due to locomotor adaptation on a split-belt treadmill and the ability to perceive left-right speed differences.

METHODS: Eighteen healthy adults performed two types of walking tasks to evaluate perception threshold for left-right speed differences and locomotor adaptation ability during split-belt walking. To evaluate the perception threshold for speed difference, the treadmill belt speed on one side was increased from 1.0 m/s to 1.4 m/s over 40 s while the participants were walking at 1.0 m/s. They were instructed to press a button when they perceived the speed difference and to indicate which side had the increased speed. Six trials were randomly conducted under three conditions: left-belt speed increase (4 trials), right-belt speed increase (1 trial), and no speed change (1 trial). The perception threshold was calculated

as left-right speed difference at the time of button press during the trials where the left-belt speed was increased. The walking task to evaluate locomotor adaptation ability consisted of three periods: Baseline period (both belts at 1 m/s for 2 min), Adaptation period (right: 1 m/s, left: 1.5 m/s for 10 min), and Washout period (both belts at 1 m/s for 5 min). To assess adaptation ability, step length symmetry was evaluated. Pearson correlation coefficients were calculated between the perception threshold and step length symmetry for specific phases of the Adaptation and Washout periods: 0-10 s, and 30-s intervals up to 240 s.

RESULTS: In the first 240 s of the Adaptation period, significant negative correlations were observed between the perception threshold and step length symmetry. Specifically, the most prominent correlation was observed between 30 and 60 s.

CONCLUSION: The results suggest that the ability to perceive left-right speed differences is related to the ability to adapt during split-belt walking. Individuals who can perceive small speed difference between the left and right belts are likely to rapidly adjust asymmetric walking movements into more symmetric walking patterns.

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**IDENTIFYING THE FACTORS THAT INFLUENCE CYCLING SKILLS ON CONVENTIONAL AND ELECTRIC BICYCLES IN YOUNG AND OLDER ADULTS**

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INTRODUCTION: Cycling is a widely practiced and sustainable activity offering substantial health benefits across all age groups. In recent years, more older adults have continued cycling at a later age, particularly on electric bicycles. However, older adults are more involved in cycling accidents compared to other age categories, especially when riding electric bicycles (1). These accidents often occur without the involvement of other road users, suggesting that reduced cycling skills in older adults is a contributing factor (2). This study aims to investigate whether balance strategies differ between younger and older adults when riding conventional and electric bikes.

METHODS: A group of young (20-35 y/o) and older adults (60-75 y/o) completed a cycling track on both a conventional and an electric bicycle while cycling at their preferred pace and at 50% of this pace. The cycling track consisted of several tasks related to real-life traffic situations (e.g. cycling through a narrow lane, mount and dismount the bicycle, shoulder checking). Wireless inertial measurement units (IMUs) were attached to the bicycle's handlebar, frame and the cyclists. This data was used to compute the steering angle and the bike roll angle. Bike stability while cycling was quantified using the standard deviation of the bike roll angle and the steering rate, which is the rate of change of the steering angle over time.

RESULTS: We will investigate the effects of bike type (conventional vs electrical bike), age group (old vs young adults), and cycling speed (self-selected vs. slow speed) on bike stability. We hypothesize that (1) cycling at lower speeds will lead to higher standard deviations in both steering rate and bike roll angle. (2) We also expect older adults to exhibit higher standard deviations in steering rate and bike roll angle compared to younger participants while completing the cycling track. (3) Furthermore, we anticipate greater standard deviations in steering rate and bike roll angle when riding an electric bike compared to a conventional bike at lower speeds. (4) Finally, we predict that the differences in bike stability will be mainly observed in more challenging tasks, such as shoulder checking, compared to easier tasks like cycling in a narrow line.

CONCLUSION: The findings will provide insights into the aspects contributing to balance difficulties while cycling, with implications for developing targeted interventions to reduce cycling-related accidents, particularly among older adults.

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**ACUTE EFFECT OF VIRTUAL REALITY EXERGAME TRAINING ON SPEED-ACCURACY TRADE-OFF**

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INTRODUCTION: The duration of arm-reaching movements depends on target distance and size, as modeled by Fitts in 1954 through a linear relationship between target difficulty and movement duration (1). Thus, increasing execution speed compromises accuracy and vice versa. Both elite sports performance and daily tasks rely on managing this speed-accuracy trade-off. This study aimed to examine how a virtual reality (VR) exergame can improve this motor competence.

METHODS: Twelve healthy young participants (23.4 years old, 4 females) completed three sessions on separate days in a random order to assess the effects of three VR interventions: control condition (CONT), accuracy-focused (ACC), and speed-focused (SPE). The control condition consisted of a neutral immersive VR video. ACC and SPE involved playing the VR rhythm game "Beat Saber" (Beat Games, Prague), where players cut approaching cubes with two virtual sabers. In ACC, cubes were at minimum size, cutting tolerance was reduced, and speed was moderate. In SPE, cube size and dis-

play speed were maximized, while cutting tolerance increased. Each intervention (CONT, ACC, SPE) lasted 15 minutes. Before and immediately after each session, participants performed a Fitts' pointing task with their right arm, targeting four difficulty levels (determined by Fitts formula) on a large vertical touchscreen (120 × 70 cm). Standing participants extended their arm to touch targets in four directions: UP, DOWN, RIGHT, and LEFT. Throughout the experiment, variation of electromyographic (EMG RMS) activity of 5 shoulder muscles and three-dimensional hand acceleration were recorded.

RESULTS: CONT induced no changes in pointing times or muscle activations. In RIGHT and LEFT pointing, SPE reduced pointing time for the largest target (low difficulty), increasing Fitts' slope ($P<0.001$). Conversely, ACC reduced pointing time for the smallest targets (high difficulty), decreasing Fitts' slope ($P<0.001$). UP pointing remained unaffected. For DOWN pointing, SPE increased pointing time in difficult targets ($P=0.011$), whereas ACC reduced pointing time in easier targets ($P=0.006$). Muscle activation strategies and deceleration patterns varied between ACC and SPE. Arm accelerometry confirmed that the game used primarily involves horizontal and downward movements.

CONCLUSION: VR exergaming acutely modifies motor strategies by adjusting the speed-accuracy trade-off, as reflected in changes to Fitts' slope. These effects are intervention-dependent: accuracy training improved precise targeting, while speed training enhanced performance on simpler tasks. However, the speed-focused session impaired accuracy in downward movements. Actimetry data suggest that these effects are direction-specific and linked to the training, as no significant impact was observed in the less trained movement direction (UP).

Reference: (1) Fitts PM (1954) J Exp Psychol

## Conventional Print Poster Presentations

### CP-BM06 Gait

**DIFFERENCES IN GAIT CHARACTERISTICS, STRENGTH AND BALANCE BETWEEN MALES WITH AND WITHOUT TYPE 2 DIABETES**

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INTRODUCTION: The prevalence of type 2 diabetes (T2D) is increasing, placing a burden on both individuals and healthcare systems. T2D accounts for approximately 90% of all diabetes cases, making it a priority for improved prevention and management. T2D is associated with various pathological complications, including those affecting the neuromuscular system. Previous research suggests that individuals with T2D often exhibit slower walking speeds, altered gait patterns, decreased muscle strength and impaired mobility compared to non-diabetic individuals. The aim of this study was to examine how strength, balance, ankle range of motion and step length are associated with self-selected walking speed (SS) and maximum walking speed (MS) among males with T2D.

METHODS: This cross-sectional study included 18 males diagnosed with T2D (age 62.5 ± 10.6, body height 177.1 ± 5.4 cm, body weight 94.7 ± 16.7 kg), recruited from the Department of Endocrinology at the University Hospital, Reykjavik, Iceland and 10 non-diabetic males, (age 67.6 ± 3.3, body height 182.3 ± 6.8 cm, body weight 98.8 ± 11.1 kg), recruited via convenience sampling. Walking speed was assessed at SS and MS by walking between two gates placed 10 meters apart. Balance was measured using a 15-second single-leg stand on VALD ForceDecks. Maximum voluntary contraction (MVC) of plantar flexors was tested using VALD ForceFrame and MVC of knee extensors using VALD DynaMo. Step length and ankle range of motion during walking were analyzed using video recordings of treadmill walking and Dartfish software. Independent samples t-tests in Jamovi software were used to compare SS, MS, strength, balance, ankle range of motion and step length between males with and without T2D. The significance level was set at $\alpha = 0.05$ and effect sizes were reported using Cohen´s d.

RESULTS: Males with T2D had significantly lower MS ($p = 0.012$, $d = -1.11$) and knee extensor strength ($p = 0.006$, $d = -1.27$), compared to non-diabetic males. Mean values suggested that males with T2D had lower SS, shorter step-length, slightly lower ankle angles at toe-off and heel strike at SS and MS (except for a slightly higher angle at toe-off during MS), greater center-of-pressure range during single leg stance and lower plantar flexor strength compared to males without T2D. However, these differences were not statistically significant.

CONCLUSION: Results of this ongoing study indicate differences in physical performance of males with and without T2D in Iceland, with significant reductions in MS and knee extensor strength in people with T2D. These findings highlight the potential impact of T2D on strength and mobility, emphasizing the importance of screening for functional limitations and implementing targeted interventions to improve the quality of life in individuals with T2D.

**LONGITUDINAL CHANGES IN STRIKE ANGLE SYMMETRY IN ACLR PATIENTS' GAIT MEASURED BY SMART SHOES**

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INTRODUCTION: Gait asymmetry after anterior cruciate ligament reconstruction (ACLR) is frequently reported, potentially raising the risk of re-injury and posttraumatic knee osteoarthritis (KOA). Conventional assessment methods focus on the

sagittal-plane knee angles and moments, which are key parameters influenced by ACLR, but require complex equipment such as optical motion capture and force plates.

With advancements in wearable sensor technology, gait analysis has become widely accessible in recent years. We have developed shoes with embedded sensors (smart shoes), which are more comfortable to wear and easy to calculate gait parameters based on foot movements. We hypothesised that ACLR-related asymmetry could be detected in the sagittal-plane foot movement measured by smart shoes, and observed the symmetry of the strike angle (the angle between the ground and the foot in the sagittal plane at initial ground contact) during the postoperative rehabilitation period. This study aimed to quantify strike angle symmetry in ACLR patients from 2 to 6 months post-surgery, comparing them with healthy controls to identify changes over time. We hypothesized that early postoperative asymmetry would decrease, approaching healthy levels by 6 months.

METHODS: Eight ACLR patients and 12 healthy participants wore smart shoes and walked on a treadmill at 4 km/h for 3 minutes. ACLR patients executed this task at 2, 3, 4, and 6 months postoperatively. Three-dimensional foot acceleration and angular velocity data (200 Hz) during walking were measured by smart shoes, and processed with gait analysis software ORPHE ANALYTICS to calculate the strike angle for each step. The symmetry index (SI) of the strike angle was computed for each participant. The effect of postoperative time (2, 3, 4 and 6 months) on the SI was tested by one-way ANOVA ($\alpha = 0.05$). The SI of each postoperative time was compared to the SI of healthy participants using Wilcoxon rank sum test with significance level $\alpha = 0.05/4$.

RESULTS: A significant main effect of postoperative time on SI was identified ($p = 0.021$). The SI decreased as postoperative time progressed (2 months: 22.19 ± 13.09 %, 3 months: 14.03 ± 8.09 %, 4 months: 10.50 ± 5.00 %, 6 months: 9.61 ± 4.58 %). While at 2 months, ACLR patients had a significantly larger SI than healthy participants (6.57 ± 5.95 %; $p = 0.0015$), no significant differences emerged at 3 ($p = 0.047$), 4 ($p = 0.115$) or 6 months ($p = 0.208$) compared to healthy controls.

CONCLUSION: We quantified the change in gait symmetry over time in ACLR patients by gait analysis with smart shoes. The symmetry of the strike angle changed over time, and no statistically significant difference was observed already at 3 months postoperatively, indicating that the ACLR patients may have reacquired a level of symmetry like that of the healthy controls. Although strike angle symmetry alone may not be sufficient to assess the symmetry of kinetics inducing KOA, it may lead to the development of a new screening modality that is versatile in clinical practice.

**COMPARATIVE ANALYSIS OF IN-SHOE KINETICS DURING LOADED RUNNING AND WALKING USING TWO MILITARY FOOTWEAR TYPES**

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INTRODUCTION: Wireless insoles offer a field-viable alternative to traditional, laboratory-based force plate measurements, enabling ecological assessment of mechanical loading during physical activity. While foot-ground and shoe-ground interactions are well studied [1,2] in-shoe plantar forces remain poorly characterised. This study examined kinetic parameters associated with lower limb injury aetiologies, [3,4] using force-measuring insoles. We aimed to characterise in-shoe loading profiles of military relevant ambulation to enhance understanding of in-shoe loading dynamics.

METHODS: Seven members of the United Kingdom armed forces (age: 20.6 ± 3.5 years, body mass: 81.2 ± 6.2 kg, height: 1.80 ± 0.04 m, shoe sizes 9-13) walked (1.5 $m{\cdot}s^{-1}$) and ran (3.6 $m{\cdot}s^{-1}$) along a 10-m runway with a designated foot-strike target. Trials were performed whilst wearing military-issue boots (BOOT) and military-issue training shoes (SHOE) under body-worn loading conditions: 0 kg, 20 kg, and 40 kg during walking and 0 kg and 20 kg during running. Force data were recorded wirelessly at 200 Hz using proprietary software. Data analyses included initial impact peak (iGRF), propulsive force (pGRF), loading rate (LR), impulse (IMP) and stance time (ST). Differences between footwear types, loading states and modes of locomotion were assessed using paired sample t-tests ($p<0.05$).

RESULTS: Increased load significantly increased: iGRF, 1.19 ± 0.15 [0 kg], 1.46 ± 0.17 [20 kg], 1.75 ± 0.16 [40 kg] times BW; pGRF, 1.16 ± 0.14 [0 kg], 1.43 ± 0.15 [20 kg], 1.62 ± 0.20 [40 kg] times BW; IMP, 452.3 ± 48.4 [0 kg], 556.1 ± 54.1 [20 kg], 663.7 ± 71.7 [40 kg] $N.s^{-1}$; LR, 7.7 ± 0.8 [0 kg], 11.1 ± 1.8 [20 kg], 13.5 ± 2.5 [40 kg] $BW.s^{-1}$ and ST, 0.70 ± 0.02 [0 kg], 0.71 ± 0.3 [20 kg] and 0.72 ± 0.03 [40 kg] seconds ($p<0.05$). Compared with walking, running increased iGRF, pGRF, IMP and LR and decreased ST ($p<0.05$). During walking trials, iGRF was higher ($p=0.01$), ST shorter ($p=0.02$) and LR higher ($p<0.005$) in the SHOE vs the BOOT condition. During running trials, LR was significantly higher in the BOOT vs SHOE condition ($p=0.02$).

CONCLUSION: This study quantified injury-relevant in-shoe kinetics during walking and running in two standard issue military footwear types. Load carriage increased kinetic parameters associated with injury aetiology. Training shoes were associated with higher loading rates and iGRFs across walking trials compared with boots. This study has demonstrated the utility of in-shoe force measuring insoles, which can be used in field studies to quantify walking and running kinetics. Future work will assess how in-shoe kinetic differences influence the mechanical loading of the lower limbs and their potential impact on injury risk.

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**EFFECTS OF DUAL-TASKING ON DYNAMIC GAIT STABILITY DURING WALK-TO-STAIR DESCENT TRANSITION**

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INTRODUCTION: Stair descent is an activity of daily living with the potential for falls. Performing level walking before stair descent should bring additional challenges. The effects of a concurrent cognitive or manual dual-task condition on dynamic gait stability (DGS) during the stair descent transition remain uncertain. COM–COP Inclination Angle (IA) can comprehensively assess DGS as it considers both center of mass (COM) and center of pressure (COP) [1]. This study aimed to investigate the effects of dual-task conditions on DGS during walk-to-stair descent transition.

METHODS: Twenty healthy young male participants performed five-step staircase descent tests under three conditions: (1) single task (ST, descend stairs only); (2) cognitive dual-task (CT, descend stairs while subtracting serial sevens from a three-digit number); and (3) manual dual-task (MT, descend stairs while carrying a glass of water weighing 500g in their right hand). Participants were instructed to perform level walking on the 5-meter walkway followed by stair descent in a step-over-step manner at a self-selected comfortable speed to the bottom and continued their walk for 5 meters. A 14-camera motion capture system (Qualisys AB, 200Hz) and two force plates (Kistler, 1000Hz) were used to obtain the kinematic and kinetic data. Data from level walking to stair descent transition were obtained from stance phases of lead leg (foot contacting the first step down on the staircase) and trail leg (foot contacting the top step of the staircase) and used to calculate IA in the sagittal and frontal plane. Two-way RM ANOVAs were performed. Significant ANOVAs were followed up with Bonferroni post-hoc procedures. Alpha level was set at 0.05.

RESULTS: In the sagittal plane, the CT condition showed increased time-averaged anterior IA during single leg stance of lead leg (ST: -0.8±0.8, CT: -1.2±0.8, MT: -0.7±0.6 °, $P<0.001$), but the MT condition showed increased time-averaged posterior IA during single leg stance of trail leg (ST: 2.1±1.6, CT: 2.0±1.2, MT: 2.6±1.4 °, $P<0.001$). The MT condition showed decreased ranges of IA (ST: 17.1±1.5, CT: 16.9±1.5, MT: 16.4±1.5 °, $P=0.021$) and anterior IA at contralateral-heel-strike (CHS) (ST: -7.6±1.3, CT: -7.6±1.3, MT: -6.9±1.1 °, $P<0.001$) for both lead and trail legs. In the frontal plane, ranges of IA for both lead and trail legs increased during CT, but decreased during MT (ST: 1.9±0.4, CT: 2.1±0.5, MT: 1.8±0.4 °, $P<0.001$). Medial IA at CHS for trail leg increased during CT, but decreased during MT (ST: 4.8±0.9, CT: 5.2±0.9, MT: 4.6±0.9 °, $P<0.001$).

CONCLUSION: The results of the current study suggest that during walk-to-stair descent transition, performing a cognitive task results in decreased DGS, especially in the frontal plane. However, performing a manual task improves gait stability. The unconscious alteration in IA might be key to avoiding hazards and preventing falls.

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**PREDICTION OF GROUND REACTION FORCES BY KINEMATIC VARIABLES DURING GAIT: BASED ON OPTIMIZED ARTIFICIAL NEURAL NETWORK ALGORITHM**

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INTRODUCTION: Gait is a fundamental daily movement involving alternating single- and double-leg stances that propel the body forward. Ground reaction forces (GRF) provide critical biomechanical insights for diagnosing disorders and monitoring rehabilitation. However, conventional force plates face practical limitations, including fixed positioning and high costs. This study explores an alternative approach to predict GRF by integrating center of mass (COM) coordinates from infrared motion capture and accelerometer (ACC) data from wearable sensors using artificial neural networks (ANN). The study evaluates the reliability and accuracy of GRF predictions using ANN integrating COM and ACC data, aiming to develop a cost-effective, versatile alternative to force plates.

METHODS: Eighty university students (52 males, 28 females) participated. Data were collected using 18 infrared cameras, two force plates, and wearable inertial measurement units (IMU) recording at 100 Hz, 1,000 Hz, and 100 Hz, respectively. Reflective markers were placed at 72 anatomical landmarks. Participants performed 20 gait trials on a 10-meter walkway, ensuring force plate contact. Kinematic data were processed with Visual3D, using 6 Hz and 20 Hz low-pass filters for marker trajectories and GRF/ACC data, respectively. GRFs were normalized to body mass, and time-normalized to 100 data points per stance phase. A feedforward neural network (FNN) with two hidden layers (500 units each, ReLU activation) predicted GRF. Bayesian optimization determined hyperparameters. Input data included time-normalized COM and ACC variables; outputs were GRF components. Metrics included Pearson correlation (r), root mean square error (RMSE), and normalized RMSE (NRMSE).

RESULTS: Using COM data alone, GRF predictions achieved highest accuracy in the medial-lateral direction ($r = 0.963$, RMSE = 0.088 N/kg). Using ACC data, the anterior-posterior direction showed the highest correlation ($r = 0.941$), while the medial-lateral direction exhibited the lowest error (RMSE = 0.123 N/kg). Combining COM and ACC data improved accuracy across all directions, with medial-lateral GRF achieving $r = 0.979$ and NRMSE = 6.07%. Anterior-posterior and vertical GRF predictions also showed significant error reductions.

CONCLUSION: The integration of COM and ACC data enhances GRF prediction accuracy, particularly in the medial-lateral direction. This approach offers a viable, cost-effective alternative to force plates, with applications in gait analysis, rehabilitation, and performance optimization. Future studies should refine ANN models and incorporate additional sensor data to improve vertical GRF predictions further.

**VALIDITY AND RELIABILITY OF INERTIAL MEASUREMENT UNITS FOR ASSESSING LOWER EXTREMITY JOINT COORDINATION AND VARIABILITY IN GAIT AMONG COMMUNITY-DWELLING OLDER ADULTS**

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INTRODUCTION: Joint coordination and variability are key indicators for assessing fall risk in older adults. As a convenient tool, it is crucial to determine whether IMUs can accurately measure these parameters for effective fall risk evaluation. This study aimed to assess the validity and reliability of inertial measurement units (IMUs) in measuring lower extremity joint coordination and variability in gait among community-dwelling older adults.

METHODS: Forty-five older adults participated in the study. Lower extremity joint angles during walking at preferred speeds were simultaneously measured using IMUs and an optical motion capture (OMC) system. The modified vector coding technique was applied to calculate coupling angles (CA) and coordination variability (CAV) for four joint coupling pairs: hip flexion/extension-knee flexion/extension (HXKX) and hip flexion/extension-ankle dorsiflexion/plantarflexion (HXAX). The Coefficient of Multiple Correlation (CMC) was used to assess waveform consistency, and systematic error (SE) was calculated to quantify deviations. Pearson's correlation coefficient (r) and root mean square error (RMSE) were used to evaluate CAV. Additionally, the 1-dimensional statistical parametric mapping (1d-SPM) method was employed to compare differences in joint coordination during validity analysis.

RESULTS: IMUs demonstrated excellent validity in measuring lower extremity joint coordination waveforms both before (HXKX: CMC = 0.936, SE = 24.8°; HXAX: CMC = 0.921, SE = 33.9°) and after offset correction (HXKX: CMC = 0.949, SE = 19.5°; HXAX: CMC = 0.942, SE = 28.8°). The reliability of IMUs was confirmed with within-rater assessments (HXKX: CMC = 0.959, SE = 27.4°; HXAX: CMC = 0.927, SE = 35.7°) and across-rater assessments (HXKX: CMC = 0.970, SE = 23.8°; HXAX: CMC = 0.950, SE = 29.2°). Statistical parametric mapping (SPM) revealed significant differences in joint coordination during specific gait intervals for both HXKX (8.9–9.8%, 13.8–18.3%, 30.7–33.8%, 58.9–62.3%, and 89.8–93.7%) and HXAX (13.0–21.8%, 42.9–48.3%, 75.6–79.3%, and 89.9–98.0%) coupling pairs. Regarding CAV results, IMUs showed strong performance, with Pearson correlation coefficients ($r > 0.7$) and low deviations (RMSE values < 5°) during validity and reliability analysis.

CONCLUSION: IMUs demonstrate high validity and reliability in measuring hip flexion/extension-knee flexion/extension and hip flexion/extension-ankle dorsiflexion/plantarflexion coordination and variability in community-dwelling older adults. These findings suggest that IMUs are a reliable and accurate tool for gait analysis in the context of fall risk assessment.

**STEP COUNTING AND GAIT SPEED ESTIMATION USING ARM-BASED WEARABLE ACCELEROMETRY: A PROOF OF CONCEPT FOR A CUSTOM ALGORITHM**

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INTRODUCTION: Step count estimation using wearable accelerometers is widely applied in commercial settings, with accuracy depending on both device placement (e.g., wrist, hip) and the algorithm used (1, 2). However, algorithms tailored for upper-arm acceleration data remain rare. As part of a broader gait abnormality recognition system, we developed an acceleration-based algorithm for upper-arm data to measure walking cadence and peak foot strike acceleration (pFSA). This study serves as a proof of concept for step count and average walking speed (AWS) estimations of our self-developed algorithm.

METHODS: Ten participants each completed two 420-meter walking trials on a flat surface while manually counting their steps. Both walking trials were self-paced: one at a leisurely pace and one at a fast pace. Acceleration data (52 Hz) was collected using a Polar Verity Sense device worn on the upper arm. Step count and pFSA were estimated using our algorithm. We evaluated algorithm performance using Pearson correlation, mean step difference, and mean absolute percent error (MAPE) between estimated and manually counted steps. A random forest regression was performed to predict AWS using participant height, weight, pFSA, and cadence.

RESULTS: All participants (f = 4, m = 6; height = 173.5 ± 9.5 cm; weight = 72.9 ± 11.5 kg) successfully completed both trials with a mean AWS of 5.7 ± 0.7 km/h. Manually counted and estimated steps showed a strong correlation ($r = 0.95$), with the algorithm slightly overestimating step count by 6.8 steps (503.4 ± 41.5 vs. 510.2 ± 42.4) and a MAPE of 2.2%. The random forest regression for predicting AWS resulted in a $R^2$ of 0.91 (MAPE = 3.1%), with cadence (importance = 0.68) and pFSA (0.17) contributing most to reducing model uncertainty.

CONCLUSION: Our acceleration-based algorithm demonstrated high accuracy in step count estimation, with a MAPE of 2.2%. In comparison, recently tested open-source wrist-based accelerometry algorithms reported a MAPE of 19% or higher under similar conditions (1). The $R^2$ of 0.91 in the random forest regression suggests strong predictive potential for gait speed estimation, highlighting applications in gait analysis and load monitoring. Future research should explore the generalizability of these findings across different populations and conditions.

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Conventional Print Poster Presentations

CP-BM08 Sports Biomechanics

**A COMPARATIVE ANALYSIS OF ISO-INERTIAL ECCENTRIC-OVERLOAD (YOYO) RESISTANCE EXERCISE AND ALPINE SKIING BIOMECHANICS**

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INTRODUCTION: Alpine skiing requires strength, power, and neuromuscular control due to its complex biomechanics and intense eccentric muscle contractions, particularly in the lower body. Effective training is crucial for performance optimization and injury prevention. Iso-inertial, eccentric-overload resistance training, especially using YoYo devices, has been explored for its benefits in skiing.

This study compares kinematics, kinetics, and muscle activation patterns between YoYo training and alpine skiing data from the literature, highlighting biomechanical similarities and potential applications for sport-specific training.

METHODS: Six moderately trained subjects performed three 20-second trials, executing lower limb flexion-extension movements to simulate skiing. Trials took place on an inertial system (YoYo, Hance, Sweden) with ski bindings. Joint angles were estimated using an Xsens system (Movella). Forces exerted were measured via four load cells (Fyearfly, 200 kg) mounted between the ski bindings and YoYo, two per side-one front, one rear. EMG sensors (MiniWave, Cometa) recorded muscular activation of the Vastus Lateralis (VL), Biceps Femoris (BF), Gastrocnemius Medialis (GM), and Tibialis Anterior (TA) bilaterally.

Data were processed, cycle-averaged based on minimum knee flexion, and compared with literature. Left and right side data were averaged due to movement symmetry.

RESULTS: Trunk flexion ranged from 20° ± 20° to 53° ± 11°, hip flexion from 24° ± 11° to 86° ± 22°, knee flexion from 14° ± 4° to 53° ± 7°, and ankle dorsiflexion from 6° ± 2° to 18° ± 5°. Considering forces, the anterior force varied between 0.3 ± 0.08 BW and 1 ± 0.21 BW, the posterior force between 0.2 ± 0.08 BW and 0.6 ± 0.15 BW, while the total force ranged from 0.5 ± 0.05 BW to 1.6 ± 0.32 BW. VL showed a peak activation at around 52% of the cycle, BF at 76%, GM at 90%, and TA at 42%.

CONCLUSION: Greater trunk flexion ROM was observed. Hip and knee flexion angles were lower than outdoor data, while ankle dorsiflexion was comparable [1]. Max vertical forces were slightly lower, while min vertical forces were higher than outdoor [2]. TA showed a similar activation pattern with a peak slightly earlier. BF showed peak activation only during knee extension. Since no VL and GM data were available, activation was compared with synergistic muscles. VL showed a similar pattern to VM, while GM was comparable to GL [3].

The exercise can be used in training as muscle activations resemble outdoor activities, and ground reaction forces are comparable. Proper technique is crucial, as there is a tendency for lower hip and knee angles and increased trunk flexion, which may raise injury concerns.

Further investigations are ongoing to compare indoor and outdoor data using a similar setup.

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**3D PEDALLING ANALYSIS AT DIFFERENT INTENSITIES AND SLOPES IN COMPETITIVE YOUNG OFF-ROAD CYCLISTS: PRELIMINARY RESULTS**

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INTRODUCTION: Cross-country races feature a mix of steep ascents, where the cyclists must generate high power to tackle the slopes, and descents, where the cyclists' performance depends on their riding skills. To optimize the cyclist's efficiency, the bike fitting is performed with the aim of improving performance (1). Although bike fitting is often performed on a cycling simulator without simulating various slopes, they can influence the cyclist's pedalling. The aim of this study was to evaluate the three-dimensional kinematics at different pedalling intensities and slopes in young competitive cyclists.

METHODS: Eleven off-road cyclists were recruited. Each cyclist was assessed on own bike after a bike fitting. In the first test session, each cyclist performed an incremental test with a 15 W per minute increase until exhaustion. During the test, a gas analyzer (Cortex; MetaLyzer 3B) was used to assess the VO2max. In the second test session (48 h later), each cyclist performed 4 trials of 2 minutes at different intensities (65%, 75%, 85%, 95% of the VO2max) and the bike set at a 0° slope with a 3-minute rest between trials. Subsequently, the same 4 trials were repeated with a 10° slope. For the kinematic analysis, a 3D motion capture system composed of multiple cameras positioned around the cyclist (Cycling 3DMA, STT Systems), who wore markers in certain anatomical points, was used (2). For statistical analysis, the following parameters

were considered: mean ankle flexion angle at 90° (AFA), mean knee flexion angle at 180° (KFA), mean hip flexion angle (HFA), vertical hip oscillations (VHO), mean shoulder flexion angle (SFA).

RESULTS: At 90°, AFA decreased between: the trials at 65% and 95% and at 0°slope (p=0.001), the trials at 65% and 95% at 10°slope (p<0.001). At 180°, KFA increased between: the trials at 65% and 75% and at a 0°slope (p=0.049), the trials at 65% and 75% at 10°slope (p=0.029). Additionally, there was a significant decrease between the trial at 65% at 0°slope and the trial at 65% at 10°slope (p=0.035). There were no VHO in the flat trials, but between the slope trials from 65% to 85% (p=0.025). A significant decrease in SFA was observed both on flat trial (between 65% and 95%, p=0.003) and on slopes (p=0.001), with no differences between flat and slope conditions.

CONCLUSION: Since slope influences the pedalling kinematics and considering that cyclists generate power during ascents in cross-country races, we suggest that coaches and cycling biomechanics perform bike fitting using slopes that simulate at least a 10° slope to best reproduce racing conditions.

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**EFFECTS OF CADENCE, LEVELS OF ASSISTANCE, AND THEIR INTERACTION ON OXYGEN UPTAKE WHILE RIDING AN E-BIKE. WHAT'S THE ROLE OF FREE CHOSEN CADENCE?**

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INTRODUCTION: PURPOSE: While it is known that the electric motor provides some power, reducing the overall effort required by the cyclist [1-2], and the cadence affects the oxygen uptake in the common muscular bike [3], it is not known if, using an e-bike, the oxygen uptake is influenced by assistance, the RPMs and their interaction. This study aimed to evaluate the effects of different levels of assistance at different pedaling cadences (RPM) on oxygen uptake while riding a city e-bike.

METHODS: Fourteen (8 male, 6 female) active subjects (age 27±3.4 years), were tested at three different RPMs (60 – 90 and free choice: FCC), and three different levels of assistance (no assistance A0, the lowest A1 and the highest A3) in random order. The tests were performed using a city e-bike on a bike trainer, where an external power corresponding to the anaerobic threshold previously determined for each subject (4 mmol/L: 2.6 ± 0.5 W/kg) was set. Averaged oxygen uptake (VO2) values of the last 30" of each 5-minute trial were analyzed using a two-way ANOVA followed by a post hoc test (Bonferroni).

RESULTS: VO2 is influenced both by the cadence (P< 0.01) and the level of assistance (P< 0.01), but not by their interaction (P>0.05). As expected, A3 shows lower values compared with A1 and A0, with a difference of 10 ml/min/kg and 23 ml/min/kg respectively. The cadence shows higher VO2 values at 90RPMs compared with 60RPMs and FCC with a difference of 5.98 ml/min/kg (P=0.02) and 4.78 ml/min/kg (P= 0.03) respectively. Interestingly, there are no significant differences in VO2 between FCC (80 ± 10 RPMs) and 60 RPMs (P=1.00).

CONCLUSION: in this study, as expected, we can see the effect of motor assistance on VO2 uptake with lower consumption at the highest assistance. Moreover, we observe that the behavior of VO2 relative to cadence is similar to that studied on a conventional muscular bike: the higher the cadence at the same power output, the greater the oxygen consumption [3]. Last, as we didn't expect, the VO2 at FCC is very close to VO2 at 60 RPMS. Therefore, we can assume that the cadence chosen by the subjects is probably the optimal balance that combines the metabolic and muscular efforts as in the conventional bike. However, in this case, the effect of RPM on oxygen consumption may also be influenced by the properties of the electric motor of the bike, which was found to provide more power at lower RPMs. From a practical point of view, we could, therefore, suggest developing engines based on FCC cadences to ensure also the best efficiency.

**BIOMECHANICS OF BACKSTROKE START IN ELITE SWIMMERS: EXAMINING THE EFFECTS OF POSTURE, DYNAMIC BALANCE AND VERTICAL JUMP PERFORMANCE**

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INTRODUCTION: In swimming competitions, the start phase has a high impact on competitive performance. The postural, motor and biomechanical aspects of this phase, which have only been studied to a limited extent, especially in the backstroke, are critical for understanding start performance. The aim of this study was to investigate the relationship between kinematic parameters of the backstroke start performance of swimmers and dynamic balance, vertical jump and postural values.

METHODS: Elite male (n=7) backstroke swimmers with a mean FINA score of 716 (±22.25) were included in the study. The study consisted of 4 sessions. In the first session, 2 sessions of start trials were performed to adaptation to the start platform where the start measurement would be performed. The data from the trials were used to optimize the placement of the start systems. In the second session, kinematic parameters related to start performance were evaluated and the swimmers performed three repetitions of the supine start using the supine start platform. The kinematic parameters of the

start performance were recorded using stabilized GoPro10 Cam System and DACTRONICS HS-200 Start System and the images were analyzed using Kinovea 0.9.5 motion analysis program. In the third session, the dynamic balance (DB) performance was evaluated with the TecnoBody PK200 device and the vertical jump (VJ) measurements were evaluated with the Microgate Witty Wireless Training Timer. In the fourth session, a postural analysis of the athletes was performed using Apecs Posture Analysis Pro Plus 8.2.6 and the New York Posture Assessment (NYPA) method. The statistical analysis of the study was carried out using Pearson Correlation analysis with SPSS 25.0 package program.

RESULTS: There was a significant negative correlation between supine hip height (HH) and NYPA scores (p=-0.790). Similarly, a significant negative correlation was found between NYPA scores and flight time (FT) (p=-0.792). A significant positive correlation was found between front hip angle (FPT) and water entry distance (ED) (p=0.805). However, no significant correlation was observed between start kinematic parameters and VJ, DB.

CONCLUSION: In the supine ascent mechanics, the static posture HH was found to be an important parameter influencing the FT, and the degree of FPT was also found to be a value that strongly influenced the FT. Swimmers who have the advantage of postural adaptation required by the start performance show better start performance. There is no direct relationship between DB and VJ performance and start velocity (SV), vertical (VV) and horizontal velocity (HV), HH, FD, block time (BT), FT,ED, hand entry angle (HEA) kinematic parameters. We believe that the mechanical difficulty of the starting position highlights the contribution of postural factors more than motor factors.

**ANALYSIS OF SWIMMING PARAMETERS DURING THE PERFORMANCE OF DIFFERENT BREATHING PATTERNS: A CASE STUDY OF AN AMATEUR TRIATHLETE**

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INTRODUCTION: Triathlon is a sport composed of the sequential modalities of swimming, cycling and running, which individually contribute to the final race result (1). Swimming, as it is performed in open water, requires athletes to frequently execute front-lateral breathing for orientation purposes (2). However, performing this movement causes an elevation of the torso and head, which generates greater water resistance (3). Thus, front-lateral breathing can influence the kinetic and kinematic factors of swimming performance. The objective of this study was to analyze the force production, stroke length, and stroke frequency of an amateur triathlete while executing different breathing patterns.

METHODS: The study participant was a male amateur triathlete (24 years old, 1,79m, 73kg). Peak force was measured through a 30-second maximum effort test using a tethered swimming protocol, with alternating execution of lateral and front-lateral breathing every four strokes. The kinematic swimming parameters, stroke length (SL) and stroke rate (SR), were measured through video recording of a 100-meter performance in a previously calibrated space.

RESULTS: The average peak force during front-lateral breathing and in the absence of breathing was similar (approximately 140N), while force production during lateral breathing was slightly higher (147N). SL was relatively higher and SR was lower during the stroke cycle with front-lateral breathing (1.81 m and 40 cycles/min, respectively) compared to lateral breathing (1.72 m and 42 cycles/min) and the absence of breathing (1.62 m and 43 cycles/min).

CONCLUSION: Although force production was similar among the breathing patterns (justified as a maximum test performance), SL was greater during the stroke cycle with front-lateral breathing. This likely occurred because more time was required for its execution, resulting in a lower SR. The study objectively demonstrates the influence of breathing patterns on swimming performance. It is suggested that training strategies be adopted to minimize the need for front-lateral breathing during the swimming stage of triathlon races.

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**COMPARISON OF BUTTERFLY SWIMMING SPEED BETWEEN SEXES USING STATISTICAL PARAMETRIC MAPPING**

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INTRODUCTION: The main objective of sports science is to identify, develop and refine strategies to improve performance [1]. In competitive swimming, given its time-based nature, researchers and coaches focus on understanding how to improve swimming speed [2]. Traditionally, swimming speed is measured as an average value (i.e., a discrete variable with no time dimension) [3]. However, this approach only provides insights into the entire stroke cycle or the average of a combination of stroke cycles. This study aims to compare swimming speed in the butterfly stroke between sexes using Statistical Parametric Mapping (SPM).

METHODS: Ten competitive swimmers (5 males, 5 females) who regularly participate in national and international competitions were analyzed. The male swimmers (18.8 +- 3.2 years, 77.6 +- 12.0 Kg of body mass, 187.2 +- 8.3 cm of height, 189.0 +- 8.3 cm of arm span and 605.8 +- 69.2 of WAPS) and female swimmers (18.3 +- 3.1 years, 73.1 +- 7.3 Kg of body mass,179.2 +- 5.5 cm of height, 181.6 +- 5.7 cm of arm span and 525.7 +- 112.4 of WAPS) performed three all-out 25 m butterfly trials with a push-off start and a 10-min recovery interval. The fastest trial and the average of the three-stroke

cycles were analyzed. The mechanical device (SpeedRT, ApLab, Rome, Italy) was used to measure velocity, with a string attached to the swimmer's waist. A GoPro Hero 7 (San Mateo, CA, USA) filmed the swimmers in the sagittal plane to identify hand entry and exit from the water.

RESULTS: Male swimmers were significantly faster than female swimmers throughout the entire stroke cycle. SPM revealed significant differences ($t = 3.456$, $p < 0.001$) between the sexes, throughout the entire stroke cycle.

CONCLUSION: SPM analysis revealed significant sex differences throughout the entire stroke cycle in butterfly swimming, which traditional methods might miss. This continuous approach offers deeper insights into biomechanical variations, aiding in optimizing training and performance in competitive swimming.

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## Conventional Print Poster Presentations

### CP-BM09 Upper Limb Biomechanics

**TECHNICAL, ANTHROPOMETRIC AND NEUROMUSCULAR ASSOCIATIONS WITH BALL RELEASE SPEED IN ELITE AND EMERGING FEMALE CRICKET FAST-BOWLERS**

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INTRODUCTION: Fast bowlers play a critical role in cricket, with effective bowlers greatly contributing to team success. The rapid growth of women's cricket means that research into performance is in its infancy however the available information suggests there may be anthropometrical, neuromuscular or technical differences between sexes. Using an exploratory research design this study explored these factors with respect to ball release speed in elite and emerging female fast-bowlers.

METHODS: 3D motion analysis and ground reaction force assessment quantified the bowling action and ball release speed of 34 elite and pathways female fast-bowlers (17.6 ± 3.5 years). Anthropometry measures of height, mass, leg length and bowling arm length were assessed, as were neuromuscular measures of 20m sprint, countermovement jump (CMJ), isometric mid-thigh pull (IMTP) and unilateral sub-maximal stiffness. Correlation analyses were undertaken to identify associations between ball release speed and the measured variables.

RESULTS: Ball release speed exhibited associations with anthropometrical measures of stature (r=0.529), body mass (r=0.469) and mean leg length (r=0.576). Ball release speed was associated with front leg knee flexion at front foot contact (FFC) (r=-0.350) and horizontal and resultant ground reaction force at FFC (r=-0.511, r=0.687 respectively). Neuromuscular measures of CMJ power (r=0.443), IMTP peak (r=0.518) and net force (r=0.491), front (r=0.342) and back leg absolute stiffness (r=0.397), and back leg relative stiffness (r=0.397) all revealed associations with ball release speed.

CONCLUSION: The associations between ball release speed and strong, powerful and long legs may inform the methodologies of future studies. The current cohort revealed relationships between ball release speed and certain biomechanical measures at FFC, whereby less front knee flexion, higher levels of braking force and higher overall ground reaction force at FFC were associated with faster bowling speeds. Future research could focus on FFC during bowling given it's apparent relevance. The general lack of associations between ball release speed and kinematic and kinetic factors at other parts of the bowling action may be due to the wide age range and physical maturation of the participants. Alternatively, data from discrete timepoints may not reflect the individualised nature of cricket bowling technique and there may be scope for other types of analysis such as functional data analysis to examine the entire action. The current findings provide insights into new relationships with ball release speed in female fast-bowlers that require validation by future confirmatory research.

**KINEMATIC ANALYSES OF FASTPITCH SOFTBALL PITCHES**

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INTRODUCTION: Fastballs(FB) and changeups(CU) are fastpitch softball's most commonly used pitch types. Studies have shown that the speed range for FB is 85-95 km/h and 60-75 km/h for CU. CU typically has greater torso flexion and lateral flexion at ball release, while FB relies more on the linear movement of the torso to increase ball speed [1]. The individual differences between pitchers can often be observed by examining the changes in the kinematics of the limbs over the

pitching movement. This study examined the 3-D kinematic parameters of fastpitch softball pitchers throwing fastballs and changeups to provide recommendations for individually targeted training strategies.

METHODS: 4 collegiate division I womens softball pitchers threw 10 FB and CU each. The pitch speed was recorded with a speed gun. 5 strikes of each pitch type were selected for analysis. 2 high-speed cameras and Simi Motion software captured the 3-D kinematics of the pitchers head, wrist, elbow, shoulder, hip, knee, and ankle on the throwing side from the stride foot off the ground to the ball leaving the hand. A camera behind the net captured the ball's position as it passed the home plate, which is used as the basis for determining a strike. The independent sample t-test was used for each pitcher between the 2 pitch types; a significant level was set at a=.05.

RESULTS: The results of the independent sample t-test of the 4 pitchers were all significant (ps<.05), but only 2 reached 85 km/h ball speed in FB. For the kinematics, the maximum absolute velocity of the hips of all but one qualified FB pitcher was significantly different between the 2 pitch types (ps<.05). The exception pitcher, however, found a significant difference in changes in elbow joint angles between pitch types (p<.05) and no other pitchers did. In addition, the absolute speed of the wrist at the time of the ball release was significantly different between the pitch types (ps<.05) except for one pitcher of FB speed under 85 km/h.

CONCLUSION: The association between absolute hip velocity and pitch speed in most pitchers supports the relation between the FB and the linear movement of the torso. 2 pitchers did not reach 80 km/h in FB pitches. Post-hoc examination indicated that a lower absolute hip velocity may have contributed to the low pitch speed. One pitcher who met the FB standard did not differentiate in absolute hip velocity between pitch types but was the only one with a difference in the amount of elbow angle change between pitch types. Although the upper limbs' movement may also generate faster pitch speed, the smaller mass of the upper limbs is prone to injury. Strengthening torso acceleration should be a primary way to improve pitch speed. The analysis of the kinematics of pitcher movement is an important basis for coach-player training programs, and future research should consider the stability of pitching for different pitching types.

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**BIOMECHANICAL ANALYSIS OF SHOTPUT PERFORMANCE IN ELITE PARALYMPIC ATHLETES**

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INTRODUCTION: This study aims to correlate biomechanical implement release variables with implement distance (performance) in elite Paralympic shot put.

METHODS: Six athletes (A1–A6) from different functional classes (F11, F12, F42, F57, F55) participated in the research conducted at the Paralympic Center in São Paulo in preparation for the Paris 2024 Games. A total of 36 throws were analyzed using data captured by two synchronized SONY FDR-AX40 cameras (120 Hz), the 3D data was obtained through standard calibration and reconstruction methods. The analyzed variables included the release angle in the XZ and XY planes (RAxz; RAxy), release height (RH), distance from the sector limit (DSL), scalar velocity (SV), and its components (Vx, Vy, Vz).

RESULTS: Results show significant differences across functional classes, for standing athletes (F11, F12, F42), phase times from T1 to T5 were also analyzed. Spearmans correlation analysis revealed distinct patterns for each athlete. For A1, a moderate positive correlation was found between distance from the sector limit (DSL) and throw distance (TD) (r=0.522; p=0.288), and between scalar velocity (SV) and TD (r=0.829; p=0.058). The T3-T4 phase showed a positive correlation (r=0.478; p=0.338), while the T4-T5 phase showed a negative correlation (r=-0.432; p=0.392). For A2, there was a strong positive correlation between release height (RH) and TD (r=0.696; p=0.125) and between SV and TD (r=0.771; p=0.103). The T2-T3 phase had the highest correlation with TD (r=0.794; p=0.059). For A3, the relationship between SV and TD was statistically significant (r=0.812; p=0.0499), while DSL had a strong negative correlation (r=-0.754; p=0.084). For seated athletes (F57, F55), A4 showed a strong positive correlation between TD and DSL (r=0.794; p=0.059) and between RH and TD (r=0.627; p=0.183), while SV had a moderate positive correlation (r=0.464; p=0.354). In A5, the release angle (RAxz) had a strong negative correlation with TD (r=-0.829; p=0.058), suggesting that higher angles may reduce distance. SV had a moderate positive correlation (r=0.580; p=0.228), while RH had a negative correlation (r=-0.609; p=0.200). For A6, RH had a significant negative correlation with TD (r=-0.956; p=0.0029), while DSL had a strong positive correlation (r=0.779; p=0.068) and SV a moderate negative correlation (r=-0.725; p=0.103).

CONCLUSION: The correlations between variables and distance highlight the complex interplay of factors influencing performance in Paralympic shot put. The findings indicate that different variables influence throwing distance (TD) depending on the athlete and their technique, suggesting the need for individualized adjustments to maximize performance in Paralympic shot put.

**KINETIC AND KINEMATIC ANALYSIS OF TENNIS SERVE: INFLUENCE OF LOWER LIMB STRENGTH ON SERVE VELOCITY**

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INTRODUCTION: The tennis serve is a complex motor action requiring precise coordination of various body segments. Effective force transmission from the ground to the ball is essential for maximizing serve performance. Lower limb strength may be a critical factor influencing serve speed. This study investigates the effects of countermovement jump performance and isokinetic knee strength on serve speed in elite tennis players.

METHODS: Thirteen elite-level competitive tennis players voluntarily participated in the study. The data collection process was completed in two phases. In the first phase, the athletes lower limb strength and power profiles were analyzed by assessing their isokinetic knee flexion (FLX) and extension (EXT) strength, along with their countermovement jump performance. In the second phase, their serve speeds were measured. Serve speed assessments were conducted using the flat serve technique, and athletes were instructed to exert maximal effort during each trial. If a serve was unsuccessful, it was repeated; however, participants were required to execute the serve in a first-serve manner (high-speed execution). Serve speed was measured using a handheld radar device (Bushnell 101911, USA). Countermovement jump performance was evaluated with an electronic jumping mat (Microgate Witty, USA). Isokinetic knee strength measurements were performed concentrically at angular velocities of 60°/s, 180°/s, and 240°/s using a Humac NORM isokinetic dynamometer (CSMI, Stoughton, MA).

RESULTS: The analysis revealed a highly significant relationship between serve speed and countermovement jump performance ($r=0.745$, $p<0.01$). Additionally, serve speed exhibited moderate to strong correlations with peak knee FLX torque at various angular velocities: at 60°/s in the non-dominant limb ($r=0.652$, $p<0.05$), at 180°/s in both the dominant and non-dominant limbs ($r=0.597$; $r=0.582$, $p<0.05$), and at 240°/s in the dominant ($r=0.712$, $p < 0.01$) and non-dominant ($r=0.670$, $p<0.05$) limbs. The relationships between serve speed and other isokinetic torques were not significant ($p>0.05$).

CONCLUSION: Lower limb strength plays a crucial role in generating higher serve speeds in tennis. The results of this study demonstrate that torque production at higher angular velocities exhibits a stronger relationship with serve speed, suggesting that the ability to generate rapid force in the lower limbs contributes significantly to serve performance. This finding underscores the importance of not only maximal strength but also the rate of force development in optimizing tennis serve mechanics.

Given these results, training interventions that emphasize explosive power development may be particularly beneficial for tennis players. Incorporating plyometric exercises alongside submaximal resistance training with lighter loads performed at high velocity could enhance both lower limb strength and neuromuscular efficiency. Such training strategies may improve the rapid force application needed for an effective and high-speed serve.

**EXPLORATION OF ANTAGONISTIC RELATIONSHIP BETWEEN BARBELL HIGH-HANG MUSCLE SNATCH AND KIPPING BAR MUSCLE-UP BASED ON MACHINE LEARNING ALGORITHMS**

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INTRODUCTION: The kipping bar muscle-up constitutes a multifaceted, multi-joint maneuver that significantly augments upper-body explosiveness and neuromuscular synergy, yet demands intricately honed technique and entails notable injury risks. To elevate acquisition efficacy without escalating training volume, a posture-oriented approach designates the high-hang power snatch as a plausible antagonist. By analyzing biomechanical trajectories via machine learning, this study seeks to quantify their antagonistic nexus and refine training methodologies.

METHODS: Eight males (21.2±1.2 yrs, 175.6±2.2 cm, 70.3±6.6 kg), able to perform ≥5 kipping bar muscle-ups and a ≥60 kg snatch 1RM, participated. Over six test days, bar muscle-ups or snatches (20–60 kg) were alternated in five sets of three reps, with two-day intervals. Warm-up involved brief cycling and stretching; main tests used five sets×3 reps and three-minute rests. Xsens and Gymaware captured displacement, velocity, angles, force, power, and work. Paired t-tests (Jamovi, $\alpha=0.05$) compared temporal and kinematic data, while SPM1D analyzed time-series. DTW examined reversed snatch data for antagonistic joint motion; Python scripts executed SPM1D and DTW.

RESULTS: Barbell displacement during snatches markedly surpassed body COM displacement in kipping muscle-ups ($p<0.001$), with no significant difference in total movement time ($p>0.05$). Although the 20 kg snatch required less time than muscle-ups ($p<0.05$), peak power and relative force showed no significant discrepancy ($p>0.05$). Notably, the 40 kg snatch produced the highest velocity (3.05±0.08 m/s), power (3201.03±1061.52 J/s), and relative force (14.84±2.86 N/kg), closely paralleling muscle-ups. While muscle-ups had the largest shoulder range (e.g., frontal plane 26.53±3.59°–122.25±0.94°), the 60 kg snatch exceeded other loads (16.63±1.14°–140.51±3.97°). Elbow motion at 40 kg most resembled muscle-ups. SPM1D revealed minimal time-series discrepancies in velocity and power. DTW analysis indicated a 63.18% reduction in distance for the 30 kg snatch upon sequence reversal, underscoring reversed kinematic patterns that better align with the muscle-up profile.

CONCLUSION: The results revealed that the barbell high-hang power snatch exhibits an antagonistic relationship with the kipping bar muscle-up in specific degrees of freedom—namely shoulder abduction-adduction, rotation, flexion-extension, and elbow rotation. Notably, a 40 kg snatch (61.5% 1RM) produced the highest peak velocity, peak power, and relative force, closely approximating the muscle-up profile. By contrast, 20 kg and 30 kg snatches (30.8% and 46.2% 1RM) demonstrated the strongest antagonistic joint kinematics per DTW analysis, suggesting lighter loads may be preferable for

technique training or injury prevention. Overall, to boost explosive strength, loads near 60% 1RM are advisable; while to refine muscle-up technique or accommodate joint limitations, lighter loads constitute a safer, more effective antagonistic alternative.

**AN INVESTIGATION OF UPPER LIMB ELECTROMYOGRAPHIC PERFORMANCE IN BACKHAND DRIVES AMONG MALE BADMINTON PLAYERS OF DIFFERENT SKILL LEVELS**

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INTRODUCTION: The backhand drive is a crucial mid-court technique in badminton, playing a key role in matches. The core of this technique lies in accurately and consistently returning the shuttle to the opponent's court while maintaining a degree of control over the match's tempo. By precisely managing the shuttle's trajectory, height, and speed, players can strategically time their returns to disrupt the opponent's attack and reestablish their own rhythm. Compared to other strokes such as serves and smashes, biomechanical research on the backhand stroke in badminton remains relatively limited, as most previous studies have primarily focused on other aspects of the match. This study is to compare the racket head speed and upper limb muscle activation in backhand drive technique among male badminton players of different skill levels.

METHODS: Twenty-four male badminton players, divided into twelve from the elite group and twelve from the sub-elite group. All participants were right-handed, there were no upper limb muscle, skeletal, or nerve injuries in the past six months. Surface electromyography (sEMG) was used to collect activation characteristics of nine muscle groups on the right side (first dorsal interosseous, thenar eminence, extensor carpi ulnaris, flexor carpi ulnaris, biceps brachii, triceps brachii, anterior deltoid, posterior deltoid, and pectoralis major) at a sampling frequency of 2000 Hz. A 3D motion analysis system, sampling at 250 Hz, was synchronized for motion segmentation. The Shapiro-Wilk test was used to determine the normality distribution. For normally distributed data, independent sample t-tests were used; for non-normally distributed data, the Mann-Whitney U test was applied. Statistical significance was set at $\alpha = .05$.

RESULTS: The racket head speed during the impact moment showed no significant difference between groups. Analysis of the percentage of upper limb muscle activation in different phases revealed that during the backswing phase, the peak and mean electromyographic activation levels of the biceps brachii and pectoralis major were significantly lower in the elite group compared to the recreational group ($p < .05$), while no significant differences were observed in the other muscle groups.

CONCLUSION: Elite players exhibit lower activation of the biceps brachii and posterior deltoid muscles during the backswing phase, allowing for a controlled utilization of antagonist muscles and resulting in a smoother and more precise stroke execution. Coaches are advised to closely observe the activation patterns of the shoulder and elbow muscle groups while emphasizing wrist and finger stability to further enhance the effectiveness of return strokes.

**IMPACT OF MOVEMENT DURATION ON TENNIS FOREHAND PRECISION: A KINEMATIC PERSPECTIVE.**

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INTRODUCTION: In sports like tennis, an athlete's technique is a key factor in determining their success. To improve technical skills, it is essential to understand the biomechanical characteristics of each movement in the sport. In tennis, the forehand is the most commonly used groundstroke during a match (1). This study aimed to analyze the relationship between the duration of the forehand stroke and shot precision.

METHODS: Sixteen skilled tennis players of both sex (11 males, 5 females; age: 14.88 ± 2.06 years, height: 1.71 ± 0.10 m, weight: 59.13 ± 11.59 kg, Italian National Class: 3.11 ± 0.43) were evaluated before and after six weeks of routine training during a non-competitive phase. The test involved performing 15 forehands with maximal acceleration from a standing position. Each forehand was video recorded for subsequent analysis of movement duration using Kinovea software, and precision was recorded by marking whether the ball landed in or out of the court. Total movement duration was divided into two phases for analysis: the backswing to impact (initial phase) and the impact to follow-through (final phase).

RESULTS: The results indicate a significant reduction in total movement duration (PRE: 814.69 ± 67.68 ms; POST: 715.59 ± 42.97 ms; $t(15) = 6.641$, $p < 0.001$, Cohens $d = 1.66$), suggesting improved efficiency. However, no significant differences were observed in precision (PRE: 9.13 ± 2.19 balls in; POST: 10.00 ± 2.66 balls in: $t(15) = -1.431$, $p = 0.173$). A significant negative correlation was found between precision and the final phase of the movement ($r = –0.40$, $p = 0.023$), highlighting the importance of efficient technique in improving shot precision. Additionally, a linear regression model including the initial and final phases as predictors showed that the latter significantly explains the variability in precision ($\beta = -0.027$, $p = 0.025$). Nevertheless, the model accounts for only 19.6% of this variability ($R^2 = 0.196$), indicating that other factors also play a significant role.

CONCLUSION: These findings suggest that optimizing specific phases of movement, particularly the second phase, may enhance tennis forehand performance. While improvements in movement duration were evident, their direct impact on shot precision remains influenced by other factors, such as technical and strategic adjustments. Further studies are recommended to explore these dynamics in detail.

**THE EFFECTS OF MOTOR IMAGERY TRAINING ON THE ACCURACY OF THE FOREHAND TENNIS PERFORMANCE**

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INTRODUCTION: Motor imagery (MI) is the mental rehearsal of a movement without any overt motor output. Scientific literature provided successful examples of the application of MI as tool for enhancing motor performance particularly in sports contexts. For instance, positive hints about the use of MI in sports came from studies on tennis serve performance (1,2). In tennis, together with tennis serve, another fundamental stroke that could benefit from MI training is the forehand. The aim of this study is to test whether MI can enhance the forehand performance accuracy of young tennis athletes when applied during corrective exercises for the forehand technique.

METHODS: Sixteen young tennis players (14.88±2.06 years, 11 males, 5 females) from the Italian national category (2.7 – 4.0) participated in a six-week training program (12 sessions). Eight of them were assigned to the motor imagery training group (MIT), where they practiced MI combined with two corrective exercises for the forehand technique. During training, they stood on the court in the loading position for the forehand and were instructed to kinesthetically imagine executing a forehand stroke before physically performing it with corrective exercises (6 reps x 2 exercises). The control group (CONTR, eight participants) performed only the corrective exercises without MI. Before and immediately after the training period, the stroke's performance was monitored using the Baseline Vision system in two tests: 20-forehand (starting from the loading position) and 5-minute (during which the highest number of forehands must be executed, thus inducing fatigability) tests. The percentage of balls within and outside the designated area in the opponent's field (BALLS IN, BALLS OUT) was monitored together with rate of perceived exertion, fatigability with a visual analogue scale and heart rate.

RESULTS: Statistical analysis in the 20-forehand test revealed that, from PRE to POST, the MIT group showed a significant decrease in BALLS OUT compared to the CONTR group (p=0.03). Additionally, in POST, BALLS IN and BALL OUT of MIT were significantly higher and lower, respectively, than those of CONTR (p=0.015). In the final minute of the 5-minute test, BALLS IN was significantly higher in the MIT group than in the CONTR group (p=0.01), while BALLS OUT was significantly lower (p=0.01).

CONCLUSION: This study suggests that incorporating kinesthetic MI into corrective exercises for forehand training in young tennis players enhances accuracy in both training-like and match-like conditions, suggesting coaches to include it in the athletes' training routine.

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**KINEMATIC DIFFERENCES BETWEEN THREE FOREHAND OPEN-STANCE STROKE TRAJECTORIES IN TENNIS**

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INTRODUCTION: This study applied kinematic principles to investigate the movement characteristics of body joints in tennis players during forehand shots with different trajectories.

METHODS: Ten male tennis players with an ITF level of 4 or higher, all right-handed and employing an open stance technique for forehand shots, were recruited. The study selected three forehand shot trajectories: baseline straight, baseline diagonal, and midcourt diagonal. For each trajectory, 50 balls were grouped into one set. Only shots landing within the target area were deemed valid, and data from at least 20 successful in-zone shots per set were recorded and collected. Two high-definition cameras captured three-dimensional (3D) video of the forehand motions. The Fastmove-3D AI motion capture system extracted and synthesized the X, Y, Z coordinates of five right-side joints (elbow, shoulder, hip, knee, ankle). A Butterworth low-pass filter was applied to the 3D coordinates of the markers. Kinematic parameters were calculated, and the forehand motion was divided into four key frames: A. body rotation, B. backswing, C. ball impact, and D. follow-through. Repeated-measures ANOVA was used to analyze differences across shot types and subjects, focusing on resultant angles, angular velocities, and angular accelerations of the five joints ($P < 0.05$).

RESULTS: 1) For midcourt diagonal shots, the right elbow exhibited significantly higher resultant angles in key frames A and B compared to baseline diagonal and straight shots ($P < 0.05$). The right hip showed significantly higher resultant angular velocity in frame C and higher angular acceleration in frame D ($P < 0.05$).

2) Baseline straight shots demonstrated significantly greater angular velocity in the right elbow (frame B) and right shoulder/ankle (frame C) compared to other shot types ($P < 0.03$), while the right hip exhibited lower angular acceleration in frame C ($P < 0.05$).

CONCLUSION: 1) Midcourt diagonal shots demand faster hip rotation during impact to better wrap around the ball and prevent out-of-bounds trajectories.

2) Baseline straight shots require increased upper limb engagement (e.g., shoulder acceleration) to counteract incoming ball spin while maintaining hip stability.

3) The shoulder and elbow joints generate peak resultant angular velocities, accelerations, and angles during forehand strokes, rendering them high-risk injury zones.Coaches should develop targeted training programs to optimize joint force sequencing and improve kinematic patterns in tennis forehand techniques.

## Conventional Print Poster Presentations

### CP-BM11 Jumping and Squating II

**DIFFERENT PHYSICAL ACTIVITIES CAN INFLUENCE THE MECHANIC AND NEUROMUSCULAR BEHAVIOR DURING A REACTION TIME TASK: A PILOT STUDY**

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INTRODUCTION: A growing number of people prefer gym instead of sports practice. In the long term, the practice of activities in which there is a lack of a decision-making process associated with rapid whole-body movement could influence physical performance. The study aim was to investigate the differences in a time reaction task (TRT) between a sportive, a sedentary, and a gym user group.

METHODS: A total of 80 participants were recruited. Only 18 participants met the eligibility criteria and presented a complete EMG data set. The control group (CG) (3 females, 3 males, 24 ± 2.1 years, 171.5 ± 9.8 cm, 75.7 ± 19 kg) was composed of sedentary people. The sports group (SG) (6 men, 21.8 ± 2.3 years, 178.7 ± 5.2 cm, 73.1 ± 6.7 kg) was composed of people practicing soccer or basketball. The gym group (GG) (2 females, 4 males, 21.2 ± 1.5 years, 171 ± 6.9 cm, 67.5 ± 8.6 kg) was composed of gym users. For the SG and GG, the participants had to perform at least 360 min/week. All groups performed a TRT in which they had to react to a stimulus with a jump for 3 times. Was recorded the time between the stimulus and the jump. Furthermore, s-EMG was recorded for the tibialis anterior (TA) and gastrocnemius lateralis (GL) during the task. A maximal voluntary contraction was recorded before the time reaction task to normalize data (MVC%). Data were analyzed with the Friedman and the Durbin-Conover comparison to detect differences between the groups. The Spearman correlation analysis was used to detect the correlation between body fat percentage (%F) and the variables studied.

RESULTS: No significant statistical differences were detected between the CG (mean (m) 0.54±0.08 s), the SG (m 0.5±0.13 s) and the GG (m 0.56±0.08 s), and between the SG and GG. A significant difference was detected between the TA of the CG (m 3.93±1.61 MVC%) and the SG (m 1.43±0.13 MVC%) (p=0.004) and between the SG and the GG (m 2.08±0.6 MVC%) (p=0.034). No significant difference was detected between CG and GG, and among GL and CG (m 8.20±5.23 MVC%) and the SG (m 5.76±3.39 MVC%), between CG and GG (m 9.96±5.23 MVC%), and between SG and GG. After the correlation analysis, no significant difference was detected in most of the variables. Was found correlation between the % of activation of the TA and the %F, total (correlation coefficient (CC) 0.585; p=0.011), of the right (CC 0.622; p=0.006) and of the left leg (CC 0.621; p=0.006). This was also confirmed by the regression model built with % tibial activation as the dependent and total and limb fat as independent variables.

CONCLUSION: The results show a less active TA and GL for the SG but a better performance in the TRT. Was verified that practicing a sport increases the quality of neuromuscular action, suggesting sporting activity as a more effective tool for agility. These preliminary findings could be important as the current generation of gym-goers gets older, in some everyday tasks. Future studies should consider these findings in older adults from a retrospective point of view.

**THE EFFECTS OF LOADS AND FATIGUE LEVELS ON MUSCLE ACTIVATION AND GROUND REACTION FORCE DURING THE REAR-FOOT-ELEVATED SPLIT SQUAT**

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INTRODUCTION: The Rear-foot-elevated split squat (RFESS) is a typical unilateral exercise[1, 2]. Previous studies have shown that the RFESS not only equally improve strength levels but also have superior effects on enhancing change of direction and single-leg jumping performance compared to the back squat, [3-5]. Identifying the change of muscle activation and ground reaction force distribution is important in needs analysis of the RFESS, Knowledge of that can be used to guide the design of the resistance training program.However, there is currently a lack of research on the muscle activation and GRF of the RFESS under different loads and fatigue levels. Therefore, the purpose of this study is to explore the changes in muscle activation and GRF of RFESSs with the changes of loads and fatigue levels.

METHODS: 19 male college athletes (RFESS 1RM: left leg, 103.06±13.3 kg; right leg, 103.61±13.15 kg) attended five experimental sessions. During the session 1 and 2, anthropometric data (height, weight) were collected, and the participants were familiarized with the testing procedures. In the testing session 3 and 4, the 1RM of RFESS was tested, followed by randomized testing of 75% 1RM fatigue-to-failure and different loads (40%,50%,60%,70%,80%,90%1RM). surface electromyographic (EMG), kinetic and three-dimensional kinematic data were collected during the tests. Two-factor repeated measures ANOVA was used to determine differences of GRF, GRF ratio, and average surface electromyographic

(AEMG) % between different loads and fatigue level (initial, middle, and final stages of fatigue to failure set) on the lead and rear foot. The overall alpha level was set at $p \leq 0.05$.

RESULTS: The GRF (GRF) of the front leg during the RFESS significantly increased from 40% to 90% 1RM ($p = 0.001$) and was consistently higher than that of the back leg ($p = 0.001$). The AEMG% of the vastus lateralis of the front leg was the highest, followed by the vastus lateralis of the rear leg, gluteus maximus of the front leg, and biceps femoris of the front leg. the proportion of GRF on the rear leg decreased as the load increased. The ratio of GRF between the front and rear legs was approximately 8:2. As the fatigue level up, the AEMG% of the main muscles of both the front and rear legs showed no significant changes across the initial, middle, and final stages of fatigue to failure set ($p > 0.05$). the GRF of the front leg showed an increasing trend across the initial, middle, and final stages. The GRF in the initial stage was significantly lower than that in the middle stage ($p = 0.003$) and final stage ($p = 0.001$), while there was no significant difference between the middle and final stages ($p = 0.19$).

CONCLUSION: Muscle Activation and GRF are affected by loads and fatigue levels during the RFESS. The front leg is the main force contributor (80%), and the loads and fatigue level have little effect on the contribution of the front legs to the force during RFESS exercises.

**COMPARING LANDING STABILITY ACROSS DROP LANDINGS, DROP JUMPS, AND COUNTERMOVEMENT JUMPS**

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INTRODUCTION: Landing requires athletes to attenuate ground reaction forces in three planes while establishing postural stability. Various jump or landing tasks are employed to monitor performance and injury risks. These include the Drop Landings (DL); Drop Jumps (DJ) and Countermovement Jumps (CMJ). Moreover, landing stability can be quantified using Dynamic Postural Stability Indices (DPSI) and Time to Stabilisation (TTS). The study purpose was to evaluate the stability indices of landing phases across the various landing conditions.

METHODS: 20 female recreational athletes (age: 23.4 ± 2.87 years; mass: 62.85 ± 10.28 kg; height: 1.69 ±0.08 m) volunteered to complete 40cm DL, 40cm DJ and CMJ in a randomised order. All kinetics were recorded using two Bertec force plates at 1000Hz. Force tracings were analysed in MatLab, where stability metrics (APSI, MLSI, VSI, DPSI and TTS) were calculated. One-way ANOVA with appropriate post-hoc tests were conducted with significance at $p<0.05$.

RESULTS: Stability indices showed differences across all three landings and directional components ($p<0.001$). Higher APSI were recorded for DL (0.059 ± 0.013) compared to DJ (0.027 ± 0.025) and CMJ (0.019 ± 0.013) and a lower MLSI in DL (0.023 ± 0.01) compared to CMJ (0.032 ± 0.015). VSI and DPSI were the lowest in DL (0.265 ± 0.068; 0.273 ± 0.07) compared to DJ (0.578 ± 0.175; 0.564 ± 0.148) and CMJ (0.514 ± 0.136; 0.516 ± 0.136). Finally, no TTS differences were observed across the landings (DL: 1.50 ± 0.27s; DJ: 1.52 ± 0.35s; CMJ: 1.40 ± 0.28s).

CONCLUSION: Stability differences were noted across the various conditions, with the DL reporting the most differences with DJ and CMJ. It's apparent that DJ and CMJ are more dynamic movements and more variable in terms of joint movements (1). Furthermore, studies have shown that cognitive load can negatively impact knee joint stability during landing tasks (2), showing that dual-task conditions can significantly increase peak GRF. This may translate into the findings of the current study, where VSI and DPSI are significantly larger in DJ and CMJ compared to DL. Additionally, DJ and CMJ require more reactive landings compared to DL. APSI in DL may indicate a greater joint excursion as most of the force attenuation occurs in the AP and vertical planes. Specific to the vertical stability (VSI & DPSI) differences might be attributed to the landing heights, leading to greater joint flexion angles and higher GRF (3).

In conclusion, Landing stability may be determined by the dynamics of the jump or preceding events. Additionally, postural stability might be affected by the landing height and kinematic strategies used to attenuate force.

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**GROUND REACTION FORCE ASYMMETRIES AND PERFORMANCE DURING DIFFERENT VERTICAL JUMPS MODALITIES IN YOUNG RHYTHMIC GYMNASTS**

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INTRODUCTION: Rhythmic gymnastics (RG) is characterized by unilateral jump exercises that may accentuate dominance, determining asymmetries and increase injury risks. The purpose of this study was to investigate lower limb asymmetries by recording vertical ground-reaction force-time profiles during squat jump, counter movement jump, and drop jump in young RG athletes.

METHODS: Young rhythmic gymnasts (N=15; Age: 12.15±2.26 years; Stature: 148.89±14.31 cm; Body Mass: 39.02±12.26 kg; BMI: 17.11±2.65 Kg/m2), performed SJ, CMJ and DJ in a random order on a dual force platform that recorded the vGRF-time profile in the preferred or non-preferred limb. Three trials were conducted for each jump, and the jump with the highest flight time was selected for analysis. The values of the vGRF-time profiles in distinct jump phases for each leg were

retained for analysis: in the SJ, the highest vGRF values were analysed during the propulsion and landing phases; in the CMJ, the highest values were analysed during the counter movement, propulsion, and final landing; and in the DJ, the highest vGRF values were analysed during the braking, propulsion, and final landing phases. Other performance variables, such as flight time, jump height, and power propulsion, were also analysed.

RESULTS: The intra-class correlation coefficient (ICC) of the measurements ranged from 0.87 to 0.98 (95% confidence limit= 0.65-0.99). The flight time measured during the CMJ was significantly higher than that of DJ (451.21±27.62 vs. 410.07±35.29 ms; p<0.001) and SJ (451.21±27.6 vs. 419.1±26.57 ms; p<0.001). The jump height was higher in DJ than in SJ (22.65±4.61 vs. 21.55±2.67 cm; p<0.001) and in CMJ than in SJ (25.02±3.02 vs. 21.55±2.67 cm; p<0.01). Similarly, the power propulsion yielded higher values in DJ (2682.81±938.01 watt) and CMJ (2454.74±599.54 watt) when the values were compared to those of SJ (1988.48±479.35 watt) (p<0.01).

During the braking phase of DJ, the non-preferred limb displayed higher vGRF values compared to the preferred limb (delta=40%, p<0.01). In contrast, the preferred limb showed higher vGRF values than the non-preferred limb during the propulsion phase (delta=45%, p<0.05). During the SJ and CMJ, the differences between preferred and non-preferred limb did not show significant values in any phase of the jumps (delta ranged from 7 to 15%; p>0.05).

CONCLUSION: The observed asymmetries in the vGRF-time profile during DJ highlight the distinctive characteristics of RGs performance requirements. The neuromuscular patterns may be the result of the sustained similarity of training volume and task-specific to the technical demands in which rhythmic gymnasts are involved. Through compensative training protocols focused on the high-impact phases like DJ and landing, it may be possible to improve the long-term technical development of young gymnasts, optimize performance, and reduce injury risk.

**INFLUENCE OF TEACHING STRATEGIES ON BIOMECHANICAL CONTROL AND ATHLETIC PERFORMANCE IN ADOLESCENTS: COMPARISON OF INTERNAL AND EXTERNAL FOCUS**

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INTRODUCTION: Optimising motor learning and physical performance in adolescents is very important for the biomechanical learning of the sporting gesture. This study therefore examined the impact of two differential teaching strategies with respect to attentional focus: the first based on internal focus (FI), oriented towards the understanding of the causes of movement by the Sincrony methodology, the second with external focus (FE), focused on the visible effects of the athletic gesture. The aim was to identify which approach favours better motor control and long-term performance maintenance.

METHODS: 196 competitive adolescents (mean age: 15.2 ± 0.8 years) were recruited and randomly divided into two groups (FI and FE). Athletes participated in a standardised 8-week training programme focused on biomechanically relevant exercises, including vertical jumps (Squat Jump and Countermovement Jump) and flat bench presses protocolized by Sincrony methodology. Performance was measured with the ChronoJump Bosco system for explosive power and a digital dynamometer for maximum force in push-ups. Evaluations were conducted at three time points: baseline (T0), post-intervention (T1) and 12-week follow-up (T2).

RESULTS: Results showed significant improvements in jump height (+9.3% FI, +8.3% FE) and maximal strength (+14.6% FI, +13.8% FE) at T1 in both groups. However, the internal focus showed a greater ability to maintain improvements over time, with a minimal decrease in maximal strength at T2 (-1.1% FI vs. -2.2% FE). The FI approach favoured a more stable biomechanical control in static exercises such as the flat bench, highlighting a superior cognitive involvement in understanding the dynamics of the gesture.

CONCLUSION: The study emphasises the role of internal focus in improving movement biomechanics, in line with the Sincrony methodology, particularly in static exercises. This approach has been shown to promote more stable motor learning and greater persistence of improvements. The integration of specific biomechanical instructions may be an effective strategy to optimise athletic performance in young athletes. Future studies could further investigate the effectiveness of internal focus in complex, high-load biomechanical contexts.

**VARIABILITY OF MEAN PROPULSIVE VELOCITY IN BACK SQUAT DURING THE MENSTRUAL CYCLE IN FEMALE RUGBY PLAYERS: PRELIMINARY RESULTS**

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INTRODUCTION: The menstrual cycle (MC) is being studied as one of the possible causes of variation in sports performance in female athletes. Numerous variables are affected by it, both at a physiological (Kissow et al., Sports Medicine, 2022) and biomechanical level (Montalvo et al., Journal of athletic training, 2019). One of the theories related to this possible variation in performance is the cyclic fluctuation of female sex hormones, such as estrogens and progesterone (Draper et al., Scientific reports, 2018). The aim of this research is to determine whether the different phases of the menstrual cycle influence the mean-propulsive-velocity (MPV), and the power developed in the back squat exercise in female rugby players.

METHODS: Ten female rugby players (age: 25.3 ± 3.2 years; height: 167.3 ± 4.2 cm; weight: 68.0 ± 13.6 kg) performed a back squat test to measure, through a linear encoder, the MPV (m/s) in the three phases of the MC. It was considered the early follicular phase (days 1 to 8), late follicular phase (days 9 to 12) and luteal phase (days 14 to 28), estimated through

calendar and ovulation strips. An incremental power test (Maté-Muñoz et al., J Int Soc Sports Nutr, 2018) was performed in the first late follicular phase to ascertain the load at which the following speed tests would be conducted (i.e., maximal power developed). If the external load remains the same, an increase in MPV will mean an increase in sports performance in resistance training. Therefore, the measurement of this value can be significant for evaluating the athlete. Differences between the values of the three phases of the MC were analyzed using a repeated measures analysis of variance (ANOVA) via SPSS Statics. The statistical threshold was set at $p < 0.05$.

RESULTS: Statistically significant differences in MPV are observed between the early follicular phase (0.533 ± 0.031 m/s) and the late follicular phase (0.596 ± 0.040 m/s); ($p < 0.001$, [IC 95% -0.091, -0.035]) with a high effect size: $F(2) = 21.554$, $p < 0.001$, $d = 0.84$, $\beta\text{-}1 = 1$; calculated throw Cohen's d. Although the differences are significant, there is a large inter-subject variability.

Power and velocity have a directly proportional relationship, so the observed changes in MPV are also shown in power values. The difference in power (w) between late follicular phase and early follicular phase was 11%, while between the late follicular phase and luteal phase was 5.3%.

CONCLUSION: These preliminary data seem to indicate that MPV, related to sports performance, might be higher during the late follicular phase, just before ovulation, while the lowest data appear during the menstruation phase. Moreover, it would be relevant to include an objective MPV measure to control the athlete's performance during the sport season, and during the rehabilitation and return to play process.

**THE INFLUENCE OF EXTERNAL ATTENTIONAL FOCUS ON SINGLE-LEG DROP JUMP ASYMMETRY**

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INTRODUCTION: Inter-limb asymmetry (IA) refers to the differences between limbs in function or performance, which has implications for sports performance and injury risk. While some studies indicate that IA negatively affects activities like jumping and sprinting, findings remain mixed due to the task-specific nature of IA. External attentional focus (EAF) such as an overhead goal (OG), was shown to promote automatic motor control, significantly enhancing the vertical rebound jump performance. This study investigated the effects of OG on single-leg drop jump (SLDJ) asymmetry, aiming to determine if OG can reduce IA while maintaining consistency in the asymmetry direction.

METHODS: Sixteen recreational overhead sports athletes performed SLDJs from a 20cm-platform under non-overhead goal (NOG) and OG conditions as repeated measures. In the OG condition, the subjects were required to grasp the OG after the single-leg vertical rebound jump at the peak of jump height (JH) and land with the same instructed leg. Ground contact time (GCT), JH, and reactive strength index (RSI) were measured using the mobile device with the app My Jump2.

RESULTS: The results of the paired T-test revealed no significant difference ($p > 0.05$) between NOG and OG conditions in all measured metrics and no significant difference ($p > 0.05$) in the IA of SLDJ, with the magnitude of IA deemed small effect size. GCT asymmetry showed "substantial" agreement (Kappa = 0.63), while RSI and JH asymmetry showed "fair" agreement (Kappa = 0.25) between conditions.

CONCLUSION: The lack of significant differences may be due to task complexity, athletic level, and jumping capacity in relation to the nature of IA. Moreover, the specific requirement of the OG condition, where the arms are required to reach a fixed goal, limits the joint range of motion and restricts the coordination patterns of muscle synergies across one or more joints, which might affect the magnitudes of asymmetry. The following key messages should be considered for practitioners when evaluating IA with EAF. It is essential to exercise diligence in selecting tasks that align with the athletes sport-specific contexts and physical capabilities, as exercise demands beyond the athletes current level may obscure accurate performance metrics. This study suggests that adding an overhead target does not lead to a positive impact on SLDJ asymmetry.

**COMPARING THE LOWER LIMB JOINT KINETICS AND KINEMATICS BETWEEN SINGLE-LEG DROP LANDING AND DROP LANDING WITH 90-DEGREE ANTI-CLOCKWISE TURN**

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INTRODUCTION: Single-leg landing is highly demanding in both individual and team sports whereas, athletes may suffer from lower limb injuries such as knee pain and injuries when performing this motor skill improperly. When the single-leg hop and land is incorporated with an anti-clockwise turn during the flight phase, it may increase the demand on knee control in the frontal plane such as the hip abduction/adduction and knee valgus/varus position as it potentially increases the horizontal moment of inertial during landing.

METHODS: A total of 12 male healthy active individuals participated in the single-leg drop landing conditions (all performed 3 trials of the vertical drop landing (VDL) and drop-landing with a 90-degree anti-clockwise turn (90ACDL) with their dominant leg on a 30-cm platform). The joint kinetic such as the vertical ground reaction force (vGRF) was measured by the force plate (ATMI, sampling rate at 1000 Hz) meanwhile the joint angles including the knee flexion, hip adduction, and knee valgus (peak and mean during landing phase as well as the peak and mean values at the time point of highest vGRF value) were observed using the inertial measurement unit (IMU sensors, APDM Opal, sampling rate at 128 Hz).

RESULTS: Paired sample t-tests showed no significant difference (p>0.05) in the comparison of all metrics between the VDL and 90ACDL conditions. Only the peak knee valgus angles of the 90ACDL were apparently shown to be larger than the VDL with marginal significance (p=0.09) while the magnitude-based decision (MBD) showed a likely increase (standardized change in mean = 0.50) in the peak knee valgus angles.

CONCLUSION: Paired sample t-tests showed no significant difference (p>0.05) in the comparison of all metrics between the VDL and 90ACDL conditions. Only the peak knee valgus angles of the 90ACDL were apparently shown to be larger than the VDL with marginal significance (p=0.09) while the magnitude-based decision (MBD) showed a likely increase (standardized change in mean = 0.50) in the peak knee valgus angles.

**ARE WE THERE YET?: A SYSTEMATIC REVIEW AND META-ANALYSIS OF MARKERLESS MOTION CAPTURE FOR LOWER LIMB ASSESSMENT DURING JUMPING TASKS**

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INTRODUCTION: Accurate measurement of lower-limb biomechanics is crucial for rehabilitation monitoring, performance assessment, and return-to-sport decisions. Although marker-based motion capture and force plates are the accepted gold standards for kinematic and kinetic measurements, their cost, complexity, and laboratory requirements constrain widespread field-based use. Markerless motion capture (MMC) which uses computer vision and AI-driven pose estimation has the potential to deliver biomechanical insights in more accessible settings. This systematic review and meta-analysis evaluated the validity, reliability, and real-world applicability of MMC for assessing lower-limb kinematics, kinetics, and performance during jumping tasks.

METHODS: A systematic literature search of four databases (EBSCOhost, PubMed, Web of Science, Scopus) identified studies involving (1) jumping tasks, (2) MMC compared with marker-based or force-plate gold standards, (3) lower-limb kinematic/kinetic/performance measures, and (4) validity or reliability outcomes. The methodological quality of included studies was appraised using the COSMIN risk-of-bias checklist. A meta-analysis of root mean square error (RMSE) for key kinematic variables was conducted using a random-effects model.

RESULTS: Of 478 identified records, 12 met the inclusion criteria, and 6 contributed data to the meta-analysis. Overall methodological quality was rated "doubtful," indicating uncertainty regarding risk of bias. MMC performance varied across measurement planes, with sagittal plane measurements showing RMSE exceeding 5° at all lower limb joints. While some studies reported lower RMSE, wide Bland-Altman limits of agreement (>10°) and high minimal detectable change values raised concerns about detecting clinically meaningful changes. Frontal-plane kinematics showed better accuracy (RMSE ~5°), though discrete events remained variable. Kinetic validation studies were limited in number and scope, with mixed findings regarding force and joint moment accuracy. Jump height emerged as the most robust measure, showing minimal bias and higher reliability.

CONCLUSION: Markerless motion capture shows potential for field-based assessments, particularly for jump height measurements and frontal-plane movements, but current limitations in sagittal plane precision restrict its use in clinical decision-making. Performance notably varied with hardware configurations and processing methods, with higher accuracy often achieved through multiple cameras and specialised setups that may limit practical implementation. Future research requires standardised reporting of error metrics, systematic evaluation of minimum camera requirements, model training protocols, and environmental constraints to establish whether MMC can serve as a viable alternative to traditional laboratory methods.

## Conventional Print Poster Presentations

### CP-BM15 Fatigue

**EFFECTS OF EXPERIMENTALLY INDUCED FATIGUE ON MOTOR LEARNING: A SCOPING REVIEW**

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INTRODUCTION: The literature on the effect of fatigue on motor learning is limited and marked by inconsistent findings, likely due to significant variability in methodologies. This scoping review aimed to explore the available knowledge on the effects of fatigue induced by physical and mental exertion on motor learning. Specifically, this review sought to investigate: 1) how fatigue and motor learning were defined, 2) the methods used to induce and quantify fatigue, 3) the methods used to assess motor learning, and 4) the target populations that have been investigated.

METHODS: A pre-registered comprehensive search was conducted in 8 databases. The included studies had to apply a fatiguing protocol performed during the same session as the motor learning task and include at least one criterion to verify the successful fatigue induction. Studies were included if they involved practicing a motor learning task. All types of

fully published peer-reviewed articles and gray literature were eligible for inclusion. The language was restricted to English and French.

RESULTS: The initial database search returned 1887 references, of which 36 full texts met the inclusion criteria. An additional article was identified through forward citation searching. In total, 21 sources were included: 19 primary sources and 2 secondary sources (1 MSc thesis and 1 book chapter). Results from the 19 primary sources revealed that only 1 study included definitions for both fatigue and motor learning. Fatigue induced by physical exertion was the most frequently used method across studies, accounting for 84% of cases. Fatigue induced by mental exertion was employed in only 16% of the studies. No study employed a combined mental and physical exertion method to induce fatigue. Motor acuity was the most frequently used paradigm to infer motor learning, accounting for 53% of the studies. Adaptation and sequence learning paradigms accounted for 26% and 21% of the studies, respectively. No association paradigm was employed to infer motor learning. All participants were aged 19-31 years old. Of all the studies, 47% reported participants sex and 42% reported participants' gender. None of the studies included information about participants ethnicity.

CONCLUSION: This review underscores the critical need for clear, operational definitions of both fatigue and motor learning to enhance measurement consistency and reproducibility. Given the limited research on the effects of fatigue induced by mental and combined exertion, future studies should prioritize using these types of experimental manipulations to induce fatigue. Additionally, exploring adaptation, sequence learning, and association paradigms could provide deeper insights into how fatigue influences motor learning. Future studies should expand their participant pools to include middle-aged and older adults as well. Moreover, reporting key participant characteristics such as sex, gender, and ethnicity should be prioritized.

**SIMULTANEOUS TRANSDERMAL APPLICATION OF CARBON DIOXIDE AND MENTHOL ACUTELY RESTORES LEG MUSCLE FUNCTION IMPAIRED BY PROLONGED STANDING**

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INTRODUCTION: Prolonged standing can cause neuromuscular fatigue, tissue swelling, and subjective fatigue in the legs (1). However, few studies have investigated recovery strategies for these symptoms. Carbon dioxide (2) and menthol (3) have been shown to improve peripheral circulation when applied transdermally and may serve as promising treatments for fatigue and swelling. We thus aimed to determine individual and combined effects of carbon dioxide and menthol on the recovery from prolonged standing.

METHODS: Thirteen healthy adults (7 men and 6 women) participated in this study. The participants first underwent 70 minutes of quiet standing and then rested in a seated position for 30 minutes with a gel sheet (12.5 x 8.5 cm) applied to the posterior aspect of both lower legs. Four types of gel sheets were tested in a randomized order on separate days: placebo (P), carbon dioxide (C), menthol (M), and a combination of carbon dioxide and menthol (CM). Ankle dynamometry combined with tibial nerve stimulation, surface electromyography, near-infrared spectroscopy, bioelectrical impedance analysis, and ultrasonography were used to comprehensively evaluate neuromuscular function and morphology in the lower leg before and after standing and after recovery. Subjective fatigue was assessed using a visual analog scale. One-way ANOVA was performed to test whether changes in each variable differed between conditions. A generalized linear mixed model was used to examine how the change in subjective fatigue was related to those in selected physiological variables.

RESULTS: No significant differences between gel sheets were observed for changes in heart rate, lower leg skin temperature, volume, extracellular water ratio, electromyographic activity of soleus (Sol) and medial gastrocnemius (MG) during maximum voluntary contraction, or subjective fatigue. CM more effectively reduced electromechanical delay, deoxygenated hemoglobin, circumference, and muscle hardness than did P, while increasing twitch force, maximum isometric torque production, voluntary activation, rate of torque development, and Sol and MG activity at 0-200 ms ($p < 0.05$, Tukey HSD test). C more effectively reduced muscle hardness and increased MG activity than P. M had no significant effect compared with P. The recovery of subjective fatigue was linked to the recovery of lower leg circumference, rate of torque development, and Sol activity.

CONCLUSION: Our results provide the first evidence that compared with the individual application, the simultaneous application of carbon dioxide and menthol markedly restores leg muscle function impaired by prolonged standing. The recovery of subjective fatigue was apparent even with the placebo application but may be partly attributed to improvements in peripheral circulation and neuromuscular function.

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**MECHANICAL PERFORMANCE IN LEG PRESS EXERCISE AND GLYCOLYTIC INVOLVEMENT DURING RESISTANCE TRAINING PROGRAMMES DIFFERING IN SET CONFIGURATION: INSIGHTS FROM THE CARE STUDY ON POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Resistance training is hardly recommended for postmenopausal women to counteract negative effects of hormonal changes (1). Furthermore, OMS guidelines include the recommendation of different levels of strength training depending on age. It has been demonstrated that set configuration can modulate velocity and power loss causing different levels of fatigue (2), but this topic has been mainly investigated in healthy and young people. The objective of this study was to compare de effects of set configuration on mechanical performance in leg press exercise of postmenopausal women.

METHODS: 50 physically active postmenopausal women participated in this study funded by the Spanish Ministry of Science, Innovation and University (PID2021-124277OB). After a medical exam and familiarization, women completed in a randomized order 3 experimental sessions differing in set configuration: 9 sets of 4 reps with 45s of inter-set rest; 6 sets of 6 reps with 72s of inter-set rest and 4 sets of 9 reps with 120s inter-set rest. They completed a total of 36 reps per exercise with 12RM load (i.e., leg press, bench press, prone leg curl and lat pull-down). Resting time between exercises was 4 min. Throughout leg press performance mechanical data (i.e. velocity and power loss) was collected. Blood lactate concentration samples (La) were obtained before and 1min after session. Explosive performance was also evaluated before and after each session by 2 reps at maximum intended velocity with 70% of 12RM in leg press exercise.

RESULTS: Regarding the percentage of velocity and power loss, a main effect of session ($p<0.001$) was found with significant greater losses in 6S and 9S compared with 4S for both variables. La after session was significantly higher than before for all sessions, with greater values in 9S compared to 6S and 4S (9S>6S>4S) ($p>0.001$). For neuromuscular test, main effect of session ($p=0.035$) and time ($p<0.001$) with no interaction ($p=0.266$) was found, suggesting the same velocity reductions in the explosive test for all set configurations.

CONCLUSION: Set configuration modulated the mechanical performance of postmenopausal women in leg press exercise in terms of mechanical performance. Short configurations (i.e.,4S) allow to reduce the loss of velocity and power in leg press during training sessions with low lactate values, which helps preserve movement quality and may increase exercise adherence by reducing the effects of delayed onset muscle soreness.

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**INFLUENCE OF MUSCLE-SPECIFIC DIFFERENCES IN THE NEUROMUSCULAR FATIGUE DEVELOPMENT AND LOSS OF TORQUE COMPLEXITY INDUCED BY SEVERE-INTENSITY EXERCISE**

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INTRODUCTION: The use of hand (Handgrip, HG) and leg (Knee-extensors, KE) muscles for tasks such as holding or handling objects and walking or standing, respectively, needs distinct motor coordination tasks [1]. These functional tasks performed by both muscles are linked to different morphological and physiological characteristics, including muscle size, fiber type proportions, recruitment strategies, and perfusion capacity, which can affect torque production, neuromuscular fatigue (NMF), and exercise tolerance (TLIM) [2-4]. This study investigated the effects of a high-intensity exercise until task failure on NMF and torque complexity in HG and KE muscles of untrained subjects.

METHODS: 11 Untrained males (23 ± 4 years, 76 ± 14 kg, 177 ± 6 cm) participated in this study. The following experimental procedures were carried out on different days: 1) Familiarization with HG and KE protocols; 2) 3-maximal voluntary contractions (MVC) to evaluate maximal torque production, and a 5-min all-out test (60 MVC of 3s/ 2s rest) to determine critical torque of HG and KE muscles; and 3) An intermittent constant-load test (3s effort/2s rest) at critical torque +15% until failure to assess NMF, torque complexity, and TLIM.

RESULTS: At baseline, KE muscles had greater MVC (KE 240 ± 58 N·m vs. HG 75 ±17 N·m, $p<0.001$), but lower voluntary activation (KE 81 ± 13% vs. HG 96 ± 4%, $p<0.001$) than HG muscles. Critical torque was not different between HG and KE muscles in relative terms (%MVC) ($p= 0.82$). Similarly, there were no differences in mean torque during constant load test, when normalized to MVC (KE 40 ± 9% vs. HG 40 ± 6%, $p= 1.00$) and as percentage above critical torque (KE 15 ± 3% vs. HG 15 ± 4%, $p= 0.85$). TLIM did not differ between KE and HG muscles (KE 413 ± 179 s vs. HG 319 ± 89 s, $p= 0.27$). KE muscles had a greater decrease on central (KE -15 ± 12% vs. HG 8 ± 5%, $p<0.001$) and peripheral fatigue (KE -64 ± 21% vs. HG -29 ± 14%, $p<0.001$) than HG muscles, but there were no differences in MVC (KE -40 ± 14% vs. HG -47 ± 10%, $p= 0.19$) loss. NMF reduced torque complexity in KE muscles (ApEn: 1.55 ± 0.09 to 1.25 ± 0.20, $p<0.001$; DFA-α: 1.40 ± 0.11 to 1.52 ± 0.06, $p<0.001$), while in HG, only DFA-α was affected (1.01 ± 0.16 to 1.24 ± 0.16, $p<0.001$).

CONCLUSION: When performing a similar task within the severe intensity domain, KE muscles experienced greater central and peripheral fatigue than HG muscles, despite their similar TLIM and MVC loss. Meanwhile, loss of torque complexity induced by NMF occurred in both muscles. These findings further highlight that factors such as muscle torque control may have contributed to the inability of the two muscles to sustain the task, thereby influencing their TLIM capacity.

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**THE EFFECTS OF THREE DAYS OF SLEEP RESTRICTION ON VIGILANCE, MANUAL DEXTERITY, AND HIGH-INTENSITY PHYSICAL PERFORMANCE IN RECREATIONAL ATHLETES**

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INTRODUCTION: Athletes and military personnel commonly experience consecutive days of sleep restriction (SR) due to their demanding schedules. Consecutive nights of SR impair daytime alertness (1), mood, and motivation (2), which is thought to reduce physical performance (3). However, the effects of cumulative SR on vigilance and physical performance have rarely been explored concurrently. This study investigated the effects of three consecutive nights of SR on vigilance, manual dexterity, and high-intensity physical performance.

METHODS: Fifteen recreational athletes (12 males, age 37 ± 4.5 y; 3 females, age 39 ± 8.7 y) completed a familiarisation (FAM) trial involving subjective rating scales, the Psychomotor Vigilance Task (PVT), the Perdue Peg Board Test (PPT), a high-intensity intermittent cycling (HIIC) protocol (5 x 10s sprints) and an isometric mid-thigh pull (IMTP). Each participant wore a wrist-worn accelerometer and completed a daily sleep diary throughout the study. The laboratory tests (from FAM) were repeated after three nights of normal sleep (CON) and three nights of SR in a counterbalanced sequence. SR involved participants delaying bedtime by two hours and waking at their usual time for three consecutive nights. Differences between conditions were assessed using paired t-tests and Wilcoxon signed-rank tests.

RESULTS: Sleep duration was reduced from 7.5 ± 0.6 h (CON) to 5.4 ± 0.64 h (SR) per night, resulting in an average sleep deficit of 6.3 ± 1.5 h across three nights ($p < 0.001$). Subjective sleep quality decreased by 12% between CON (7.2 ± 1.1) and SR (6.4 ± 1.8, $p = 0.04$). Sleep efficiency was unchanged between conditions. After SR, the rating of sleepiness ($p < 0.001$), fatigue ($p < 0.001$), and stress ($p = 0.02$) increased by 60%, 73% and 28%, respectively, and motivation to exercise decreased by 35% ($p < 0.001$). PVT median reaction time decreased by 3.6% ($p = 0.02$), and response speed increased by 2.6% ($p = 0.02$) compared to CON. No significant differences were observed for other PVT metrics between conditions. Performance in the manual dexterity tasks, IMTP peak force, and objective metrics measured during the HIIC remained unchanged between CON and SR. However, increased ratings of perceived exertion (2.1%, $p = 0.004$) and fatigue (10%, $p < 0.001$) were observed after SR.

CONCLUSION: Three consecutive nights of SR led to impaired reaction time, reduced motivation, and increased sleepiness, fatigue, and stress ratings. Although manual dexterity and indices of power and force during high-intensity physical tasks did not change after SR, subjective ratings of perceived exertion and fatigue increased. Individuals who regularly experience consecutive days of SR should seek evidence-based interventions, such as caffeine use and napping, to help mitigate the negative effects of SR on vigilance, motivation and perceived exertion.

**FORCE DECLINE RATE IS SEX-DEPENDENT AFTER NORMALIZATION FOR CSA IN ECCENTRIC RESISTANCE EXERCISE TO EXHAUSTION**

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INTRODUCTION: Eccentric exercise is known to induce a high incidence of neuromuscular fatigue during execution [1]. Recent studies suggest that knee extensor force generation is primarily dependent on muscle size rather than neural factors [2]. However, sex differences in response to eccentric resistance exercise remain unexplored. This study aims to investigate knee extensor force decline and rate of decline during an eccentric resistance exercise performed to volitional exhaustion and sex-related differences in fatigability.

METHODS: Nineteen physically active, healthy volunteers (9F/10M; age: 23.4 ± 4.0 years) performed repeated sets of 12 isotonic eccentric knee extensions at 100% of peak torque on the Kineo Multistation System (Globus Corp., Italy) until exhaustion. Quadriceps cross-sectional area (qCSA) was assessed via MRI scan at baseline; eccentric maximal voluntary contractions (eMVCs) and rate of perceived exertion (RPE) were recorded after each set.

RESULTS: Mean qCSA was significantly larger in males (90 ± 14 $cm^2$) than in females (60 ± 9 $cm^2$) ($p = 0.0002$). Similarly, baseline mean eMVC was higher in males (61 ± 17 kg) than in females (37 ± 6 kg) ($p = 0.002$). Males completed 93 ± 25 repetitions, while females completed 110 ± 24 ($p = 0.15$), with a mean %eMVC decline of 42 ± 14% in males and 41 ± 9% in females from start to end of the protocol ($p = 0.91$). The fatigability index, calculated as the change in eMVC from baseline to the end of exercise divided by repetitions, was 0.5 ± 0.6 in males and 0.2 ± 0.1 in females ($p = 0.11$). The force decline rate, assessed via one-phase decay analysis, was similar between sexes ($\tau$: males 12 ± 7, females 5 ± 4; $p = 0.06$). After normalizing for CSA, the fatigability index remained similar between sexes ($p = 0.30$), but the force decline rate differed significantly ($\tau$: males 12 ± 7, females 3 ± 2; $p = 0.018$).

CONCLUSION: Results suggest that while the percentage of force decline is not sex-dependent during eccentric resistance exercise to exhaustion, the rate of decline becomes sex-dependent after normalizing for muscle size (qCSA). Males expe-

rience a faster absolute force decline, likely due to their higher initial strength. However, after CSA normalization, their decline rate remains constant, indicating that fatigue resistance is influenced not only by muscle size but also by physiological and metabolic factors. In contrast, females exhibit a more rapid decline in force post-normalization.

Additionally, the fatigability index showed no significant sex differences in either absolute or normalized values. Further research is needed to explore the physiological mechanisms underlying sex-related differences in force decline rate during eccentric resistance exercise.

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**AGE-RELATED DIFFERENCES IN MAXIMAL STRENGTH AND MUSCLE FATIGUE: ASSOCIATION WITH MOTOR UNIT ACTIVATION PATTERN**

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INTRODUCTION: Differences in muscle strength and fatigue between children and adults are well documented, but the mechanisms explaining these differences are not understood. Beyond smaller muscles, differences in motor unit (MU) activation may also explain age-related differences in muscle performance. Studies of age-related differences in discrete MU activation are limited and inconsistent. Thus, the aim of this study was to investigate age-related differences in discrete MU recruitment patterns and firing rates (MUFRs) during maximal volitional isometric contractions (MVIC) of the knee extensors and during a fatiguing maximal contraction.

METHODS: Following a habituation session, MVIC was determined for 20 men (22±3yr) and 20 boys (10±1yr). Participants then completed a ramped MVIC at 33%/s, held for 20s. After a 30-min recovery, participants completed a 50s maximal contraction. sEMG from the vastus lateralis were recorded and decomposed into individual MU action potential trains (Trigno®, Galileo, Delsys Inc.). Recruitment thresholds (RT) and MUFRs were calculated for each MU. Boys-men differences in the MUFR-RT relationship during the ramped contraction were assessed using a linear mixed-effects model. A mixed-model ANOVA was used to assess group differences in MUFR during the fatiguing contraction.

RESULTS: MVIC relative to lean body mass was greater ($p<.001$) in men (4.3±0.9 Nm/kg) than in boys (2.6±0.7 Nm/kg). MUFR was lower in boys than in men in both the ramped MVIC and the fatiguing contraction (Age effects, $p<.01$). During the ramped MVIC the MUFR-RT slope was steeper in men than in boys (Age-RT interaction, $p=.005$). The initial RT at which MUs were identified were not different between groups ($p=0.2$); however, the maximum detected RTs were greater in men compared with boys (71±13 and 60±17 %MVC, respectively, $p=.03$). During the 50s fatigue contraction, torque decreased more in men (52±24%) than in boys (40±22%) but differences were not statistically significant ($p=.13$). Both groups experienced a significant decline in MUFRs over the course of the contraction ($p<.001$). Furthermore, there was a significant age-time interaction ($p < .001$), wherein MUFRs decreased linearly in boys and remained initially stable with a steep decrease in the last 20s in men.

CONCLUSION: Our results demonstrate that boys display lower MUFRs compared with men during maximal and fatiguing isometric tasks. In maximal contractions, boys' RT range appears smaller. Additionally, the pattern of decrease in MUFR during fatigue differs between boys and men. It is suggested that children have different neuromotor strategies to complete maximal and fatiguing tasks compared with adults and support the notion that children may have a lesser ability to activate their higher-threshold MUs. The findings provide further insight into the mechanisms underlying age-related differences in muscle performance, and neuromuscular control.

**UNDERSTANDING FATIGUE RESISTANCE: RELATIONS TO KEY PHYSIOLOGICAL LANDMARKS**

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INTRODUCTION: Fatigue resistance is a key determinant of endurance performance and is often considered its fourth dimension. It influences the ability of an athlete to sustain high-intensity efforts over prolonged durations. Understanding the mechanisms underlying fatigue resistance is essential for optimizing training strategies and improving competitive performance in endurance sports. Despite extensive research on endurance performance, the specific determinants of fatigue resistance and their interrelationships remain an area of ongoing investigation. This study aims to assess fatigue resistance in well-trained cyclists by comparing fresh and fatigued time-trial (TT) performance following a race simulation. Furthermore, the study also aimed to examine the association between fatigue resistance and physiological parameters.

METHODS: Seven well-trained male cyclists (body mass: 68.8 ± 4.0 kg; stature: 1.79 ± 0.04 m; maximal oxygen uptake [VO2max]: 69 ± 4 mL/min/kg; maximal minute power [MMP]: 6.05 ± 0.27 W/kg) completed a series of exercise tests. These included an initial graded exercise test to examine ventilatory threshold (VT) 1, VT2, MMP, VO2max, and a 5-min TT familiarization, and a baseline testing session comprising steady-state testing at VT1 to assess gross efficiency (GE) and oxygen uptake kinetics (i.e., time constant tau), a 5-s all-out sprint test, and a 5-min TT. During the third visit, participants performed a 1-hour race simulation (ca. 15 kJ/kg) followed by a 5-min TT under fatigued conditions. The race simulation featured a fast start and multiple high-intensity efforts mimicking a cycling road race. Fatigue resistance was evaluated as

the relative change in power output (PO) between fresh and fatigued 5-min TTs. Pearson's correlation was used to analyse relationships between fatigue resistance and physiological parameters, while a paired samples t-test assessed differences in 5-min TT PO.

RESULTS: Mean 5-min TT PO was 5.77 ± 0.34 W/kg and 5.29 ± 0.31 W/kg for fresh and fatigued conditions, respectively (P = 0.001), corresponding to a -8.3 ± 3.7% relative decline. This relative decline in 5-min TT PO was not significantly associated with relative PO associated with VT1 or VT2, relative MMP, relative VO2max, GE, tau, or relative 5-min TT PO under fresh conditions (0.088 < P < 0.995).

CONCLUSION: These findings suggest that fatigue resistance is not related to traditional physiological markers typically assessed during laboratory testing. As recently proposed, fatigue resistance should be considered a distinct fourth dimension of endurance performance and be tested separately. The decline in 5-min TT PO following a 15 kJ/kg trial does not appear to be predicted by commonly used physiological variables.

## Conventional Print Poster Presentations

### CP-MH11 Cardiovascular and Neurological Diseases

**ARTERIAL HYPERTENSION AND ITS DELETERIOUS EFFECTS ON CARDIOVASCULAR AUTONOMIC CONTROL BEFORE AND AFTER MENOPAUSE - THE ROLE OF AEROBIC PHYSICAL EXERCISE**

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INTRODUCTION: Systemic arterial hypertension (SAH) affects pre-and postmenopausal women, and cardiovascular autonomic impairments are often observed. While pharmacological treatment can reduce blood pressure, it does not seem to restore cardiovascular autonomic control fully. In contrast, aerobic physical training may be decisive in this process, but little is known about its effects in these conditions. This study aimed to investigate the effects of aerobic physical training on baroreflex sensitivity (BRS), autonomic modulation of heart rate (HRV), and blood pressure variability (BPV) in hypertensive women, both pre-and post-menopause.

METHODS: A non-randomized clinical trial in which hypertensive women (35–65 years) treated with renin-angiotensin system inhibitors (RASi) were allocated to two groups: premenopausal (N=49) and postmenopausal (N=55). Hemodynamic, metabolic, cardiorespiratory, and cardiovascular autonomic modulation (spectral analysis) parameters were assessed before and after 16 weeks of aerobic physical training.

RESULTS: Before aerobic physical training, the premenopausal group exhibited a higher BRS gain (9.0±4.8 vs. 5.6±3.0 ms/mmHg) than the postmenopausal group. HRV spectral analysis revealed that the premenopausal group had higher values of low-frequency (LF, 396±377 ms2 vs. 173±157 ms2) and high-frequency oscillations (HF, 593±683 ms2 vs. 142±139 ms2), and a predominance of vagal autonomic modulation (LF/HF, 0.94±0.64 vs. 1.42±0.69). The differences in BRS gain, LF, and HF between the two groups persisted after aerobic physical training. However, significant increases in HRV parameters were observed, particularly in the postmenopausal group, which began to exhibit vagal dominance in cardiac autonomic modulation (LF/HF 0.97±0.48). Additionally, a reduction in low-frequency BPV was observed in both groups.

CONCLUSION: SAH affects HRV, causing significant impairments in women, especially after menopause, even when the treatment with RASi is effective in reducing blood pressure values. Physical training is a fundamental therapeutic tool that counteracts cardiovascular autonomic impairments and increases cardiorespiratory fitness. However, its benefits in autonomic modulation of HRV and BRS were limited. The reason for this limitation is unknown and may involve adaptations induced by the genesis of hypertension in different autonomic regulation sites and adverse adaptations in the heart itself.

**ANAEROBIC THRESHOLD AS A PREDICTOR OF SURGICAL COMPLICATIONS IN ROBOT-ASSISTED SURGERY: A PILOT STUDY**

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INTRODUCTION: Cardiopulmonary fitness testing (CPET) is recognised as a clinical risk stratification tool. This pilot study examined the relationship between CPET variables and postoperative complications in robot-assisted surgery (RAS).

METHODS: Retrospective analysis was conducted on RAS patients (n=80). Anaerobic threshold (AT) (mL/min/kg), Peak $VO_2$ (Peak) (mL/min/kg), BMI, age, sex, and Clavien-Dindo (CD) classification were analysed. Linear regression assessed relationships between AT, Peak and complications. Groups were compared with the Mann-Whitney U test.

RESULTS: The regression model explained 53.9% of the variance in AT ($R^2 = 0.539$, $p < 0.001$). Complications were associated with a lower AT (β = -2.46, 95% CI: -4.18 to -0.74, p = 0.006, d = 0.41). CD classification was also significant (p < 0.001), with Class V patients recording lower AT (-11.49 mL/min/kg, 95% CI: -18.03 to -4.95, p < 0.001, d = 1.12). Small effects were detected in the Mann-Whitney U tests, but these were not significant: Peak was lower in the complication group (U = 634, p = 0.190, d = 0.20, 95% CI: -0.60 to 2.20). AT was also lower in the complication group, (U = 623, p = 0.226, d = 0.33, 95% CI: -0.40 to 1.90).

CONCLUSION: Although underpowered, this pilot suggests that lower AT is associated with the presence of complications following RAS and that patients with higher CD classifications were more likely to have a lower threshold. These findings support preoperative fitness assessment via CPET for risk stratification and care optimisation. Larger samples are required to confirm the findings.

**EFFECTS OF ACUTE AND REPEATED EXPOSURE TO WHOLE-BODY CRYOSTIMULATION ON CARDIOVASCULAR RESPONSES IN HEALTHY YOUNG MEN**

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INTRODUCTION: Whole-body cryostimulation (WBC), a non-pharmacological intervention, has been shown to improve cardiovascular and autonomic regulation. This study aimed to investigate the acute and repeated effects of WBC on baroreflex sensitivity (BRS), heart rate variability (HRV), and blood pressure in physically active men.

METHODS: Fifty male participants (22 ± 4 years) were randomly assigned to an experimental group (N=25) and a control group (N=25). Within each group, participants were further classified according to BMI categories (normal weight and overweight). The experimental group underwent 10 WBC sessions over two weeks, while cardiovascular responses were assessed before and after the 1st and the 10th session of WBC. Heart rate (HR), BRS, HRV, and blood pressure (SAP, DAP, MAP) were measured.

RESULTS: A significant reduction in blood pressure was observed after repeated WBC exposures, with systolic arterial pressure (SAP) and mean arterial pressure (MAP) decreasing by 7% (–8.6 mmHg for SAP and –6.3 mmHg for MAP) ($p < 0.05$). In addition, acute WBC exposure significantly increased BRS by 42% after the 1st WBC exposure and 44% after the 10th ($p < 0.001$). Similarly, R-R intervals increased by 11% and 16%, while RMSSD rose by 19% and 34% after the 1st and 10th exposures, respectively ($p < 0.001$). However, no long-term adaptation was observed in HR, HRV, or BRS. No significant differences were found between normal-weight and overweight participants.

CONCLUSION: Our findings demonstrate that WBC induces acute improvements in autonomic regulation, as evidenced by increased BRS and HRV, while significantly lowering systolic and mean arterial pressures at rest. The observed reduction in SAP and MAP suggests beneficial vascular adaptations, potentially mediated by improved endothelial function and enhanced parasympathetic activity. These results align with previous studies highlighting the positive effects of WBC on cardiovascular regulation, supporting its role as a promising non-pharmacological intervention for blood pressure management.

The acute increase in BRS and HRV following WBC exposure indicates a transient enhancement in autonomic balance, which could be beneficial for individuals at risk of hypertension or cardiovascular dysregulation. Although WBC provides acute benefits, no long-term autonomic adaptations were observed, indicating that regular exposure may be needed to sustain its effects. The mechanisms behind blood pressure reduction, such as vascular compliance, nitric oxide availability, or sympathetic regulation, require further investigation.

WBC shows promise as a non-pharmacological strategy for blood pressure control, but further research is needed to evaluate its long-term effects, clinical applicability, and interactions with lifestyle factors. Future studies should also investigate individual variability based on age, metabolism, and cardiovascular conditions to optimize its therapeutic potential.

**INTENSITY OF THE 6-MINUTE WALK TEST IN HEART FAILURE PATIENTS: INSIGHTS FROM CARDIOPULMONARY EXERCISE TESTING AND VENTILATORY THRESHOLDS**

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INTRODUCTION: The 6-minute walk test (6MWT) is widely used to assess functional capacity in individuals with heart failure (HF). However, its intensity compared to maximal cardiopulmonary exercise testing (CPET) remains controversial. The physiological threshold concept also requires the relative position intensity for proper exercise prescription. Identifying the intensity of the 6MWT in HF patients could enhance its utility for exercise prescription. This preliminary analysis explores the intensity of the 6MWT concerning physiological thresholds.

METHODS: A preliminary cohort from the CO-CREATION-HF study (33 individuals, 25M/8W, age 67.1±11.8, BMI 29.9±4.9, NYHA II-III) was assessed. The 6MWT recorded heart rate (HR), breathing rate (BR), and distance. The day after next, a 6-10W/min incremental ramp test (60 rpm, cycle ergometer) determined maximal HR, BR, and $VO_2$. Shapiro-Wilk normality tests, Pearson correlation, and one-way ANOVA analyzed relationships and differences in 6MWT distance, HRmax, and BRmax (95% significance) with respect to physiological thresholds from CPET.

RESULTS: During the 6MWT, HRmax expressed as a percentage of threshold values was 109.1% ±20.9 (VT1), 94.1% ±18.3 (VT2), and 79.43% ±13.0 ($VO_2$max). During the 6MWT, BRmax was 106.3% ±25.5 (VT1), 89.4% ±20.6 (VT2), and 69.1% ±18.4 ($VO_2$max). A significant correlation was found between 6MWT distance and $VO_2$max ($r=0.53$, $p=0.02$). Distance in the 6MWT correlated with %BRmax of 6MWT normalized to $VO_2$max BR ($r=-0.33$, $p=0.34$) but not with VT1 or VT2 BR. HRmax in the 6MWT was not significantly different from HR at VT1 or VT2 but was significantly lower than $VO_2$max HR. BR at VT2 and $VO_2$max significantly differed from 6MWT BRmax, whereas VT1 BR showed no difference.

CONCLUSION: The 6MWT intensity, based on HR, falls between VT1 and VT2 but is significantly lower than $VO_2$max HR. Regarding BR, the 6MWT BRmax is only comparable to VT1 and significantly lower than BR at VT2 and $VO_2$max.

There were no differences in the distance achieved and the intensity relative to physiological thresholds in the 6MWT. These findings suggest that the 6MWT intensity aligns more closely with VT1 in individuals with NYHA II-III HF, supporting its use as a moderate-intensity exercise prescription tool.

**IS PHYSICAL FITNESS LEVEL ASSOCIATED WITH HEART RATE RECOVERY IN THE GENERAL POPULATION?**

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INTRODUCTION: The relationship between heart rate recovery (HRR) and physical fitness has been previously studied in numerous studies [1-4]. However, a few studies have included a sufficiently large sample to determine whether a true association exists between these variables. Several studies have found a negative association between recovery time and physical fitness, examining different types of recovery [1]. Additionally, they suggested that measured HR recovery in beats per minute is not a reliable predictor of physical fitness [3, 4]. Therefore, our objective is to identify the variables most strongly associated with physical fitness within a heterogeneous sample.

METHODS: A total of 2815 participants (484 women and 2331 men; 36±10 yrs; 72.6±11 kg; 173.7±7.8 cm; maximum oxygen uptake (VO2max): 53.8±10.6 ml/kg/min) underwent a ramp incremental exercise test. The cycle ergometer protocol involved a 2-10 min warm-up at 20-100 W followed by an incremental phase starting at 20-110 W, with power output increasing by 12-25 W/min. The treadmill protocol involved a 3-min warm-up at 4-6 km/h followed by an incremental phase starting at 4-8 km/h, with speed increasing by 1-1.5 km/h/min. Maximum HR (HRmax) and VO2max were determined as the highest values averaged over 15 s intervals. Basal HR (HRrest) and HR at 2 min post-exhaustion (HR2min) were also recorded. The heart rate recovery index was calculated using Calderon´s equation: HRRI= (HRmax-HR2min)/(HRmax-HRrest).

RESULTS: A weak but significant correlation was observed between HRRI and VO2max, ($r=0.181$, $p<0.001$). In contrast, no association was observed between VO2max and the absolute HR reduction at 2 minutes post-exhaustion (HR2min-HRmax; $r=-0.005$, $p=0.778$). The obtained regression model indicates that percentage recovery by Calderon´s equation is significantly associated with age (standardized $B=0.05$, $p=0.049$), VO2max ($B=0.288$, $p<0.001$), sex ($B=-0.069$, $p=0.01$; 0 for female and 1 for male), and HRmax ($B=-0.147$, $p<0.001$). This model explains 6.0% of the variance ($R^2=0.060$) with a statistical error of mean (SEM= 9.7%).

CONCLUSION: HRR, when expressed as a cardiac reserve (HRRI), is significantly associated with physical fitness, while absolute HR reduction at 2 minutes post-exercise does not. Age and VO2max are positively associated with HRRI, while sex and HRmax exhibit a negative correlation. However, the low explained variance indicates that additional factors likely influence HRR.

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**AFFERENT PATHWAY TO THE BRAIN IN SPASTIC STROKE FEMALES**

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INTRODUCTION: Stroke occurs when a blood clot causes thrombosis, often resulting in blockage of the arterial vessels; or when a weakened vessel ruptures. In both cases blood flow is prevented from reaching some brain region. This interruption can lead to various brain tissue lesions, particularly in sensory areas, and impairs effective communication along the afferent pathways to the brain. Inadequate afferent input may lead to spasticity, a condition characterized by persistent excitatory responses in the nervous system, causing muscle contractures, such as "frozen limb."

METHODS: Three female participants (age 60.3±6.4 years; height 161±3 cm; body mass 73±6 kg) were randomly recruited for this study. They had no history of epilepsy, no auditory or cardiac implants, and were free from musculoskeletal injuries. The participants completed a single session (acute) to assess the passive and active stiffness, maximum range of motion (ROM), reflex (Ia afferent) excitability (Hoffman reflex, H-reflex), and cerebral electrical activity (electroencephalography, EEG) of their affected side (left side of the body) before and after receiving cathodal transcranial direct current stimulation (c-tDCS) in combination with traditional rehabilitation.

RESULTS: Due to the small sample size, statistical analyses were not performed. However, mean values are presented to illustrate trends and offer insights for future studies using similar methods and populations. Maximum dorsiflexion ROM (ROMmax) (plantarflexor stretch) increased from pre- (+29.4±11.5 °) to post-c-tDCS (+31.8±4.1 °), and plantarflexion ROMmax increased from pre- (-26.6±17.1 °) to post-c-tDCS (-32.8±14.8 °). Maximal voluntary contraction (MVC) torque was lower for dorsiflexor (pre-c-tDCS: 2.1±1.9 kg; post-c-tDCS: 0.97±0.85 kg) and plantarflexor muscles (pre-c-tDCS: 5.2±2.2 kg;

post-c-tDCS: 4.4±3.2 kg). Maximum passive force measured by handheld dynamometer during passive stretch with the help of a well-trained physiotherapist increased for both plantarflexor and dorsiflexor muscles from pre- (plantarflexor: 6.9±5.3 kg; dorsiflexor: 1.4±1.2 kg) to post-c-tDCS (plantarflexor: 31.9±4.2 kg; dorsiflexor: 32.9±14.9 kg). The soleus H:M ratio and H-reflex amplitude tended to increase in plantarflexion but decreased in dorsiflexion from pre- (plantarflexion: 0.6±0.3 and 2.8±1.8 mV; neutral: 0.5±0.7 and 4.6±3.0 mV; dorsiflexion: 2.5±0.7 and 4.5±1.3 mV) to post-c-tDCS (plantarflexion: 0.8±0.3 and 5.5±1.9 mV; neutral: 0.4±0.4 and 3.5±1.6 mV; dorsiflexion: 0.3±0.2 and 2.4±0.9 mV).

CONCLUSION: Maximum ankle ROM increased while resistance to stretch decreased following acute c-tDCS. Reflex (Ia) pathway excitability, measured by H-reflex, decreased with the ankle in dorsiflexion but not when in plantarflexion after c-tDCS, indicating potential improvements in spasticity symptoms. The H:M ratio changed minimally after c-tDCS, which may be attributed to the variability of muscle responses and because individuals with stroke often experience hemiparesis.

**EFFECTIVENESS OF A 3-MONTH TELECOACHING TRAINING PROGRAM ON FUNCTIONAL MOBILITY AND QUALITY OF LIFE IN INDIVIDUALS WITH CHARCOT-MARIE-TOOTH DISEASE: PRELIMINARY RESULTS**

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INTRODUCTION: Charcot-Marie-Tooth disease (CMT) is the most common inherited neuromuscular disorder, with an estimated prevalence of 1 in 2.500 [1]. CMT is a hereditary peripheral neuropathy characterized by progressive muscle weakness, balance impairments, and reduced functional mobility [2]. Although exercise can help maintain strength, balance, and overall function, individuals with neuromuscular disorders typically exhibit low levels of physical activity [3]. Telecoaching (TC) is an innovative training approach that utilizes digital tools to remotely access and manage training services. This study aimed to evaluate the effects of a 3-month TC-based training program on physical performance and quality of life in individuals with CMT.

METHODS: A total of 15 participants (48.13±12.15 years; 168±0.09 cm; 73.04±14.78 kg; 25.54±4.00 kg/m2) were randomly assigned to either the experimental group (telecoaching-based training, n = 8) or the control group (usual care, n = 7). Primary outcomes included the Timed Up and Go (TUG) test, the Short Form Health Survey 36 (SF-36), handgrip test, and the Berg Balance Scale (BBS). Assessments were conducted at baseline and after 12 weeks. A mixed ANOVA was conducted for the analyses.

RESULTS: No statistically significant changes were observed between the groups. However, significant improvements over time were noted only in the experimental group for TUG ($p = 0.01$), SF-36 ($p = 0.03$), right handgrip ($p < 0.001$), and left handgrip ($p = 0.03$). No significant changes were found in the BBS scores ($p = 0.13$).

CONCLUSION: A 3-month TC-based training program effectively improved functional mobility, muscle strength, and quality of life in individuals with CMT. Despite no significant changes in balance, these findings suggest that TC can be a valuable approach to enhancing overall physical function in individuals with CMT. Further studies are needed to explore long-term benefits and optimize TC strategies.

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**ASSESSMENT OF THE BALANCE AND STABILITY OF STUDENTS WITH VISUAL IMPAIRMENT: PRELIMINARY RESULT OF RCT IN A ROMANIAN SCHOOL**

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INTRODUCTION: For visually impaired people, postural balance (PB) is a significant difficulty that affects their quality of life and motor development. Physical activity, particularly strength training, is advised by the WHO guidelines to improve function and well-being in children with disabilities [1]. Dynamic and static balance are worse in people with visual impairments [2], whereas athletes have better balance than sedentary people [2]. Plyometric and balance exercises in the school curriculum can enhance both dynamic and static balance in children whose balance is still developing [3], and postural control can also be improved [4].

The aim of this study is to assess and improve balance in students visually impaired engaged in 15-week plyometric training.

METHODS: A RCT is conducted from February 2025, with 36 students randomly split into an experimental group and a control group. For balance assessment, a balance board measurement was used with parameters such as center of pressure, weight distribution, plantar pressure, and Bruininks-Oseretsky Test of Motor Proficiency (BOT-2).

RESULTS: According to preliminary results, equilibrium is greatly impacted by changing the support surface or lowering the visual component. Students can maintain the position in bipodal support for over ten seconds (AVG 3, SD 0.90) with variation in monopodal. Students find it difficult to hold the stance for longer than 3 to 5 seconds with eyes closed, and the average drops to 2.9 (SD 0.79). With AVG ranging from 2.3 to 2.7, the difficulty rises when on a beam, indicating difficulties sustaining stability. These findings confirm stabilometric analyses that reveal oscillations due to increasing CoP distance and speed.

CONCLUSION: According to the results, students with visual impairments can greatly increase their stability and quality of life by participating in a school balance program.

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**INDICATORS OF SARCOPENIA AND LUNG CANCER RISK AMONG NON-SMOKERS**

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INTRODUCTION: Lung cancer is the second most commonly diagnosed cancer and the leading cause of cancer-related deaths, with about 10% of cases linked to non-tobacco-related factors. There is still a need to determine whether indicators of sarcopenia—such as grip strength, appendicular lean mass index, and walking speed—can act as early predictors of lung cancer in non-smokers.

METHODS: This study is a prospective cohort analysis utilizing data from the UK Biobank, focusing on participants aged 40 to 69 years. The primary outcome assessed was lung cancer in non-smokers. Indicators of sarcopenia evaluated included relative grip strength (RGS), appendicular lean mass (ALM) index, and walking speed. Grip strength was measured using a Jamar J00105 hydraulic hand dynamometer and normalized to body weight, resulting in the RGS. Appendicular lean mass was determined through bioelectrical impedance analysis and adjusted for height squared to calculate the ALM index. Walking speed was self-reported by the participants.

RESULTS: In this study, we evaluated 164,337 non-smokers without lung cancer and 586 non-smokers with lung cancer. Individuals with lung cancer demonstrated significantly lower grip strength (mean relative grip strength: lung cancer-free group 0.41 [SD 0.13] vs. lung cancer group 0.38 [SD 0.13], $P < 0.001$) and a reduced appendicular lean mass index (lung cancer-free group 8.14 [SD 1.34] vs. lung cancer group 8.00 [SD 1.23], $P = 0.009$). Additionally, the incidence of slow walking speed was higher in the lung cancer group at 11.1%, compared to 5.8% in the lung cancer-free group.

CONCLUSION: Non-smokers with lung cancer show significant impairments in muscular strength and physical performance compared to those without lung cancer. Specifically, they have lower grip strength and appendicular lean mass index, as well as a higher prevalence of slow walking speed. These findings suggest a potential association between sarcopenic indicators and lung cancer, underscoring the need for further research to explore the mechanisms involved and the implications for early detection and intervention strategies to enhance physical function and quality of life in this population.

**ASSOCIATIONS BETWEEN PHYSICAL FITNESS, CANCER-RELATED FATIGUE, AND SLEEP QUALITY IN PATIENTS WITH CANCER: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: Patients with cancer often experience fatigue and sleep disturbances due to the disease and treatment side effects. Physical exercise may help to alleviate this impairment, even if few data are available concerning the relationship with physical fitness components. This study examines the associations between fatigue, sleep quality, and physical performance in patients with cancer.

METHODS: The physical and patient-reported data, along with the clinical and demographic variables, were collected by a dedicated exercise professional. The parameters included in the analysis were: Body Mass Index (BMI), and the waist-to-hip (W/H) ratio; functional capacity, assessed using the Six-Minute Walk Test (6MWT); upper limb strength, with the handgrip strength test (HSGT); and flexibility of the upper and lower limbs, assessed with the back scratch (BST) and chair sit-and-reach tests (CSRT), respectively. Data on sleep quality and fatigue were also collected using the Pittsburgh Sleep Quality Index (PSQI) and the Brief Fatigue Inventory (BFI) questionnaires, respectively. Descriptive analysis, absolute frequencies, and Pearsons correlations were used for data analysis.

RESULTS: A total of 84 patients (mean age 59 years, 61% female) were included in the study. Regarding the disease type, 28% of patients had breast, 20% pancreatic, and 15% colorectal cancers. Overall, 40% presented an advanced stage of disease, 85% were receiving chemotherapy and 45% radiotherapy. Forty-five percent of patients reported poor sleep quality, while 9% experienced a clinically significant level of fatigue. Patients reached the following mean values in the physical fitness parameters: 523.8 m (± 91,4) for 6MWT, 60.8 kg (± 20.2) for HSGT (right plus left hand), -8.9 cm (± 23.8) for CRST and -12.2 cm (± 21.6) for BST. A moderate and significant correlation was found between fatigue levels and 6MWT ($rs = -0.416$; $p < 0.001$), as well as a mild but significant correlation for upper limb strength and fatigue ($rs = -0.247$; $p < 0.028$). Finally, high levels in upper limb strength were correlated with lower impairments in sleep quality ($rs = -0.222$; $p = 0.048$).

CONCLUSION: Sleep quality and fatigue can significantly impair the quality of life in patients with cancer. Our study identified correlations between certain physical fitness parameters, lower fatigue levels, and improved sleep quality. Additional enrollments are currently underway to further clarify these associations.

**CARDIORESPIRATORY ASSESSMENT IN CHILDHOOD CANCER SURVIVORS ONE YEAR POST TREATMENT**

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INTRODUCTION: Survival rates for children, adolescents, and young adults with cancer have increased over the years due to improved care and personalized treatment. Treatment may cause short- and long-term toxicity limiting their ability to participate in exercise programs and sports. Survivors engage in less physical activity, leading to reduced exercise tolerance. An important tool for assessing the reduced exercise tolerance is cardiopulmonary exercise test (CPET). The CPET provides key indicators such as $VO_2$ peak and cardiopulmonary efficiency that can be a predictive index of morbidity and mortality [1]. Despite the increased use of CPET in pediatric oncology units, what occurs during the first year of follow-up remains partially unknown. Our aim is to evaluate exercise tolerance in a cohort of survivors of solid pediatric cancers within one-year post-treatment and identify possible indicators of cardiopulmonary fitness shortly after ending cancer therapy.

METHODS: CPET was performed on a cycle ergometer at the pediatric oncology unit using an incremental workload protocol until exhaustion. At the beginning of the test, participants were asked whether they had participated in any exercise programs during their treatment. The predicted peak $VO_2$ was calculated using the gender-, age-, and weight-adjusted Hansen/Wasserman equations.

RESULTS: We tested 17 patients (7 females; median age 15.01 years; range 13-20 years) at median 8.90 months post-treatment. The averaged of $VO_2$ peak value was 30.63 ± 10.22 ml/min/kg (range: 14.10–52.20) for males and 28.28 ± 10.08 ml/min/kg (range: 19.20–46.30) for females. These values were reduced of 54% and 34%, respectively, comparing to the predicted values of healthy peers [2]. Analysis of cardiovascular efficiency, measured by slope of the relationship between heart rate (HR) and $VO_2$ , revealed significant differences depending on physical activity levels during treatment. Survivors who engaged in moderate-to-vigorous tailored exercise programs during treatment had statistically significant greater efficiency (Y = 2.886*X + 67.68) compared to those who did not train (Y = 3.952*X + 66.03) (p=0.009).

CONCLUSION: These data highlight the importance of starting supervised precision-based exercise programs early in the disease trajectory. Additionally, we suggest that exercise should be continued soon after treatment to enhance recovery and improve long-term fitness outcomes. CPET has been shown to be an effective tool for assessing the fitness status of survivors, providing valuable insight into their exercise tolerance and guiding personalized training programs.

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**ASSESSING THE NEEDS AND POTENTIAL OF A MOTIVATIONAL APP TO SUPPORT CANCER SURVIVORS IN PHYSICAL ACTIVITY PARTICIPATION**

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INTRODUCTION: Cancer survivors often experience treatment-related challenges such as pain, fatigue, and anxiety.1,2 Despite the well-documented benefits of physical activity in alleviating these symptoms and improving overall well-being3,4, only 18-47% meet recommended levels5,6. Integrating Internet and mobile technologies in healthcare shows promise in promoting physical activity among cancer survivors7, and leveraging municipal services could help make such solutions more accessible to a broader population. Therefore, before implementing new initiatives, this study explored the potential of a motivational app as a support tool, the availability of physical activity programs for cancer survivors, and municipal health workers needs regarding its integration and regular use in their work.

METHODS: A survey was distributed via SurveyXact to all 235 municipalities with healthy life centers in Norway, as listed by the Norwegian Directorate of Health.8 A total of 92 (39%) health professionals responded. We examined their perceived need for a motivational app, the existence of physical activity programs for cancer survivors, preferred app features, and the importance of combining digital and in-person support. Additionally, a stakeholder workshop was conducted with representatives from healthcare providers, patient organizations, municipal services, and user representatives to discuss app functionalities and implementation strategies.

RESULTS: Eighty percent of respondents reported not having specific physical activity programs for cancer survivors. Eighty-eight percent believed a motivational app could enhance their ability to support this population in being physically active. Key desired features included an intuitive interface (84%), access to up-to-date evidence on physical activity and cancer (83%), tailored exercise programs (71%), and goal-setting functionalities (60%). Ninety-nine percent favored combining app-based support with guidance from healthy life centers. The workshop confirmed these findings, suggesting social support features, self-assessment tools, improved tailoring for the needs of different cancer diagnoses, and a training course to improve app usability for both health professionals and cancer survivors.

CONCLUSION: This study highlights a significant gap in the availability of tailored physical activity programs for cancer survivors within Norwegian municipal health services. A motivational app with user-friendly, evidence-based functionali-

ties and a tailored training course could address this gap. However, combining digital tools with in-person support remains crucial to optimizing outcomes.

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**ADDRESSING OPPORTUNITIES FOR INCLUSION IN LIFE AND SPORT FOR CHILDHOOD BLOOD CANCER SURVIVORS BEGINS AT THE TIME OF DIAGNOSIS**

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*FONDAZIONE MONZA E BRIANZA PER IL BAMBINO E LA SUA MAMMA*

INTRODUCTION: Cancer is the leading cause of death from non-communicable diseases in children, adolescents and young adults (CAYA-c) in Europe. During blood cancer treatment, patients exercise tolerance and quality of life (QoL) are reduced due to side effects of therapies, physical inactivity/bed rest, and cancer-related fatigue. Personalized exercise training (PEx) in CAYA-c is a promising therapy to alleviate these problems if started soon after diagnosis. However, there is a lack of scientific evidence to support the use of PEx in pediatric oncology. To build on this rationale, it is compelling to recognize that the efficiency of the CAYA-C performance and QoL could still be reduced in the late phases of cancer treatment.

AIM Identify exercise tolerance and QoL outcomes in CAYA-c to address barriers to their inclusion in life and sports activities as early as possible.

METHODS: CAYA-c aged 9-21 years, both sexes, with a diagnosis of blood cancer, just after the intensive phases of cancer treatment, underwent a cardiopulmonary evaluation at exhaustion (CPET) and peak values were measured (oxygen uptake-VO2, heart rate-HR, rating of perceived exertion-Borg RPE, skeletal muscle O2 extraction by NIRS-HHb/isch). The following tests were used to determine strength and functional capacity: leg extension (LE), 6-minute walk test (6MWT), time up and down stairs (TUDS), sit to stand (StoS), quick motor function (QMFT). The PedsQL Generic Core Scales questionnaire was used (higher scores indicating better QoL).

RESULTS: Seventeen CAYA-c completed all evaluations (mean±SD: 14.7±3.3 yrs, 41.0% female). The diagnoses were acute lymphoblastic and myeloid leukemia (41% and 7%), lymphoma (52%), and 17% had undergone bone marrow transplantation, 64% were in the maintenance phase of cancer treatment and had already returned to activities outside the hospital, 46% had been off therapy for 14.4±0.2 months. No major clinically relevant events were observed during the evaluations. CPET peak values were impaired: VO2 28.0±4.9 ml/min/kg (68.2±1.3% of predicted values-range 42-89%); HR 167.5±17.2 bpm (84.5±1.0 of predicted values-range 72-105%); Borg RPM 15.9±2.8; HHb/isch 75.0±3.0% (range 26-102%). Strength and functional capacity were impaired: LE 5RM 51.8±25.0 kg; 6MWT distance 529.4±60.7 m; TUDS 5.6±0.7 sec; StoS 6.0±1.0 sec. QMFT scores were normal 63.0±2.0 on 64. PedsQL scores were 76.6±10.3 and 86.9±11.4 (range 67-91 and 71-100) for children and parents, respectively.

CONCLUSION: Performance assessments could be safely used even in complex clinical settings. Oxidative pathway, strength and functional capacity are still reduced in the final stages of cancer treatment as a result of the individual clinical history, with varying degrees of severity. QoL is affected. PEx introduced early from diagnosis can be an opportunity to address CAYA-c and their families willingness to participate in life and sports activities throughout their care and during long term follow up.

**EXERCISE-INDUCED HYPOALGESIA IN CHILDHOOD CANCER PATIENTS: A PILOT STUDY**

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INTRODUCTION: Pain is a common symptom in childhood cancer patients, which is a burden not only during cancer treatment but also beyond. Strategies to reduce pain perception are therefore of great importance for these patients. Recent studies in adults have demonstrated that acute exercise can lead to a temporary reduction in pain perception and an increase in pain thresholds, a phenomenon known as exercise-induced hypoalgesia (EIH). The aim of this pilot study was to determine whether acute endurance exercise on a cycle ergometer induces EIH in childhood cancer patients.

METHODS: A total of 13 childhood cancer patients aged 11.0 ± 4.9 years were examined following the completion of intensive cancer treatment. To measure the effects of potential EIH, pressure pain thresholds (PPT) were measured using a handheld pressure algometer (Citec Dynamometer CT3002; pain applicator). Immediately before and after an acute en-

durance exercise, punctual pressure was applied to the rectus femoris and deltoid muscle at a rate of 10 newtons per second. The endurance exercise consisted of a cycling protocol performed on an electronically braked cycle ergometer (Corival Pediatric or Corival CPET, Lode BV, Groningen, Netherlands) using a modified Godfrey protocol to voluntary exhaustion. A Wilcoxon signed-rank test was performed to analyze the differences in PPT before and after the endurance exercise. The significance level was set at $p < 0.05$, and effect sizes (r) were interpreted in accordance with Cohens guidelines ($r = 0.1$ - 0.3: small effect, $r = 0.3$ - 0.5: moderate effect, $r > 0.5$: strong effect).

RESULTS: The findings indicate a statistically significant increase in PPT following endurance exercise on the rectus femoris ($z = 2.04$, $p = .038$, $r = .57$) and on the deltoid muscle ($z = 2.17$, $p = .028$, $r = .60$). These effects can be considered strong.

CONCLUSION: This pilot study suggests that acute endurance exercise may induce EIH in children with cancer. These findings indicate that exercise therapy could be a non-pharmacological approach to reduce pain perception in this patient group. However, further studies with larger sample sizes are needed to confirm these preliminary results.

**SKELETAL MUSCLE MASS AND STRENGTH AMONG OVERWEIGHT OR OBESE BREAST CANCER SURVIVORS: IMPLICATIONS OF BMI ON MUSCLE-RELATED OUTCOMES**

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INTRODUCTION: Reductions in skeletal muscle mass and strength impairments, in combination with the presence of overweight or obesity, are associated with reduced survival and quality of life among breast cancer survivors. Among otherwise healthy individuals, higher body mass index (BMI) is associated with increased strength and muscle mass than those with lower BMI, suggesting that obese individuals are expected to be stronger than those who are overweight. However, this phenomenon has not been previously reported among breast cancer survivors. As a result, exercise specialists might underestimate levels of strength and prescribe resistance exercise at insufficient intensity. Therefore, the purpose of this cross-sectional analysis was to examine the differences in skeletal muscle mass and strength in overweight or obese breast cancer survivors.

METHODS: This analysis included sedentary breast cancer survivors with overweight or obesity (BMI >25 kg/m2), enrolled in a randomized controlled exercise trial. At baseline, the following variables were assessed: muscle mass, measured by bioelectrical impedance analysis; strength measures with a handgrip strength test and 10 repetition maximum (RM) tests performed for leg press (LP), chest press (CP), leg curl (LC), seated row (SR), and leg extension (LE). The estimated 1-RM was calculated using the Bryzcki equation. Baseline participant characteristics were calculated as mean±SD. Differences between overweight (BMI 25-29.9 kg/m2) and obese (BMI >30 kg/m2) participants were explored using the two-sample t-test or the Mann-Whitney U test, according to normality assumption.

RESULTS: A total of 58 participants who completed baseline testing were included in this analysis. Of the included participants, 27 were obese (34.2±3.1 kg/m²) and 31 were overweight (28.1±1.1 kg/m²). Obese participants had significantly higher muscle mass compared to overweight participants (mean difference: obese vs overweight, 5.7 kg, 95% CI 3.1 to 8.4; $p<0.001$). Higher levels of strength were observed among obese breast cancer survivors for handgrip (3.7 kg, 0.6 to 6.0; $p=0.018$), LP (18.2 kg, -0.0 to 35.6; $p=0.054$), and CP (6.4 kg, 2.1 to 11.0; $p=0.009$). No significant group differences were observed for LC, SR, and LE, although obese participants showed higher strength performance in these exercises (mean differences, 6.1 kg, -0.9 to 13.0; 3.0 kg, -0.9 to 7.0; and 7.0 kg, -0.7 to 14.7; for LC, SR and LE, respectively).

CONCLUSION: Breast cancer survivors with obesity can present with higher muscle mass and strength compared to those who are overweight. This phenomenon highlights the need for personalized aerobic and resistance training interventions to enhance physical fitness. These data can help exercise specialists to accelerate exercise adaptations by leveraging baseline strength and muscle mass in untrained breast cancer survivors.

## Conventional Print Poster Presentations

### CP-MH13 Ageing II

**INFLUENCES OF DM AND HTA ON FUNCTIONAL TEST AND HEART RATE VARIABILITY IN INSTITUTIONALIZED ELDERLY WOMEN**

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INTRODUCTION: The elderly population (EP) worldwide represents important challenges in public health policies. Chile is no exception with its exponential population growth. Chronic non-communicable diseases are the pandemic of the 21st century and strongly affect this population, losing years of healthy life. The EP in Chile has a 73.3% prevalence of suspected arterial hypertension (HTA), with only 60% aware of the condition and in treatment (DIPRECE, MINSAL). Regarding Diabetes Mellitus type 2 (DM2), 31% of EP have diabetes with low percentages of control of the pathology (SOCHED). For them, it is of great relevance to study these pathologies and how they may affect the performance of functional tests and heart rate variability (HRV) in institutionalized older women

METHODS: 91 older women who met the eligibility criteria participated on this study. Fall risk tests were measured (dynamometry, arm curl, single leg balance test, timed up and go -TUG-, quadrant test and sit to stand 30 seconds), as well as HRV at rest for 5 minutes. The sample was grouped into EP with DM2 and HTA, this was statistically analyzed with JAMOVI software and ANOVA of one-factor was used.

RESULTS: The tests that assess the risk of falls in institutionalized EP behave differently depending on the presence of DM2 or HTA, the median age of the observed population was 87 years (range 68-97). The prevalence of HTA 68% and DM2 was 20%. There was a lower performance in the different tests of risk of falls in people with DM2 in the hand dynamometry test ($p = 0.01$), as well as in the measurement of HRV, we observed lower values in pNN50 ($p = 0.043$) and pLF ($p = 0.044$). In EP with HTA we observed lower values in the different tests of risk of falls, dynamometry ($p = 0.002$), arm curl ($p = 0.017$), right and left one leg balance test ($p = 0.020$ and $p = 0.028$ respectively) and TUG ($p = 0.004$).

CONCLUSION: We can conclude that there are significant differences between the behavior of the tests of risk of falls in older adult women when they present HTA and DM2, we also observe that in HTA the indexes of the HVR are affected, while in EP with DM2 the tests of risk of falls are mainly affected, the common point is that in both pathologies the performance of the hand dynamometry is affected. It can be proposed the utility of a battery of test of application in institutionalized women to assess the follow-up of these health conditions.

**THE EFFECT OF 2 VS 3 RESISTANCE TRAINING SESSIONS PER WEEK USING ELASTIC BANDS ON FUNCTIONAL FITNESS IN ELDERLY WOMAN**

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INTRODUCTION: Elastic band strength training has been proved to enhance myriads of fitness attributes in elderly cohort (1). However, effects of training frequency on fitness outcomes are less investigated, producing general recommendation that 2 to 3 resistance training per week provides the optimal stimulus for fitness improvements (2). Therefore, we aimed to explore effects of 2 vs 3 elastic band training sessions per week on functional fitness in older woman.

METHODS: Eighty-two women were allocated randomly to an 2 sessions/week (2SW, n = 41, 75,7 ± 8,9 years, 70,8 ± 12,3kg) or a 3 sessions/week group (3SW, n = 41, 74,5 ± 8,2 years, 72,3 ± 11,6 kg). Resistance training protocol consisted of equal volume, chair-based, low- load whole-body resistance exercises (2 sets, 12-15 repetitions, 40-60% of one repetition maximum-1RM) using an elastic band, for 12 weeks. Functional fitness (30-s Chair Stand,30-s Arm Curl, 2-min Step Test, Chair Sit-and-Reach, Back Scratch, 8-Foot Up-and- Go, Handgrip Strength) were measured before and after the training period. A 2x2 repeated measures ANOVA was utilized to identify pre/post intervention changes and differences between groups.

RESULTS: At baseline, no statistically significant differences were found between 2SW and 3SW groups ($p > 0.05$). The participants adherence to training sessions of over 90% was reported. Both groups exhibited a statistically significant improvements over time for the following variables: 30-s Chair stand, Arm Curl, 2-min step test, Back Scratch, 8-Foot Up-and- Go and Handgrip Strength. Chair sit -and-reach improved in 2SW only. Furthermore, statistically significant interactions for time*group were found for the Handgrip strength (before = 39.6 ± 12.1 kg and after = 42.4 ± 12.5 kg compared to before = 28.2 ± 14.4 kg and after = 36.0 ± 15.6 kg for 2SW and 3SW, respectively, $p < 0.05$).

CONCLUSION: Implementing 2 or 3 elastic band training sessions per week over a duration of 12 weeks resulted in functional fitness benefits in elderly women that were comparable, in addition to improvements in handgrip strength. Therefore, both training approaches can be recommended for this particular population.

**ASSOCIATION BETWEEN FEAR OF FALLING AND PREFRAILTY IN COMMUNITY-DWELLING OLDER ADULTS**

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INTRODUCTION: The fear of falling (FOF) is associated with frailty among older adults [1]. As the early stage of frailty, prefrailty is more reversible and regarded as a key focus in frailty prevention [2]. However, whether FOF is associated with prefrailty and whether this association differs by gender remain unclear. Therefore, this study aimed to examine the association between FOF and prefrailty among community-dwelling older adults by gender.

METHODS: This cross-sectional study included 489 community-dwelling older Japanese adults aged 65 years or older (132 men, mean age: 75.9 ± 5.3 years; 357 women, mean age: 73.9 ± 4.8 years). Assessments included anthropometric measurements (height, weight, BMI), physical function tests (grip strength and gait speed), and questionnaires. FOF was assessed using the Short Falls Efficacy Scale-International (Short FES-I), and prefrailty was assessed using the Japanese version of the Cardiovascular Health Study (J-CHS) criteria.

All statistical analyses were conducted separately for men and women. Comparisons were made between the prefrailty and robust groups, and binary logistic regression analyses were used to examine the associations between prefrailty status (dependent variable) and age, BMI, grip strength, gait speed, and Short FES-I (independent variables). Furthermore, for variables that showed significant associations, receiver operating characteristic (ROC) analyses were performed to assess their discriminatory ability in identifying prefrailty.

RESULTS: In men, Short FES-I scores did not significantly differ between the prefrailty and robust groups (p = 0.273), and binary logistic regression analysis showed no significant association between Short FES-I and prefrailty (OR: 1.04; 95% CI: 0.92–1.18; p = 0.494).

In contrast, women in the prefrailty group had significantly higher Short FES-I scores than those in the robust group (p < 0.001). Binary logistic regression analysis showed a significant association between Short FES-I and prefrailty (OR: 1.13; 95% CI: 1.05–1.22; p < 0.001). Furthermore, ROC analysis indicated that in women, the area under the curve (AUC) for the Short FES-I was 0.647 (p < 0.001), with an optimal cutoff value of 12 points for identifying prefrailty (sensitivity, 0.56; specificity, 0.69).

CONCLUSION: This study examined the association between FOF, assessed using the Short FES-I, and prefrailty in community-dwelling older adults. A significant association was observed only in older women, whereas no such association was found in men. This may be attributed to men having lower FOF levels than women, which could influence the association between FOF and prefrailty. These findings suggest that the association between FOF and prefrailty may differ by gender.

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**TIME-OF-DAY SPECIFIC RESISTANCE TRAINING IN ELDERLY WOMEN – EFFECT ON PERFORMANCE, BODY COMPOSITION AND BONE MINERAL DENSITY**

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INTRODUCTION: Neuromuscular performance shows diurnal variation in a sinusoidal manner with a minimum in the morning and a peak in the early evening. However, only few studies have dealt with time-of-day specific adaptation to resistance training in regards with muscle strength and hypertrophy. The only study performed on elderly women found that time-of-day did not have a major effect on outcome variables, but some evidence suggests that training in the morning may be more beneficial for muscle hypertrophy the training. This study aimed to expand on studying time-of-day specific adaptation in elderly population not only on performance but also on bone health.

METHODS: We recruited 26 previously untrained women (age between 65 to 75 year) in total, who were divided into 3 groups - morning training group (MT, n=10), afternoon training group (AT, n=10) and control group (C – n=6). Both training groups underwent identical 12-week time-of-day specific resistance training. The only difference between the groups was the time of the training. MT and AT trained exclusively between 8:00 – 9:00 AM and 4:00 – 5:00 PM, respectively. Control group did not train but was tested for performance, body composition and bone mineral density measured by DXA before and after the 12-week period, similarly to both training groups.

RESULTS: In maximal gait speed, the significance was found only in the M group (M: 5,11 ± 0,09 s vs 4,83 ± 0,13 s; p≤0,05), whereas no significance was found in afternoon group after 10 weeks of training (A: 5,51 ± 0,24 s vs 4,27 ± 0,15 s). We modified a 6 min walk test into a 6 min Airbike tests where was confirmed also significance in both experiment groups (M: 1730 ± 33,47 m vs 1866 ± 28,94 m; p≤0,01; A: 1730 ± 32,42 m vs 1866 ± 26,21 m; p≤0,01). In lower body strength we found significant differences in legpress 6RM test (M: 12,1 ± 0,57 kg vs 15,1 ± 1,05 kg; p≤0,01; A: 11,9 ± 0,46 kg vs 15,3 ± 0,90 kg; p≤0,01), nonetheless in isometric regime we did not find a difference in between experiment groups and the C group

In bone mineral density, no difference was found neither in between the groups nor within the groups (M: 27,26 ± 0,79 kg/m2 vs 26,86 ± 0,72 kg/m2; A: 26,77 ± 0,88 kg/m2vs 26,55 ± 0,91 Nm; C: 27,55 ± 1,63 kg/m2 vs 27,02 ± 1,77 kg/m2). Similarly, no difference was found in lean mass nor in total body bone mineral density.

CONCLUSION: This study founded that training in the morning and in the afternoon was similarly effective in improving performance parameters. The only parameter significantly improved in the morning was gait speed. Nor bone mineral density neither lean mass was significantly improved in the training groups. However, a positive trend in both parameters in both training groups and no sign of a change in the control group was seen.

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**EXERCISE INTERVENTION FAILED TO ATTENUATE COGNITIVE DYSFUNCTION IN AGED 3XTG-AD MOUSE MODEL OF ALZHEIMER'S DISEASE**

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INTRODUCTION: Alzheimer's disease (AD) is a neurodegenerative disorder that causes cognitive impairments. Hippocampus plays a critical role in cognitive function including learning, short- and long-term memory, and spatial memory. Whereas exercise intervention has been shown to mitigate cognitive impairments in early-stage AD, it is unknown that this neuroprotective effect of exercise is still maintained in late-stage AD. The purpose of the study was to investigate whether exercise intervention mitigates cognitive dysfunction in super-aged triple-transgenic (3xTg)-AD mice; and whether mitochondrial function in hippocampus is associated with the changes in congnitive function.

METHODS: This study used 22-month old female 3xTg-AD (n=14) and age-matched wild-type C57BL/6J female mice (n=14). Mice were randomly assigned to sedentary or exercise group, generating 4 groups: Control (CONSED), Control with exercise (CONEX), Alzheimer's Disease (ADSED), and AD with exercise (ADEX). Exercise groups proceeded with a 16-week treadmill exercise training (30 mins, 5 days/week). Cognitive function was assessed using the novel object recognition (NOR) and novel arm Y-maze tests. Hippocampal mitochondrial function was measured using the Oroboros O2k instrument.

RESULTS: In NOR test, AD groups showed lower cognitive function compared to Control groups ($p < 0.01$). There was a trend that exercise increases cognitive function only in CON not in AD ($p = 0.06$ and $p = 0.4$, respectively). The Y-maze test demonstrated that AD groups showed lower cognitive function compared to Control groups. No exercise effect was found in both CON and AD. In hippocampal mitochondrial function, compared to sedentary, exercise groups tended to be greater in mitochondrial function during the ADP phase ($p = 0.09$).

CONCLUSION: While previous studies using the early-stage AD mouse model have shown the neuroprotective effect of exercise, our findings suggest that this exercise effect is disappeared in late-stage AD mouse model. Despite a trend of enhanced mitochondrial function in hippocampus following exercise intervention, both cognitive function tests demonstrated no exercise effect in late-stage AD mice. More studies are necessary to elucidate the underlying mechanisms linking hippocampal mitochondrial function and cognitive function.

**REDEFINING FRAILTY ASSESSMENT: INTEGRATING RELATIVE STS MUSCLE POWER INTO THE FRAILTY PHENOTYPE AND FRAILTY TRAIT SCALE 5**

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INTRODUCTION: The aging of the population has increased the focus on early detection and treatment of age-related syndromes like frailty, characterized by a reduced physiological reserve and higher vulnerability to stressors. Frailty assessment comprises multiple components, one of which is handgrip strength (HG). Recently, lower-limb muscle power has emerged as a better predictor of aging, as it shows stronger associations with adverse events. This study aimed to include muscle power into frailty assessment using the Frailty Trait Scale short form (FTS5) and the Frailty Phenotype (FP) and to compare the effectiveness and predictive capacity of muscle power against HG strength.

METHODS: This prospective cohort study involved 1600 older adults (>65 years; 55% women). Frailty was evaluated using the FTS5, which assessed BMI, physical activity, balance, HG strength, and habitual gait speed (HGS). The FP assessed HG strength, HGS, low physical activity, tiredness, and involuntary weight loss. Lower-limb muscle power was assessed using the 5-repetition sit-to-stand (STS) test and the Alcazar's equation [1] with cut-off points for relative power set at 0.36 w·kg-1 (men) and 0.32 W·kg-1 (women) based on the worst BMI. Also, the incidence of disability in basic activities of daily living (BADL; Katz index) was assessed after 5 years, and hospitalization and all-cause mortality were recorded after 3 and 5 years of follow-up, respectively. Binary logistic regression and ROC curves adjusted by covariates were done.

RESULTS: Frailty assessed with the FP including relative STS power showed significant associations with all-cause mortality (OR [95% CI] = 2.45 [1.50, 4.01]) but not with hospitalization (p= 0.99) or incidence of BADL disability (p= 0.11). When evaluated using HG strength, frailty showed associations with mortality (OR [95% CI] = 2.11 [1.30, 3.42]) and incidence of BADL disability (OR [95% CI] = 3.19 [1.47, 6.91]) but not with hospitalization (p= 0.88). Frailty assessed with the FTS5 including relative STS power showed significant associations with all-cause mortality (OR [95% CI] = 3.43 [2.29, 5.13]), hospitalization (OR [95% CI] = 1.45 [1.06, 1.98]), and incidence of BADL disability (OR [95% CI] = 1.74 [1.24, 2.45]); while the FTS5 including HG strength showed associations with all-cause mortality (OR [95% CI] = 2.84 [1.89, 4.26]) and incidence of BADL disability (OR [95% CI] = 1.78 [1.24, 2.57]), but not with hospitalization (p= 0.20).

CONCLUSION: Relative STS muscle power test is a feasible and relevant tool for assessing frailty, similar to HG strength. Frailty definitions that included relative STS power showed significant associations with mortality (both FP and FTS5), hospitalization and BADL disability (FTS5), enabling low relative STS power as a criteria of frailty associated with future adverse outcomes.

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**CORRELATION BETWEEN ULTRASOUND-DERIVED ECHO INTENSITY BANDS AND PQCT-DERIVED MUSCLE FAT**

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INTRODUCTION: Fat tissue infiltration in muscle tissue increases with aging, disuse, and pathologies, and is associated with reduced muscle quality and function (1). Peripheral quantitative computed tomography (pQCT) is commonly used to estimate muscle fat content based on density (2). However, pQCT involves radiation exposure and lacks portability. In contrast, ultrasonography (US) is a low-cost, non-invasive, and portable alternative that estimates fat content through the echo signal intensity (echo intensity; EI) reflected by soft tissue structures. Traditionally, the mean pixel intensity in grayscale has been used as a proxy for intramuscular fat; however, it provides limited information. Recently, we introduced histogram-based EI bands to refine this estimate by quantifying pixel intensity across grayscale intervals (1). Early bands are thought to reflect contractile proteins, while bands >51 are believed to reflect intramuscular fat. Preliminary evidence suggests that EI bands are more sensitive to age- and disuse-related changes (1,3). However, further exploration is needed to understand the relationship between EI bands and pQCT-derived fat estimates.

METHODS: Twelve participants (n=8 healthy; n=4 with spinal cord injury; sex: male/female; age range: 27—61 years) were assessed for elbow flexors and quadriceps muscles using extended field-of-view (EFOV) US and pQCT on the same day. Mean EI and EI bands (0-50, 51-100, 101-150, 151-200, 201-255) were determined from US images, while muscle density was estimated using pQCT. Linear regression analyses were performed to examine the relationships between EI and pQCT-derived muscle density.

RESULTS: Analyses revealed significant correlations between EI mean, EI bands, and density for the quadriceps ($P<0.001$), but not for the elbow flexor muscles ($P>0.05$). EI mean was strongly and negatively correlated with muscle density ($R2=0.83$). The EI 0-50 band was strongly positively correlated with density ($R2=0.79$), while the EI 201-255 was moderately negatively correlated ($R2=0.55$). No correlations were observed for EI bands 51 to 150 and density ($P>0.05$).

CONCLUSION: The findings support that the EI 0-50 band is associated with higher contractile tissue density, while the EI 201-255 band correlates with fat tissue and lower density. Additionally, EI bands appear to be more accurate than mean EI in differentiating muscle tissue composition. However, these relationships were muscle-specific or influenced by factors such as pennation angle, as no correlation was found in the biceps, consistent with previous findings (4). Future studies should consider other factors that may affect EI.

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**SUSTAINING EXERCISE TO ENHANCE COGNITIVE HEALTH IN OLDER ADULTS WITH SUBJECTIVE COGNITIVE IMPAIRMENT**

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INTRODUCTION: Epidemiological studies indicate higher habitual physical activity levels are associated with enhanced cognitive function. However, meta-analyses of randomised controlled trials (RCTs) have not consistently demonstrated exercise interventions improve cognitive function in older adults, likely due to various methodological factors including exercise intensity. Additionally, long-term follow-ups indicate exercise is often not sustained after intervention cessation. This pilot RCT aims to examine the effect of exercise intensity parameters on cognition, while evaluating the efficacy of behavioural change strategies to prolong exercise adherence.

METHODS: Forty-six older adults (aged 65+) with subjective cognitive impairment were randomised into one of three groups: high-intensity exercise, moderate-intensity exercise, or a control group. The exercise groups participated in supervised aerobic exercise and progressive resistance training three times per week for 12 weeks, followed by a nine-month maintenance period (involving supervised booster sessions, and regular follow-up phone calls). Exercise group participants also attended weekly cognitive behavioural therapy group sessions during the 12 week supervised period. The control group engaged in thrice-weekly balance and stretching sessions for 12 weeks, followed by a non-contact maintenance period. Physical fitness and cognitive assessments were conducted at baseline (pre-intervention), 12 weeks (post-supervised intervention), and 12 months (post-maintenance period). Group differences across time points were evaluated for all outcome measures. Additionally, based on prior literature, associations between changes in fitness and cognition were examined.

RESULTS: The cohort had a mean age of 71.9 (4.5) years and was 67% female. The most notable fitness changes occurred from baseline to 12 week follow-up, including in 1RM row ($\beta = -2.52$, $p < 0.01$), 1RM leg curl ($\beta = -3.75$, $p < 0.001$), 1RM bench press ($\beta = -2.60$, $p < 0.01$), and 1RM leg press ($\beta = -7.50$, $p < 0.01$), with a stepwise improvement observed across groups (high-intensity < moderate-intensity < control). No significant differences in cognitive outcomes were observed across groups. Following combination of both intervention groups, changes in the one-card learning task from baseline to 12 weeks were associated with changes in 1RM row ($\beta = 0.66$, $p < 0.01$), and 1RM leg curl ($\beta = 0.56$, $p < 0.05$), over the same time. These findings were not observed following the maintenance period.

CONCLUSION: We did not observe any group effects of exercise, nor exercise intensity, on cognitive outcomes. As expected, the three-month supervised intervention induced physical fitness changes, and some of these changes were associated with some cognitive improvements. However, the observed effects were not sustained beyond the supervised exercise intervention. Future research should explore behavioural intervention strategies to enhance long-term adherence to exercise programs in older adults.

## Conventional Print Poster Presentations

### CP-SH08 Physical Education II

**VALIDATION OF THE ITALIAN TRANSLATION AND CULTURAL ADAPTATION OF THE CANADIAN ASSESSMENT OF PHYSICAL LITERACY-2 (CAPL-2) QUESTIONNAIRES FOR CHILDREN**

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INTRODUCTION:Physical literacy (PL) is an inclusive and holistic concept, conceived from its inception to promote lifelong health and well-being by centering on the person-in-the-world and their lived experience within their cultural context (1). Consequently, different cultures, governance structures, geographical locations, and physical environments may necessitate distinct conceptualizations and pedagogies to effectively foster physical literacy (2). Thus, it is crucial to provide physical and sport educators with validated assessment tools to ensure accurate evaluation within different contexts. One of the best-known and validated assessments of PL is the Canadian Assessment of PL (CAPL-2) (3). This study aimed to validate the Italian translation and cultural adaptation of the CAPL-2 questionnaire.

METHODS: We recruited 111 children (57 females, 8-12 year old, BMI = 17.9 kg/m²) who completed the Italian version of CAPL-2 questionnaire twice over a 10-day interval under trained supervision. Internal consistency was evaluated with Cronbach's alpha ($\alpha = 0.60$).The study was Approved by the IRB of University of Cassino. We used ROC curve analysis and AUC to evaluate the capacity of CAPL-2 score to predict adherence to WHO physical activity guidelines measured using CAPL-2 items about self-reported physical activity. Before data collection, the CAPL-2 questionnaire was translated via a forward–backward procedure by bilingual experts. A pilot test with 10 children identified and resolved comprehension and cultural issues.

RESULTS: Results showed high internal consistency for the motivation and confidence domain (Cronbach's $\alpha$: 0.88–0.97; mean: $5.3 \pm 1.4$) and lower internal consistency for the knowledge and understanding domain (Cronbach's $\alpha$: 0.20–0.34; mean: $9.3 \pm 0.98$).

Furthermore, the results revealed that the CAPL-2 questionnaire exhibited highly predictive performance in identifying children active for at least 5 days (AUC: 0.95) compared to those active for at least 6 days (AUC: 0.89).

CONCLUSION:Although the knowledge and understanding domain exhibited low internal consistency—likely due to limited variability—our findings suggest that the CAPL-2 questionnaire, translated and culturally adapted for the Italian context, is a reliable measurement tool, thereby supporting the full adaptation of the CAPL-2 test battery for Italian children aged 8 to 12 years.

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**A WIN-WIN: TEACHING PRE-SERVICE TEACHERS HOW TO NURTURE EXECUTIVE FUNCTION DEVELOPMENT THROUGH PHYSICAL ACTIVITY**

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Background: Executive functions (EF) play a crucial role in academic performance, influencing students' ability to plan, regulate behavior, and adapt to complex tasks [1]. Given the well-established cognitive benefits of physical activity [2], physical education (PE) serves as an important vehicle for fostering EF development in children and youth. The aim of this literature review was to create a framework for teaching pre-service teachers (PST) about the relationship between physical activity and EF, with a focus on how to integrate these insights into their PE practices.

Method: A literature search using PubMed and SportDiscus identified key articles on the benefits of physical activity for EF development in children and youth (search terms: physical activity OR exercise OR sport AND executive function OR inhibitory control OR working memory OR cognitive flexibility AND child OR youth OR adolescent). The Pedagogical Content

Knowledge model [3] provided the theoretical framework for analysis, guiding the organization of findings into three domains: content knowledge, pedagogical knowledge, and curricular knowledge.

Results: PST should be able to define EF as comprising inhibitory control, working memory, and cognitive flexibility and recognize its role in academic success [1]. They should be able to explain basic neurobiological mechanisms linking physical activity to EF [2] and identify optimal physical activity parameters—complex movements in unpredictable environments [4] at moderate-to-high intensity [5] for at least 30 minutes [6]. Developing pedagogical knowledge requires translating content into effective teaching. PST should be familiar with how Modeled Learning can be leveraged to teach students about perceived intensity, and how Cooperative Learning can maximize activity time while scaffolding both fundamental and functional movement skills in cognitively engaging ways [7]. PST should also be able to recall and explain regional educational standards and demonstrate how exercise-cognition science aligns with them. Assessments such as case-based problem-solving, time-on-task analyses, and interdisciplinary lesson plans help evaluate PST skills and competencies across these domains.

Conclusion: This literature review highlights the importance of educating PST on how PE can be leveraged to nurture EF development. By developing content, pedagogical, and curricular knowledge, PST can effectively integrate exercise-cognition science into their teaching, ensuring PE supports EF development and, by extension, success in the classroom.

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**COMPARISON OF PHYSICAL FITNESS BETWEEN IRANIAN AND HUNGARIAN FEMALE STUDENTS**

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INTRODUCTION: Health status has always been a vital concern for all governments, and practical assessment of it is challenging and costly (Lovecchio et al., 2019). Physical fitness is a significant measure of health, and Eurofit tests are one of the standard and widespread methods for measuring physical fitness (Mijanovic, 2022). This study aimed to examine and compare physical fitness between Iranian and Hungarian female students using standardized Eurofit tests.

Methods

Physical fitness tests were assessed on 539 students aged 13-15 years (Mean age = 13.93; SD = 0.82) from Iran and Hungary. Participants were selected from five Iranian schools and nine Hungarian schools The investigation utilized a cross-sectional design. Data was collected during the academic year 2022-2023. The Research Ethics Committee of the Hungarian University of Sports Science approved this study with the reference number TE-KEB/27/2022.

RESULTS: The results of the MANOVA test indicated a significant difference in physical fitness levels between countries, age groups, and countries*age groups. The Hungarian female students performed better in all tests, with the exception of the Plate Tapping test, compared to the Iranian female students. The findings of the Univariate test of variance (ANOVA) indicated that the countries effect on all variables, with the exception of the Sit and Reach test, is significant. The interaction of Age groups and Countries*Age groups affected fewer variables with smaller effect sizes.

Discussion and conclusions

The reasons for these results are primarily to be found in the differences in the public education systems of the two countries. An important factor is the number of lessons in PE, which in Hungary is five hours per week, while in Iran it is two hours per week. Among the reasons could be the differences in the cultural habits and lifestyles of female adolescents, as well as the different infrastructural conditions. The data can serve as a standard norm for easily assessing the physical fitness and health status of 13-15-year-old female students in Iran and Hungary.

**THE EFFECT OF THE SPORT EDUCATION MODEL ON PHYSICAL LITERACY ATTRIBUTES: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: School physical education plays a critical role in nurturing physical literacy (McLennan & Thompson, 2015). One effective curriculum and instructional model that supports this development is the sport education model (Hastie & Wallhead, 2015), which is designed to provide students with authentic and educationally rich sport experiences (Siedentop et al. 2019). Previous reviews on the sport education model have primarily focused on students' learning outcomes, and psychological and prosocial attributes. This study aims to examine how this model holistically influences physical literacy attributes.

METHODS: Utilising the PRISMA Guidelines, a comprehensive search was conducted across databases to identify relevant sport education model interventions. A meta-analysis of articles meeting the inclusion criteria was performed to examine the effects of these interventions on five physical literacy attributes including affective, physical competence, behaviour, cognitive, and social. Standardised mean differences with 95% confidence intervals were calculated to assess the effects across the different categories.

RESULTS: A total of 2,359 potentially relevant studies were initially identified across the databases, with 42 eligible studies included in the final analysis. Despite notable heterogeneity across subgroups, the sport education model demonstrated the most significant effect on behaviour (SMD = 0.72; 95% CI = 0.36–1.08), followed by affective (SMD = 0.61; 95% CI = 0.39–0.83), social (SMD = 0.24; 95% CI = 0.07–0.40), cognitive (SMD = 0.13; 95% CI = -0.23–0.49), and physical competence (SMD = 0.10; 95% CI = -0.11–0.32).

Discussion: The sport education model significantly enhances the affective, behavioural, and social domains of physical literacy. However, its impact on students' physical abilities and cognitive development does not significantly differ from traditional teaching, possibly due to the latter's emphasis on intensive skills training while often neglecting affective and behavioural domains. The lack of cognitive differences may stem from research bias, including insufficient professional development that affects the curriculum delivery. Overall, the meta-analysis confirms the effectiveness of sport education model and suggest its integration to cultivate holistic and lifelong participation in physical activity.

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**A FRAMEWORK ANALYSIS OF EXPERIENCES OF UNDERGRADUATE UNIVERSITY STUDENTS WHO COMPLETED MANDATORY PHYSICAL EDUCATION COURSES: A QUALITATIVE STUDY**

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INTRODUCTION: Physical activity (PA) among university students is essential for enhancing overall well-being as it promotes both physical and mental health as shown by existing synthesized evidence. However, not all university provides mandatory physical education (PE) on guiding professional sport knowledge, instructions and practice to undergraduate students. Whether a mandatory PE courses in the undergraduate studies curriculum would benefit physical and mental health, as well as motivating students to self-practice certain sport that learned from mandatory PE courses remained unclear. The objective of this qualitative study is to identify the feedback provided by undergraduate students who completed mandatory PE courses during their first two semesters at university.

METHODS: To obtain feedback from university students who enrolled for the required and elective PE courses, a qualitative study was conducted among students upon completion of one of their selected PE courses including physical conditioning, track and field, swimming, basketball, volleyball, softball, handball, soccer, tennis, squash, badminton, table tennis, wood ball, yoga, tai chi, taekwondo, modern dance, cycling, hip-hop dance, golf and martial arts. Students were invited to participate in a focus group interview. During the focus group interviews, the participants discussed about their experience and comments for PE courses based on a set of pre-designed semi-open questions. Purposive sampling was used to capture experience of students who had positive feedback (n=15) and students who had negative feedback (n=15) to the required and elective PE courses via focus group interviews. Design and analysis followed a framework analysis approach, with reference to an existing systematic review (SR) on PA and physical fitness among university students. Themes emerging outside of this SR were purposefully explored.

RESULTS: Students with positive feedbacks of the PE courses expressed that the professional qualifications, extensive experience and high enthusiasm among the PE lecturers strongly motivated them to choose, engage and participate in the activities and content of the course. In turn they were more actively involved, learned and played the sport themselves in their spare time. Students with negative feedbacks of the PE courses mentioned the required and elective PE courses were too exam-orientated. Students claimed that the grouping in PE classes was problematic, as putting students of different skill levels in the same class was not ideal.

CONCLUSION: Findings of the qualitative study indicated that students could positively initiate their self-interest in engaging sports that taught by the PE lecturers. Grouping of students based on their prior experience and abilities of the sport before classes commence might be suggested to be a better approach in designing and structuring required and elective PE classes among university students.

**MOVEMENT PATTERNS AND COGNITIVE-ADAPTIVE FUNCTIONS. AN EXPLORATORY EVALUATION IN THE EARLY YEARS OF PRIMARY SCHOOL**

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INTRODUCTION: Motor-sport activities are widely recognized by scientific literature and national and international regulations as fundamental tools for integral personality development, in terms of acquiring personal, cognitive and interpersonal skills (1). However, the rapid technological changes of recent decades are leading to a significant increase in sedentary lifestyles, with consequent appreciable repercussions already in childhood, both on motor and cognitive development. Reduced physical activity in children affects not only the quantity and quality of motor experience, but also the nervous systems ability to integrate and coordinate the sensory and motor information necessary for the acquisition of functional movement patterns. In the light of the most recent neuroscientific contributions, the consolidation of motor praxis and the development of coordination represent complex embodied cognitive processes that depend on the simultaneous interaction between perception, motor control and adaptation to environmental stimuli. The present exploratory study aims to observe the state of acquisition of "movement patterns" and "cognitive-adaptive functions", to investigate the quality of movement experiences in physical education in primary school.

METHODS: The study involved a convenience sample of 263 children (M=124; F=139) attending the first and second year of primary school, who were administered the APCM-2 (2) test for the assessment of praxic skills and motor coordination.

RESULTS: From the point of view of "cognitive-adaptive functions", the results show slight difficulties in the processes of motor planning and sequencing, essential aspects for the development of efficient action schemes for the regulation of movement in response to environmental stimuli. In terms of "movement patterns", there is partial acquisition of basic motor patterns, with greater difficulty in activities requiring integration between balance and dynamic coordination. The data suggest the possibility of implementing educational interventions within Physical Education activities aimed at improving the development of these areas, even in the early years of primary school, in order to positively influence the later development of more complex movement patterns.

CONCLUSIONS:

This preliminary exploratory study, which examines a specific age target for which the presence of the specialised teacher is not yet foreseen in the national educational context, seems to emphasise the need for an intervention aimed at the early and systematic introduction of structured motor activities in the school context, in order to foster the harmonious development of motor and cognitive skills from the earliest stages of learning.

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**QUALITY OF LIFE AND ITS ASSOCIATION WITH PHYSICAL ACTIVITY, PHYSICAL FITNESS, AND ENJOYMENT OF PHYSICAL EDUCATION IN YOUTH: A STUDY ON GENDER DIFFERENCES**

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INTRODUCTION: The COVID-19 pandemic significantly reduced quality of life among children and adolescents, exacerbating psychosomatic complaints, mental health disorders, and social isolation. Physical fitness (PF) also declined, highlighting the importance of physical education (PE) for promoting activity levels and well-being. Research shows gender differences in responses to PE, with boys benefiting more from competitive aspects while girls favour cooperative approaches. Enjoyment of PE, influenced by autonomy and instructional quality, is a key factor for engagement and long-term activity. Despite extensive studies, gaps remain in understanding gender-specific impacts of PE and enjoyment on quality of life, necessitating targeted research and interventions.

METHODS: A cross-sectional study was applied with schoolchildren from fifth grade of 5 public schools in the west of Austria (a total of 176 adolescents, of whom 48.29 % were girls and the mean age was 15.60 ± 0.63). Physical activity (PA), health-related quality of life (HRQoL), and enjoyment in PE were self-reported using previously validated questionnaires (KIDSCREEN-10, FEFS-J: pleasure, flow experience, recovery). PF was assessed using the German motor performance test 6-18. Multiple linear regression was carried out to analyse the regression between HRQoL and PA, PF, and dimensions of enjoyment in PE for girls and boys.

RESULTS: The mean T-score for HRQoL in the entire cohort was 52.11 ± 10.92. Spearmans correlation coefficients demonstrated significant moderate to strong positive correlations between HRQoL and the three dimensions of enjoyment in PE for girls. In contrast, among boys, only the "pleasure" dimension of enjoyment in PE exhibited a significant positive relationship with HRQoL, showing a moderate effect size. Multiple regression analyses showed that pleasure in PE was positively associated with HRQoL for both girls (ß=0.49; R^2=0.30) and boys (ß=0.52; R^2=0.09).

Discussion: The findings emphasize the importance of enjoyment in physical education and gender-specific differences in the impact of physical activity on quality of life. Tailored approaches addressing the distinct needs of boys and girls are crucial to enhance motivation and support long-term physical and mental well-being.

**REQUESTS FOR MEDICAL INTERVENTION DURING THE FIRST TRANSPLANT FOOTBALL WORLD CUP**

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INTRODUCTION: Football (soccer) is one of the most popular sports, practiced by millions of people all around the world. Regular recreational football is considered one of the best long-term guarantees of good health [1], having important potential as health-promoting activity also for solid organ transplant recipients [2]. Thus, the World Transplant Games Federation is working to improve the lives of transplant patients by encouraging participation in Olympic-type events, promoting the 1st Transplant Football World Cup which took place on September 2024 in Cervia (Italy). The aim of this study is to investigate the epidemiology of this type of new competition.

METHODS: Matches were played according to FIFA rules for 7-man teams, with some modifications to safeguard the athletes' transplanted organs. Teams consisted of a maximum of 16 female and male players of all ages. Matches lasted 20 minutes with unlimited substitutions. Two regular FIFA pitches of 60 x 40 m, with a 3 m goal were utilized at the same time. Two sports physicians were always present, providing medical assistance along with an ambulance to deal with any emergencies. They filled out a form specifically designed to collect information about any request for medical intervention (RfMI).

RESULTS: Eleven teams participated involving 172 transplanted players of kidney (N=103; 60%), liver (N=25; 15%), bone marrow (N=18; 10%), heart (14; 8%), kidney-pancreas (N=7; 4%), lung (N=5; 3%). They played 35 matches corresponding to 326 hh 40 min exposition. RfMI were 28 (16% of the participants), involving 13 (52%) liver, 9 (9%) kidney, 3 (21%) heart, 2 (11%) bone marrow and 1 (14%) kidney-pancreas recipients. They were 26 males, and 2 females, aged 36.0±11.1 years, playing as defenders (10), strikers (8), midfielders (6) and goalies (4).

Mechanisms of injury were by noncontact (n=12; 43%), indirect contact (n=9; 32%), direct contact (n=7; 25%). Injuries were classified as: acute (n=23; 82%), acute on chronic (n=4; 12%) and chronic (1; 4%), and as: contusions (n=9; 32%), sprains (n=6, 21%), muscle strain (n=5; 18%), abrasions (n=4; 14%), foot tendinopathy, wound from shoe studs, minor concussion and big toe infection (n=1; 4%, each one). RfMI incidence was 85.7/1000 h (117.4-54.0; ±95%CI); time loss injuries (TLI) were 17, with incidence of 52.0/1000 h (76.8-27.3). All injuries were treated on site, except the wound sent to hospital.

CONCLUSION: Despite the high incidence of TLI, only four injuries were of moderate severity (8-28 days) and no injuries to the transplanted organs were reported. The risks for a recreational footballer represent far less of a danger than the much greater threat posed by a lack of exercise.

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**EFFECTS OF BLOOD FLOW RESISTANCE TRAINING ON MUSCLE SIZE, STRENGTH AND SWIMMING PERFORMANCE IN AN ELITE PARA SWIMMER: A CASE STUDY**

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INTRODUCTION: Charcot-Marie-Tooth disease (CMT) is a group of neuromuscular disorder that typically affects the distal motor and sensory nerves, resulting in muscle atrophy and weakness [1]. The challenge for coaches lies in increasing muscle size and strength due to the inability to increase workloads. The aim of this study is to investigate the effects of a 4-week moderate load resistance training combined with blood flow restriction (ML-BFR) on upper body muscle size and strength, and swimming performance in a world-class paralympic swimmer with CMT.

METHODS: A multi-paralympic gold medallist female para swimmer (32y, 49.94kg) with CMT completed 8 sessions of ML-BFR training across 4 weeks. For each session, the participant performed 4 exercises (60% 1RM, 3-4 sets, 5-6 repetitions, 90s passive rest between sets) with a pneumatic cuff placed around the most proximal portion of the arm, and pressure set at 50-60% of arterial occlusion pressure (AOP). Pressure was only fully released upon completion of the final set of each exercise. Pre- and post-measurements included: 1) magnetic resonance imaging (MRI) to determine muscle cross-sectional area (CSA), 2) one-repetition maximum (1RM) testing, 3) mean concentric velocity (MVC) outputs at submaximal loads and 4) 100m swim time trial.

RESULTS: Muscle CSA of both bicep brachii (0.7%) and pectoralis major (13.0%) increased whereas triceps brachii (-6.0%) latissimus dorsi (-0.8%) CSA decreased. 1RM for all exercises increased: 2.6% lat pulldown, 5.26% bench pull, 3.03% bench press and 6.25% shoulder press. MVC in both lat pulldown and bench press also improved 5.05% and 6.35% respectively. Swim performance time lowered by 11.5%.

CONCLUSION: Results of the present study indicated that ML-BFR leads to strength increases but did not allow for a definitive conclusion of the hypertrophic response of ML-BFR training. Due to the single pre-post design of this study, it was unknown whether the changes in swimming performance were a result of BFR or specific sport training effect. Future research with a single case experimental design over multiple training blocks is warranted to fully understand the effects of BFR on muscle hypertrophy and strength.

**BALANCE PARAMETERS AMONG CLASSES OF TOP-LEVEL PARA-KARATE ATHLETES**

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INTRODUCTION: Para-karate is modality of karate focused on developing discipline of "kata" for wheelchair athletes, visually impaired (VI) athletes and athletes with intellectual impairments (II) and is a fully integrated part of operations of World Karate Federation (WKF) [1]. There are three categories for individual kata: visually impaired (VI: K10), intellectually impaired (II) – IQ less than 75 (II: K21) and Down Syndrome (DS: K22). These categories are divided into sport classes. A compensation points are given according to degree of impairment assessed by expert WKF classifiers during classification session. The system aims to determine who is eligible to compete at Paralympic Games, while ensuring that it is not degree of impairment but sporting excellence that ultimately determines which athlete or team is victorious [2]. A closer view into performance during a balance test offers practitioners better understanding of the differences among classes of para-karate athletes. This information can be a valuable clue to the detailed performance deficiencies. Intentional addressing in the training process can lead to an increase in sports performance [3].

METHODS: Fifty-eight top-level para-karate athletes participated in the study (VI: n=23, aged 30.0 ± 8.7; II: n=16, aged 26.5 ± 5.2, DS: n=17, aged 27.5 ± 6.4). We aimed at differences among classes in parameters of 30 second balance test: parallel stance, opened eyes, hands on hips and no manipulation. Athletes were instructed to step on plates, standing still for 30 seconds, maintaining eye contact with the picture on the wall in front of them during test. All completed 2 attempts with resting interval of 60 seconds. We took best attempt for statistical analysis. We used device Kistler Force plates. Parameters obtained were total path [mm] and velocity [mm.s-1] of centre of pressure (COP). Athletes performed test as a classification session of World Para-karate championship 2023. For statistical analysis we used Kruskal-Wallis H and Mann-Whitney U test.

RESULTS: We found significant differences among classes for total path $H(2) = 13.21$, $P < .001$, and revealed significant differences between VI and II ($U = 70.5$, $p < .001$) and II and DS ($U = 217$, $p = .035$) and no differences between VI and DS ($p = .112$), as well for total area $H(2) = 12.93$, $P < .002$, we revealed significant differences between VI and II ($U = 129$, $p = .047$) and VI and DS ($U = 76.0$, $p < .001$) and no differences between VI and II ($p = .184$).

CONCLUSION: VI athletes showed a significantly higher rate of COP movement during the test compared to mentally disabled karatekas of both groups showing need for working on the stability in strength and conditioning preparation. Among mentally disabled athletes, II athletes showed more pronounced fluctuations of COP in multiple directions (medio-lateral and antero-posterior) but at a lower velocity compared to DS group, suggesting better control of the COP movement for II athletes.

**CHARACTERISTICS OF PARA ALPINE SKIING FALLS DURING THE BEIJING 2022 WINTER PARALYMPIC GAMES**

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INTRODUCTION: Para alpine skiing has a high injury incidence of 19.9 per 1,000 athlete days [1], with falls as a key contributing factor. Para alpine skiing consists of five events: Downhill, Slalom, Giant Slalom, Super G, and Super Combined Slalom, each differing in course length and flag gates. Athletes compete in the standing and the sitting categories, with the standing category further subdivided into visual, upper limb, lower limb, and combined upper and lower limb impairments. Fall incidence likely varies by the event, category, and environmental factors such as temperature and snow quality, yet their relationship remains unclear. This study aimed to clarify the characteristics of falls in para alpine skiing using video analysis.

METHODS: We analyzed official competition footage of para alpine skiing during the Beijing 2022 Winter Paralympics, obtained from the official website of the International Paralympic Committee. A total of 898 races across all five events in both mens and womens categories were examined, excluding "Did Not Start" entries. Falls were identified by three physiotherapists, requiring at least two judges to confirm an incident [2]. A fall was defined as any body parts making contact with the snow surface. Basic information on the athletes and environmental conditions during the competition was recorded from the official result book. Statistical analysis included Pearson $\chi^2$ test or Fisher exact test for categorical comparisons based on the occurrence of falls, with adjusted residuals for post hoc tests. The significance level was set at $p<0.05$.

RESULTS: A total of 146 falls occurred in 898 races (0.16 falls per race). A significant difference in fall incidence was found only among categories ($p<0.01$). Residual analysis revealed that falls were significantly lower in the combined upper and lower limb impairment category (9 falls in 109 races, 0.08 falls per race) and higher in the sitting category (79 falls in 307 races, 0.26 falls per race). Among the 146 falls that occurred, 115 falls (78.8%) resulted in Did Not Finish (DNF) or Disqualified (DSQ).

CONCLUSION: Our findings suggest that fall incidence in para alpine skiing is primarily influenced by the categories. Since the PyeongChang 2018 Winter Paralympics, environmental measures during races have been implemented as fall pre-

vention [3], leading to the assumption that environmental factors did not affect fall incidence. Notably, the sitting category showed the highest fall incidence. It may have been influenced by the characteristics of sit-ski, where balance must be maintained using the upper body. Given the about 80% of the fallen athletes were DNF or DSQ, they may have sustained injuries preventing them from continuing the race. Fall prevention measures tailored to each category are crucial for both injury prevention and competition.

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**UPPER LIMB STRENGTH EVALUATION OF PARALYMPIC SUMMER SPORTS SITTING ATHLETES**

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INTRODUCTION: Strength (St) is a fundamental health related component of physical fitness (1), linked to quality of life in wheelchair bound individuals and to performance in different winter sports practiced by paralympic athletes (PA) with a locomotor impairment (LI) (2). The present retrospective chart review is aimed at describing the maximal strength of upper body muscles of PA with a LI (PA-LI) consequent to spinal cord injury (SCI), lower limb amputation (LLA) and other health conditions (OHC) determining a LI and competing in different Paralympic summer sports.

METHODS: Seventy-two male PA-LI, 48 with SCI (all with paraplegia), 24 NON-SCI (13 LLA and 11 with OHC) were included in the study and divided into 3 groups (G) of sport type: G1, skill sports(SS) (25 PA), G2, aerobic and anaerobic mixed metabolism sports (MS) (30 PA) and power sports (PS) (6 PA) and G3, endurance sports (ES) (11 PA). Maximum isometric strength of both finger flexors (handgrip, HG) and shoulder lowering muscles (SLM) was measured using a laboratory made dynamometer (MK7, Dal Monte, Italy). For both tests maximal voluntary contraction (MVC) was assessed in right and left muscles and the best value of 3 MVCs of the 2 sides were summed for the strength evaluation. Absolute and normalized (per kg of body mass) data were considered for statistics. Data were analyzed using a 1-way analysis of variance (ANOVA) design in which sport type was considered as categorical independent variable (factor) and strength as dependent variable. Through a Tukey honestly significant difference test, the probability for post hoc test was calculated.

RESULTS: Strength of PA competing in ES (1334.6±352.72 N - 19.4±3.85 N/kg) was significantly higher than in PA competing in SS (1166.5±228.83 N - 15.7±4.03 N/kg) (p=0.018). No significant differences between SS- MS and PS (1218.1±252.82 N - 16.7±3.36 N/kg), and ES- MS and PS were found. No significant difference in means among the groups was found in the analysis of SLM: SS (967.0±141.29 N - 12.9±2.54 N/kg), MS and PS (1014.0±193.21 N - 13.8±2.96 N/kg), and ES (991.0±181.20 N - 14.6±2.95 N/kg). Between SCI and NON-SCI there weren't significative differences in both HG and SLM: SCI (1228.6±249.01 N - 17.1±3.89 N/kg) NON-SCI (1195.4±313.46 N - 15.9±3.64 N/kg) and SCI (964.6±168.50 N - 13.4±2.14 N/kg) NON-SCI (1053.2±191.89 N - 14.0±2.14 N/kg).

CONCLUSION: Strength, which should be the main physical features components of power sports, has been found very high in Paralympic athletes with locomotive impairments competing in endurance sports, such as bike seating, north skiing and long distance wheelchair racing.

**INFLAMMATORY RISK AND CARDIORESPIRATORY FITNESS IN PARALYMPIC ATHLETES WITH A LOCOMOTOR IMPAIRMENT**

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INTRODUCTION: Individuals with spinal cord injury (SCI) have higher levels of chronic low-grade systemic inflammation (LGSI), health condition (HC) strictly related to non-communicable chronic diseases and in particular to atherosclerotic cardiovascular disease (ACVD), than their able-bodied counterparts (1), and this HC is highly represented in athletes with a locomotor impairment (LI) (2). Previously, we showed an association between ACVD risk factors (RF) and cardiorespiratory fitness (CRF), meaning that a low CRF is associated with a high number of ACVDRF and vice versa (3). The present study aimed at evaluating both the inflammatory status (4), assessed through the ratio between neutrophil and lymphocyte counts (neutrophil-lymphocyte ratio-NLR) in PA with different HC and competing in different sports and the relationship between CRF and NLR.

METHODS: Data from 153 male PA (82 PA with SCI and 71 with other HC PA-OHC) recruited from the pre-participation screenings preceding Paralympic Games from Sydney 2000 and Sochi 2014 (2) were retrospectively evaluated. PA had competed in skilled sport–SS (24.8%), power sports–PS (18.3% of PA), aerobic and anaerobic mixed metabolism sports–MS (39.9%) and endurance sports–ES (17.0%). They were screened through anthropometric measurements, to assess body mass and height, blood samples, to assess neutrophil and lymphocyte counts, and an incremental cardiopulmonary maximal exercise test to assess peak of oxygen uptake (VO2peak) expressed in ml kg-1 min-1. After having checked the absence of normal distribution of the variables, Mann-Whitney test and Kruskal-Wallis test were used to compare the two groups of HC and the 4 groups of sports, respectively. Spearman correlation was performed to evaluate the relationship between VO2peak and NLR.

RESULTS: NLR did no show differences when comparing both PA-SCI (1.68; 0.9-4.1) and PA-OHC (1.56; 0.7-3.8) and sport type: 1.71 (0.7-3.8) in SS, 1.61 (0.9-3.2) in PS, 1.61 (0.9-4.1) in MS and 1.41 (0.9-2.7) in ES. The prevalence of PA with high inflammatory status (cut-off NLR>3) was in accordance with health condition 6.09% in PA-SCI and 4.22% in PA-OHC and in accordance with sport type was 5.2% in SS, 3.5% in PS, 8.2% in MS and 0% in ES. VO2peak, lower in PA-SCI (28.6; 15.2-54.5) than in PA-OHC (35.1; 19.4-58.2), significantly differed in the 4 types of sports (23.88; 15.2-39.7 in SS; 32.38; 17.1-50.8 in PS; 33.26; 16.4-44.7 in MS and 43.12; 27.5-58.1) and correlated negatively with NLR.

CONCLUSION: NLR, which resulted globally high in PA-LI, showed an inverse relationship with aerobic fitness. PA-LI competing in SS which displays low VO2peak values should train also in ES to counteract LGSI.

**SELF-MEDICATION AND PARASPORT: A STUDY ON ADULT AMATEUR ATHLETES WITH MOTOR DISABILITIES**

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INTRODUCTION: Limited research has been conducted on self-medication (SM) practices in sports, particularly among amateur athletes with motor disabilities. While SM is prevalent among able-bodied athletes, there is a lack of data on its use among amateur disabled athletes.

This study aimed to determine the prevalence of self-medication among amateur sportsmen and women with physical disabilities, identify factors influencing self-medication behaviors, and address misconceptions associated with these practices.

METHODS: Quantitative cross-sectional study conducted using an anonymous online self- administered questionnaire. The study included amateur disabled sportsmen and women from Belgium and France. Self-medication behaviors were assessed for dietary supplements (DS), over-the-counter drugs (OTC), and formerly prescribed drugs (FPD) through self-reported procedures. Data on participant characteristics, sports practice, consumed products, and knowledge were collected. Descriptive statistical analyses, group comparisons, and logistic regressions were performed to assess factors influencing self-medication.

RESULTS: 164 disabled sportsmen and women recruited 38.7% of self-medication practices in the context of sports reported (23.2% used DS, and 25.6% used MEDS (OTC and FPD combined)). Self-medication with DS: positively associated with age, consumption of caffeinated and energy drinks, and self-medication with MEDS. Self-medication with MEDS: positively associated with the number of hours of sports practice, consumption of caffeinated drinks, and self-medication with DS. Paracetamol was the most commonly consumed pharmaceutical molecule, while proteins were the most commonly used DS. 36.4% of participants using MEDS and 42.1% using DS believed that self-medication posed no health risks.

CONCLUSION: High prevalence of self-medication among amateur sportsmen and women with physical disabilities. Fortunately, paracetamol, which is one of the most commonly used medications, is generally associated with a low risk of side effects. However, even with this seemingly innocuous medication, recent research has raised concerns about potential safety issues, emphasizing the need for a more cautious approach to usage of any medications. The associated risks, reliance on unreliable sources of advice and information (e.g., the internet), and lack of awareness regarding the dangers of self-medication highlight the need for educational strategies targeting amateur disabled athletes. Further research is required to gain a deeper understanding of self-medication behavior in this population.

**MAPPING THE SCIENTIFIC LITERATURE ON THE PARALYMPIC GAMES AND PARALYMPIC SPORT**

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INTRODUCTION: In recent decades, research on Paralympic sport has expanded; however, the extent of its interdisciplinarity remains uncertain. The field is predominantly shaped by biomedical and rehabilitation studies, while disciplines such as social sciences, psychology, and sports economics remain underrepresented [1], limiting comprehensive analysis of key aspects such as classification, accessibility, and inclusion.

Given this context, the present study aimed to: (1) map the scientific literature on Paralympic sport by identifying trends and thematic areas through a bibliometric analysis; (2) assess interdisciplinarity by examining co-citation networks, connections between journals and institutions, and keyword clustering; and (3) identify gaps and disciplinary imbalances by analyzing thematic concentration and proposing strategies for greater integration.

METHODS: This study employed a bibliometric approach, analyzing articles published in the Web of Science, Scopus, PubMed, and JSTOR databases. The analysis included bibliometric indicators such as co-citation networks, keyword analysis, and collaboration networks between journals and institutions [2]. Data were processed using the Bibliometrix package in R [3].

RESULTS: A total of 718 articles were included in the study. The analysis revealed a significant increase in scientific production since 2016, with a peak in 2020. However, the results showed that interdisciplinarity remains limited: 35% of studies fall within sports sciences, followed by rehabilitation (21%) and physiology (4%), while disciplines such as sociology and applied psychology account for less than 2%. Co-citation networks indicated distinct disciplinary clusters with minimal connections between biomedical and social sciences. Keyword clustering further highlighted the dominance of terms related to performance and functional classification, whereas concepts such as inclusion and accessibility appeared marginal.

CONCLUSION: The findings confirmed the growth of research on Paralympic sport but highlighted persistent challenges in achieving interdisciplinary integration. The dominance of biomedical studies limits attention to inclusion, accessibility, and sports policies. Furthermore, the concentration of publications in a limited number of high-impact journals may reduce methodological diversity. To address these challenges, greater collaboration between biomedical, sports, and social sciences is needed to foster a more integrated approach to key issues in the field.

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[2] Donthu, N. et al. (2021). How to conduct a bibliometric analysis: An overview and guidelines. Journal of Business Research.

[3] Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. Journal of Informetrics.

## Conventional Print Poster Presentations

### CP-MH16 Ageing III - Covid-19

**COLLISIONS AND CONTAGIONS: EXPLORING THE OVERLAP OF CONCUSSION AND COVID-19 ON SENSORIMOTOR AND AUTONOMIC FUNCTION IN COMMUNITY DWELLING AUSTRALIAN FOOTBALL LEAGUE ATHLETES**

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INTRODUCTION: Concussion is a concern in contact sports, as it may disrupt the sensorimotor pathways essential for movement control – visual, vestibular, and somatosensory (VVS) systems – and potentially affects autonomic nervous system (ANS) function (1,2). Emerging evidence suggests that COVID-19 may similarly impact VVS and ANS function (3). This study investigated the relationship between self-reported history of COVID-19 and/or self-reported sport related concussion (SSRC) on VVS and ANS function in athletes.

METHODS: 120 community level Australian Football League athletes (51 females, aged 16–37 years) participated in this study as part of pre-season baseline testing. Participants completed a self-report questionnaire, enabling categorisation into four groups: no history of COVID-19 or SSRC within the past 12 months (n=82), SSRC within the past 12 months (n=11), COVID-19 infection within the past 12 months (n=22), and both COVID-19 and SSRC within the past 12 months (n=5). Assessments were then conducted to evaluate visual-vestibular function (smooth pursuit and voluntary saccades), somatosensation (Active Movement Extent Discrimination Assessment, AMEDA), and autonomic function (pupillary light reflex). Independent samples t-test was performed in RStudio to detect differences between groups: no-history – COVID, no-history – SSRC, no-history – both. Significance set at $p<0.05$.

RESULTS: Athletes with self-reported history of COVID-19 infection in past 12 months demonstrated significant reductions in sympathetic ($p=0.016$) and parasympathetic ($p=0.049$) function, when compared to the no-history group. Those with combined histories of COVID-19 and SSRC exhibited significant declines in sympathetic function ($p=0.042$), when compared to the no-history group. No significant differences in VVS function were observed across groups, and the SSRC-only group showed no significant ANS or VVS reductions.

CONCLUSION: This is the first study to examine the combined impact of self-reported history of COVID-19 and SSRC on VVS and ANS function. History of COVID-19 infection significantly impaired ANS function in this population. Insufficient power limited between-group comparisons, with post-hoc analysis indicating 30 athletes required per group. While SSRC alone did not significantly affect VVS or ANS function, the combined impact of both COVID and SSRC history resulted in detectable deficits even in a small sample. Reliance on self-reported data may have introduced bias. These findings underscore the lingering effects of COVID-19 and the potential compounding effects of SSRC and COVID-19 on ANS function in athletes.

References: 1.Caccese et al. (2021) 2.Esterov & Greenwald (2017) 3.Zacher et al. (2023)

**PROTECTIVE EFFECT OF PHYSICAL ACTIVITY AGAINST COVID-19 IN THE OLDER PEOPLE: THE PROOF COHORT**

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INTRODUCTION: Epidemiological studies showed that age was a risk factor for the coronavirus disease 2019 (COVID-19) infection, severity, hospitalization and mortality [1,2]. In the same time, epidemiological studies showed a reduced risk of COVID-19 severity with the practice of regular physical activity (PA) in clinical populations [1,2] but it is unknow if is the same in elderly population. Here, we investigate the effect of PA against COVID-19 infection in elderly population.

METHODS: The PROOF cohort study (2001-) was used to prospectively allow assessment of the predictive value of PA among a healthy retired French population, with regard to COVID-19 infection (2020-2021). Moderate-to-vigorous physical activity (MVPA) and sedentary behaviour were assessed by a validated self-administered questionnaire (POPAQ) investigating 5 different types of PA during the 7 previous days. PA was measured in metabolic equivalent of task (MET)-h, which refers to the amount of energy (calories) expended per hour of PA. SB was measured in hour/day. Medical histories were

taken during each clinical visit. The relationships between MVPA and COVID-19 infection were analyzed by univariate and multivariate logistic analysis, adjusted for several covariates.

RESULTS: Among 372 subjects (214 women, mean age: 74.79 ± 0.96 years), 14 (3,76%) reported COVID-19 infection. Univariate logistic analysis revealed no association between COVID-19 infection and sitting time in hours per day (odds ratio (OR) 0,95; 95% confidence interval (CI) 0.66 to 1.36; p=0.773) or the number of hours per day of PA greater than or equal to 3 Metabolic Equivalent of Task (METs) (OR 0.65; 95% CI 0.38 to 1.09; p=0.099). Finally, multivariate logistic analysis controlled for the covariates age, body mass index, alcohol consumption, high blood pressure, cholesterol, cancer and non-insulin-dependent diabetes showed that the number of hours per day of PA greater than or equal to 3 METs per day was independently associated to low risk of COVID-19 infection (OR 0.53; 95% CI 0.30 to 0.96; p=0.037), but not sitting time in hours per day (OR 0.94; 95% CI 0.65 to 1.35; p=0.726).

CONCLUSION: The results showed that, for older people, the number of hours spent sitting per day does not seem to have an impact on the risk of COVID-19 infection. However, regular physical activity of moderate to vigorous intensity could offer protection against COVID-19 infection independently of known confounding factors. In a context of global warming with future emerging viral diseases, further researches are needed to understand the association of PA and various viral infections (such as dengue or chikungunya).

References

[1] de Souza et al. Journal of Science and Medicine in Sport, 2021.

[2] Sallis et al. Br J Sports Med, 2021.

**THE RELATIONSHIP BETWEEN SUBJECTIVE AND OBJECTIVE ASSESSMENT OF THE LEVEL OF PHYSICAL ACTIVITY IN OLDER WOMEN**

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INTRODUCTION: Physical activity is a key determinant of health in elderly women. While self-reported questionnaires provide subjective assessments, wearable devices offer objective measures [1]. Understanding the correlation between these two methods is essential for improving health monitoring strategies. This study aims to examine the correlation between subjective PA assessments obtained through International Physical Activity Questionnaire (IPAQ) and objective PA measurements from wearable sensors.

METHODS: This study analyzed PA data from 71 older women (aged 60 years and above), all of whom were of Caucasoid ethnicity. Subjective PA assessment was conducted using IPAQ, while objective PA tracking was performed using a Polar V-800 heart rate monitor (Polar Electro Oy, Finland). Additional variables included self-reported health status, pain experience, and PA levels, which were compared against device-measured standing, walking, and running times. Differences between subjective and objective PA assessments were analyzed using ANOVA, and Pearson correlation coefficients were calculated to assess associations between self-reported and device-measured PA levels.

RESULTS: Preliminary analysis identified a statistically significant discrepancy between self-reported and device-measured PA levels (mean ± standard deviation: 3098 ± 2540 MET-min/week vs. 1647 ± 324 MET-min/week, $p < 0.05$). Further correlation analysis revealed no significant association between self-reported health status, pain experience, and objectively measured PA levels ($p > 0.05$). However, education level exhibited a significant negative correlation with self-reported PA levels ($r = -0.28$, $p < 0.05$), whereas chronic pain status demonstrated a significant positive correlation with self-reported PA levels ($r = 0.29$, $p < 0.05$)

CONCLUSION: These results indicate that self-reported PA assessments may be influenced by individual characteristics, emphasizing the need for integrating objective measurement tools to enhance accuracy in PA monitoring. Future research should explore additional factors influencing self-reported PA accuracy and develop refined assessment models tailored to diverse populations.

References:

1. Cleland C. Validity of the International Physical Activity Questionnaire (IPAQ) for assessing moderate-to-vigorous physical activity and sedentary behaviour of older adults in the United Kingdom. BMC Med Res Methodol. 2018 Dec 22;18(1):176.

**MASTER ATHLETES AND CANCER RISK: EXPLORING THE PROTECTIVE BENEFITS OF LIFELONG EXERCISE**

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INTRODUCTION: Physical activity and exercise are associated with a decreased cancer risk and lower mortality rates(1). This association is also observed among elite athletes, who tend to have longer lifespans(2). Over the past two decades, various research groups have hypothesised that some of these protective benefits may stem from reducing cancer risk factors, such as obesity, and directly affecting cancer cell viability(3). However, the cellular and molecular mechanisms involved are not yet fully understood, and studies on the effects of lifelong exercise remain limited and inconsistent. Master athletes who engage in lifelong exercise could be a model of healthy ageing, providing insights into the cellular and molecular mechanisms underlying the protective benefits of lifelong exercise against cancer. Our work aimed to reinforce and expand knowledge in the emerging field of exercise oncology. We analysed the effect of lifelong exercise on cancer

risk factors and serum profiles. Furthermore, we explored the effects mediated by serum profiles conditioned by lifelong exercise and high-intensity exercise on markers of the degree of transformation of cancer cells.

METHODS: Using a non-randomized control trial study design, we assessed the body composition, cardiorespiratory fitness (VO2 max) and serological profile (lipoproteins, cytokines and growth factors) of master athletes—as a model of lifelong exercise— and healthy age-matched non-exercisers, before and after a progressive maximal aerobic test. Through in vitro assays, we assessed the effect of serum at rest and post-exercise from master athletes and healthy non-exercisers on markers of the degree of transformation of human lung carcinoma cells (A549) such as adhesion and/or resumption of proliferation, proliferation rate, clonogenic potential, the capacity of migration and bioenergetic phenotype.

RESULTS: Master athletes had an increased relative VO2 max of 7.86 ± 2.09 mL kg−1 min−1 ($p \leq 0.05$), an increase of 3.41 ± 1.46% in muscle mass, and a reduced fat mass of −5.44 ± 2.29 kg ($p \leq 0.05$) when compared to the non-exercisers. The growth factors and cytokine arrays (99 proteins) approach showed a cohort-dependent serum profile with master athletes' serum at rest with lower factors linked to the senescence-associated secretory phenotype. Mater athletes' acute exercise-conditioned serum significantly increased cell adhesion and/or resumption of proliferation, reduced cell proliferation rate, reduced colony size (2.12 ± 0.3 to 1.25 ± 0.2 μm2), and reduced L-lactate production (0.058 ± 0.01 to 0.025 ± 0.03 μmol) compared to the at-rest serum.

CONCLUSION: Our results suggest that lifelong exercise modulates cancer risk factors and serum profiles in ageing, influencing cancer prevention with each exercise session creating a chronic effect. Furthermore, the beneficial effects of exercise directly on cancer cells might depend on its characteristics, such as intensity and duration.

References:

1.PMID: 27183032; 2.PMID: 25128074; 3.PMID: 33965899

**ASSESSMENT OF PHYSICAL FITNESS IN CHILEAN INSTITUTIONALIZED ELDERLY WOMEN**

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INTRODUCTION: Assessing functional mobility and strength in institutionalized elderly women is essential for the planning of tailored interventions (1). This study evaluates the relationships between handgrip dynamometry, risk of falling test, and functional performance, utilizing the Barthel Index and various physical tests.

Reference:

1. Courel-Ibáñez, J., Buendía-Romero, Á., Pallarés, J. G., García-Conesa, S., Martínez-Cava, A., & Izquierdo, M. (2022). Impact of tailored multicomponent exercise for preventing weakness and falls on nursing home residents' functional capacity. Journal of the American Medical Directors Association, 23(1), 98-104.

METHODS: A cohort of institutionalized elderly women (n=91, 85±7 years old, 25.5±5.2 kg/m2) underwent a series of assessments including handgrip dynamometry, Barthel Index, arm curl, one-leg stance (left and right), Timed Up and Go (TUG), and the 30-second sit to stand test (30s STS). Statistical analyses, including correlation and regression, were performed to explore the relationships between the Barthel Index scores and the physical performance metrics. This study was approved by the institutional ethic committee. The statistical analysis was conducted with Jamovi software.

RESULTS: Significant correlations were found between the Barthel Index and handgrip strength ($r=0.40$, $p<0.001$), arm curl performance ($r=0.21$, $p<0.04$), and 30s STS ($r=0.40$, $p<0.001$). The one-leg stance test revealed weaker but statistically significant associations with Bathel Index (left leg: $r=0.27$, $p<0.009$; right leg: $r=0.28$, $p<0.007$). TUG times were significantly inverse correlated with Barthel scores ($r=-0.46$, $p<0.001$); as functional ability improved, mobility times decreased. The regression model accounted for 55% of the variance in Barthel scores based on performance in these tests ($F(5,94) = 12.3$, $p<0.001$).

CONCLUSION: The findings indicate that higher functional independence, as assessed by the Barthel Index, is positively associated with handgrip strength, arm curl, and sit-to-stand test performance while inversely related to TUG times. These results underline the importance of incorporating strength and mobility serial assessments to enhance care strategies for institutionalized elderly women, aiming to reduce risks of falling and promote functional independence. Future studies should explore intervention strategies focused on improving these physical capabilities to enhance overall quality of life in this vulnerable population.

**CARDIOVASCULAR ADAPTATION AND RECOVERY DYNAMICS IN ADULTS: INSIGHTS FROM PULSE WAVE ANALYSIS AND POST-EXERCISE HEMODYNAMIC RESPONSES**

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INTRODUCTION: Cardiovascular adaptability and post-exercise recovery are critical indicators of metabolic and vascular health, yet their interplay with age, gender, and body composition remains underexplored. This study investigates hemodynamic and vascular stiffness parameters in adults to evaluate how exercise impacts cardiovascular resilience and recovery, with implications for personalized health interventions.

METHODS: A cross-sectional analysis was conducted on 350 participants (aged 33–87 years, 62% female). Key metrics included resting heart rate (HR), systolic/diastolic blood pressure (SBP/DBP), pulse wave velocity (PWV), ankle-brachial

index (ABI), and BMI. Post-exercise recovery HR, vascular stiffness (classified as normal, moderately stiff, or stiff), and 3-minute HR recovery were measured. Data were analyzed using descriptive statistics and ANOVA for age/gender stratification.

RESULTS: 1.Vascular Stiffness: 42% of participants exhibited elevated vascular stiffness (PWV >1400 cm/s), with higher prevalence in males (55%) and those aged >60 (68%).

2.Recovery Dynamics: Post-exercise HR recovery lagged in older adults (ΔHR: -28 bpm vs. -42 bpm in <50-year-olds, p<0.01).

3.Body Composition: Higher BMI (>28) correlated with increased vascular stiffness (OR=2.1, p=0.003) and delayed DBP normalization.

4.Gender Differences: Females showed lower resting HR (72±11 vs. 78±14 bpm, p=0.02) but comparable PWV values to males.

CONCLUSION: Age and body composition significantly influence vascular stiffness and post-exercise recovery, highlighting the need for age-tailored exercise regimens. Elevated PWV in older adults underscores the role of vascular health in exercise tolerance. Gender-specific differences in HR dynamics suggest divergent cardiovascular adaptation mechanisms. These findings advocate for integrating vascular stiffness metrics into routine fitness assessments to optimize exercise prescriptions and mitigate cardiovascular risks. Limitations include potential confounding factors (e.g., undiagnosed vascular calcification) and incomplete recovery data in select cases.

## Conventional Print Poster Presentations

### CP-MH17 Physical Activity / Inactivity and Mental Disabilities

**HIGH ADHERENCE TO 24-HOUR MOVEMENT GUIDELINES ASSOCIATED WITH BETTER DIET QUALITY IN MULTI-DISCIPLINARY FOOTBALL STAFF**

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INTRODUCTION: Support staff in elite sports face similar stressors as athletes, yet their health behaviours remain under-researched. Studies suggest their well-being impacts team success (1). Understanding whether they meet the health recommendations they advocate for players is crucial. This study examines the association between adherence to 24-hour movement (24HM) guidelines and diet quality (DQ) among football sports staff, a group affected by irregular schedules and high-pressure environments.

METHODS: 120 male (n = 73) and female (n = 47) members of staff in England (n = 65) and Spain (n = 55) in competitive-elite football enrolled by invitation (age: 33.1 ± 9.3 years, height: 174.2 ± 9.1 cm, mass: 75.1 ± 14.9 kg). 24HM adherence is established by the Canadian 24-hour Movement Guidelines (2). Partial adherence is set at >150min of moderate-to-vigorous physical activity (MVPA) per week, >3h of light physical activity (LPA), <8h of sedentary behaviour (SB) per day and >7h of sleep per night. Total adherence includes the above criteria plus 2 sessions of resistance training per week (RT), movement if sedentary for >1h (SM), consistent bed and wake-up time (BWT) and <3h of screen time (ST) per day. The validated Mini-EAT dietary screener was used to evaluate DQ (3) and calculates a summary score. Bootstrap resampling with logistic regression was used to estimate confidence intervals for the odds ratio of the effect of DQ on 24HM adherence, with Spearman correlation to assess the relationship between 24HM adherence and DQ. ANOVA and Tukey's HSD were used to examine the influence of descriptive factors on 24HM adherence. The trial is open between January 15th to March 15th and a minimum of 229 participants will be enrolled upon closing.

RESULTS: Preliminary results show 37.5% of participants meet partial adherence to 24HM, with 10% of participants achieving total adherence. Improved DQ is positively associated with a 10.3% increase in the odds of meeting total 24HM adherence criteria (OR = 1.103, 95% CI: 1.003–1.264) and a 4.1% increase in partial adherence of 24HM, but with non-significant 95% CI (0.986–1.094). Higher DQ is significantly associated with adherence to guidelines for MVPA (OR = 1.1 [1.043, 1.162], p = 0.0002), RT (OR = 1.15 [1.083–1.231], p = 0.0001) and SM (OR 1.065 [1.008–1.137], p = 0.03). Job type was significantly associated with total adherence to 24HM (p = 0.005), with notable differences between Performance Nutritionists and both Head Coaches (p = 0.03) and Goalkeeping Coaches (p = 0.02).

CONCLUSION: Total adherence to 24-hour movement guidelines is associated with better diet quality in multi-disciplinary football staff, notably when staff follow the guidelines for MVPA, RT and SM.

Clinical Trials ID: NCT06771752

Ethics Approval: 2024-12-02 CER-FCSB

1. Leprince et al., Sports Medicine, 2024

2. Ross et al., Applied Physiology, Nutrition, and Metabolism, 2020

3. Lara-Breitinger et al., Journal of the American Heart Association, 2023

**SOCIOECONOMIC FACTORS, PHYSICAL ACTIVITY, AND SEDENTARY BEHAVIOUR AMONG AUTISTIC ADULTS AGED 40–70 YEARS: EVIDENCE FROM THE UK BIOBANK**

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INTRODUCTION: Autism is a neurodevelopmental condition marked by social impairments and repetitive behaviour. Research shows autistic individuals tend to have lower physical activity (PA) and higher sedentary behaviour (ST), increasing the risk of chronic diseases. Understanding the sociodemographic factors affecting PA and ST is crucial for developing targeted health promotion strategies to enhance the health and well-being of autistic adults.

METHODS: Using the UK Biobank database, this study included 408 autistic individuals diagnosed by professional institutions. Baseline data were analysed, focusing on sociodemographic factors such as sex, ethnicity, education, family income, housing ownership, residential population, and employment status. Sedentary behaviour was measured by screen time (TV and computer use) and total sedentary time (including screen time and driving). PA was assessed through frequency and volume, with total PA level as an outcome. Logistic regression models were used to examine the associations between sociodemographic factors and PA and ST outcomes.

RESULTS: Male participants were more likely than females to have longer screen time per day (≥4 hours: OR 1.08, 95% CI: 1.08–3.29, compared with ≤2 hours) and more total ST time per day (≥5 hours: OR 2.14, 95% CI: 1.26–3.61, 3–5 hours: OR 2.07, 95% CI: 1.23–3.50, compared with <3 hours). Males were also less likely to meet the recommended PA levels (≥150 minutes of moderate PA or 75 minutes of vigorous PA per week: OR 2.36, 95% CI: 1.25–4.46), but had lower walking frequency (>3 days/week: OR 0.52, 95% CI: 0.28–0.96). Compared with individuals with a bachelors degree, those with lower education levels had more total ST time per day (≥5 hours: OR 1.82, 95% CI: 1.07–3.09) and were more likely to meet the ≥3 days of moderate PA per week (OR 1.78, 95% CI: 1.14–2.78). Individuals with family incomes below £31,000 per year had increased screen time per day (≥4 hours: OR 4.35, 95% CI: 1.08–17.56, compared with <2 hours) relative to those with incomes above £100,000. Employment or self-employment was associated with lower screen time (≥4 hours/day: OR 0.36, 95% CI: 0.19–0.70) and a higher likelihood of engaging in moderate PA (OR 2.94, 95% CI: 1.59–5.42) compared with unemployed or retired individuals.

CONCLUSION: Gender, education level, family income, and employment status are linked to sedentary time (ST) and physical activity (PA) in autistic adults. Males, those with lower income or education, and the unemployed or retired tend to have higher ST and lower PA. These findings underline the importance of targeted health interventions for autistic individuals, particularly those from disadvantaged backgrounds. Public health initiatives should focus on promoting PA and reducing sedentary behaviour, especially in autistic males and those with lower socioeconomic status.

**CARDIORESPIRATORY FITNESS AND CAROTID INTIMA-MEDIA THICKNESS IN ADULTS WITH AND WITHOUT DOWN SYNDROME**

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INTRODUCTION: Adults with Down syndrome (DS) present different clinical characteristics that may influence their cardiorespiratory fitness and cardiovascular health. Carotid intima-media thickness (cIMT) is an established cardiovascular risk marker that has not been sufficiently studied in this population. Therefore, we aimed to describe and compare the cIMT values in adults with and without DS (Non-DS). We also examined the relationship between cardiorespiratory fitness and cIMT.

METHODS: Sixteen adult males with DS (29±6 yrs) and 16 Non-DS males (28±5 yrs) participated in this study. An informed consent and a health screening questionnaire were completed by each participant and/or legal guardian. We assess height, weight, maximum oxygen consumption ($VO_2$ peak) during a metabolic treadmill test; systolic blood pressure (SBP), and diastolic blood pressure (DBP). The right common carotid artery was imaged longitudinally 1 to 2 cm upstream of the bifurcation using a 6.0 to 13.0 MHz linear array transducer (GE L6-12-RS, GE Medical Systems, Horton, Norway). After familiarization, participants rested lying for 5–10 minutes before the measurements were taken. The cIMT was obtained using specific software (Cardiovascular Suite, Quipu, Pisa, Italy) and ultrasound (LogiqV2, GE Medical Systems, Horton, Norway) measurements.

Descriptive data were obtained for all variables. After checking the normality of the data (Shapiro-Wilk test), we used independent t-tests to check the differences between groups. Person's correlation was used to evaluate associations between $VO_2$ and cIMT. Statistical significance was defined as a two-sided p-value < .05.

RESULTS: Non-DS participants were taller (1.75±0.77 vs. 1.58±0.70 m) and heavier (73.92±10.21 vs. 67.98±9.16 kg) than the DS group (all p<.05). Not statistical differences between groups were observed for BMI; SBP and DBP.

Relative and absolute $VO_2$ peaks were significantly higher in the Non-DS group (46.10±6.95 vs. 29.43±7.62 ml/kg/min; 3.34±0.54 vs. 2.02±0.49 L/min; all p<.01).

The cIMT in the DS group was significantly higher than the Non-DS group (0.59±0.12 vs. 0.46±0.07 mm; p<.01). A negative correlation between absolute $VO_2$ peak and cIMT was found in the DS group (r=-0.54; p=.03).

CONCLUSION: Adults with DS exhibited significantly higher cIMT compared to their Non-DS counterparts, suggesting an increased cardiovascular risk in this population. Despite similar BMI values between groups, individuals with DS demonstrated markedly lower cardiorespiratory fitness. Additionally, a significant negative correlation between absolute $VO_2$

peak and cIMT in the DS group suggests that higher cardiorespiratory fitness may be associated with better vascular health. These findings emphasize the importance of promoting physical fitness interventions to increase cardiorespiratory fitness among adults with DS and potentially mitigate cardiovascular risks.

**PHYSICAL FITNESS AND ACADEMIC PATHWAYS: IS THERE A RELATIONSHIP? OBSERVATIONAL EXPLORATORY STUDY.**

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INTRODUCTION: Despite the widely recognized benefits of physical activity on health and well-being, studies highlight a significant decline in exercise participation and an increase in sedentary behaviors during university years. However, differences in physical fitness among students from different academic programs remain largely unexplored.

METHODS: Forty-five university students (age, 22.62 ± 2.82; 26 Female) were enrolled and divided into three groups of 15, based on their degree program: Motor Science (MS), which includes courses based on the practice of physical activity, Psychiatric Rehabilitation Therapy (TERP) and Physiotherapy (PT), which do not have any. Assessments were done in May 2024 at the University of Pavia with two standardized test batteries: the Alpha-Fit Test Battery and the Health Assessment Battery. These tools enabled the evaluation of the follow functional capacities: aerobic fitness, 6-Minute Walking Test (6MWT), 2 km Walking Test (2KMWT); muscular strength, 30-Second Push-Up Test, Modified Push-Up Test, 30-Second Sit-Up Test, Dynamic Sit-Up Test; muscular power, standing Broad Jump (SBJ), Jump and Reach; flexibility, Sit and Reach Test, Shoulder-Neck Flexibility Test; balance, One-Leg Stand Test. Statistical analysis was performed using SPSS software. One-way ANOVA or the Kruskal-Wallis test were applied, depending on data distribution. A statistical significance threshold of $p < 0.05$ was set. Post hoc comparisons were conducted to identify significant differences between groups.

RESULTS: Compared to PT and TERP, MS showed superior performance in aerobic fitness (2KMWT, p 0,011), muscular strength (30-second sit-up, $p < 0.001$; 30-second push-up, p 0.012; modified push-up, $p < 0.001$; dynamic sit-up, p 0.043) and power (SBJ, p 0.002; jump and reach, $p < 0,001$). Balance was significantly better in MS compared to PT ($p = 0.004$); whereas no significant differences emerged between MS and TERP. Flexibility results showed no significant differences among groups. The comparison between TERP and PT showed no significant differences in any of the outcomes.

CONCLUSION: This study underscores the impact of academic pathway on physical fitness of the university students. Despite the small sample, the observed differences suggest that curricular physical activity levels may play a crucial role in shaping physical fitness.

Future research should explore the long-term implications of these findings and investigate targeted interventions to improve the physical fitness of university students regardless of their academic background.

**DISTINCT EFFECTS OF LONG-TERM RESISTANCE EXERCISE ON ALZHEIMERS DISEASE-RELATED COGNITIVE DEFICITS, NEUROTROPHINS, AND AMYLOID PATHOLOGY IN APP/PS1 MICE**

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INTRODUCTION: Alzheimers disease (AD), the leading cause of dementia in the elderly, is marked by cognitive deficits, memory loss, and vascular dysfunction, with amyloid-beta (Aβ) accumulation and metabolic changes contributing to neuronal impairment. Women face a higher risk of AD due to hormonal, metabolic, and immune differences. Sarcopenia, characterized by muscle loss and cognitive decline, exacerbates aging and dementia. Physical exercise offers preventive and therapeutic benefits, improving cognition, metabolism, and reducing Aβ accumulation, as shown in humans and animal models. Resistance exercise (RE), recognized for its role in combating sarcopenia and enhancing muscle, strength, and bone health, also supports neuroplasticity and cognitive function. However, the long-term effects of RE on AD and sex-specific responses remain underexplored.

METHODS: Our study aimed to evaluate how long-term 4-month RE influences behavior, neurotrophic factor levels and amyloid pathology in males and females, exploring distinct sex differences in response to RE. We utilized 6-month-old double-transgenic APP/PS1 and wild-type control mice of both sexes, divided into sedentary and RE groups. The RE protocol involved climbing a 110 cm ladder with progressive loads 3x week. Behavioral assessments included the Open Field (locomotor activity), Object Recognition (short-term memory), and T-Maze (spatial long-term memory) tests. Brain VEGF, IGF-1, BDNF and Aβ levels were measured via ELISA, while Aβ plaques were quantified in hippocampal sections. Data were analyzed using appropriate statistical tests to evaluate the effects of RE on cognitive performance, neurotrophic factors, and amyloid pathology.

RESULTS: The results showed positive effects of long-term RE in modulating cognitive deficits, locomotor activity, trophic factor levels, and amyloid pathology in APP/PS1 mice, with distinct improvements observed in males and females. In APP/PS1 females, RE reduced hyperlocomotion, rescued short-term memory, increased VEGF levels, and reduced brain Aβ levels and amyloid plaque density, showing a robust neuroprotective effect. In APP/PS1 males, RE also showed beneficial effects by reducing hyperlocomotion, recovering long-term memory, and increasing IGF-1 and BDNF levels, suggesting a positive impact of RE on cognitive performance and neurotrophic levels associated with brain plasticity.

CONCLUSION: Our findings indicate that males and females have distinct behavioral and biological responses to RE and suggest that, despite identical initial age, sedentary female APP/PS1 mice exhibit a more advanced progression of the disease compared to males. These findings contribute to a deeper understanding of the behavioral and molecular impacts of RE as an alternative exercise strategy for delaying AD progression, emphasizing the importance of sex differences. These results provide insights into the potential of RE as a tool to investigate differences between sexes in response to interventions for AD conditions.

**THE EFFECTS OF PHYSICAL EXERCISE ON COGNITIVE AND LANGUAGE FUNCTIONS IN ADULTS WITH DOWN SYNDROME**

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INTRODUCTION: Individuals with Down Syndrome (DS) demonstrate significantly lower levels of physical exercise (PE) compared to the general population 1, which contributes to an increased risk of associated lifestyle-related diseases 2 . Moreover, individuals with DS exhibit cognitive decline as early as their 50s and are at an elevated risk for developing Alzheimers disease (AD) 3. Research suggests that endurance and coordination training can positively influence cognitive functions across the lifespan and may also contribute to lifestyle-based prevention measures for AD 4,5. Despite these risks, structured PE programs tailored to DS individuals remain largely absent.

The "DS in Motion" project is an innovative approach to addressing this gap by investigating the effects of a structured PE program on language, cognitive, and motor functions in adults with DS. Additionally, it aims to foster an active lifestyle, ultimately supporting quality of life and independence.

METHODS: This randomized controlled trial utilizes a six-week structured exercise intervention based on four pillars: (1) a sport program focusing on endurance, strength, and coordination; (2) educational awareness to enhance intrinsic motivation; (3) empowerment strategies to encourage long-term PE; and (4) a "train-the-trainer" module for caregivers and trainers, aimed at creating external framework conditions to ensure the long-term implementation of an active lifestyle. Adult participants with DS are recruited and undergo pre-, post-, and follow-up assessments. Language, cognitive, and motor functions, body composition, and movement behavior are assessed.

RESULTS: The project is ongoing, with preliminary data analysis in progress. Initial subjective feedback from participants suggests increased self-perceived attentiveness in daily life, fewer complaints about back pain, and an overall improvement in fitness levels.

CONCLUSION: The objective of this project is to contribute to lifestyle-based prevention measures for AD while also promoting well-being and independence throughout life. The "DS in Motion" project represents a novel approach to address-

ing the cognitive and physical health challenges in adults with DS. The project aims to enhance PE engagement to support cognitive, motor, and language functions, as well as overall well-being. To this end, it implements a structured PE program within care facilities and community groups.

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**PERCEPTION AND AWARENESS OF MUSCLE POWER DEVELOPMENT IN GENERAL POPULATION**

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INTRODUCTION: Muscular Power, defined as the product of force and velocity, is a key element in mental and physical well-being, as it is closely related to the efficiency of the human body. With advancing age, power output tends to decline, necessitating the use of exercise programs. However, few studies exist in the literature on power development in the non-athlete population. There is a lack of research examining the influence of opinion and perception, as well as knowledge, on the effectiveness of physical exercise protocols for power development for health and well-being. In addition, there are no apparent studies that relate power development to perception, opinion, and awareness of the benefits obtained.

the objective of the study is to evaluate the effectiveness of the physical exercise protocol for power development for general population in relation to participants perceptions and opinions. In addition, it aims to identify the connection between power development with the usefulness of such an physical exercise protocol to provide awareness about the benefits of power development.

METHODS: Fourteen participants (12 males, 2 females, ages 16-45 years) with no experience in power training were involved. The protocol included specific exercises three times a week for 12 weeks. The Counter Movement Jump test (CMJ) and a fatigue perception and awareness questionnaire were administered at the beginning, after 6 weeks, and at the end of the course. Statistical analysis was conducted by ANOVA for repeated measures and Friedmans test.

RESULTS: ANOVA showed significant differences between Pre, In-Itinerary and Post measurements for both CMJ height and power output. ANOVA for repeated measures found significant change in CMJ jump height ($p=0.013$) and power output ($p=0.034$), suggesting progressive improvement over time. Direct comparison between Pre and Post by t-test for dependent samples confirmed a significant increase in both variables. CMJ height increased significantly ($p<0.0001$), as did power output ($p<0.0001$). In addition, Friedmans test showed significant changes in perceived physical ability ($p<0.0001$), reduction in perceived fatigue ($p<0.0001$), and awareness of the benefits of power ($p<0.0001$).

CONCLUSION: The exercise protocol proved effective not only in increasing muscle power, but also in improving subjective perception of ones abilities and awareness of the benefits of developing muscle power. These results highlight the value of power training as a tool for improving mental and physical well-being in the general population.

**INTERNATIONAL CONSENSUS ON THE DEFINITION OF FUNCTIONAL TRAINING: MODIFIED E-DELPHI METHOD**

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INTRODUCTION: The inconsistency and disparities in existing functional training definitions have led to confusion when explaining the concept and its potential. The wide range of interpretations suggests that any training approach could be deemed functional, thereby diminishing the significance of the term and significantly limiting its understanding and application. Thus, this paper aimed to develop the first consensual definition of functional training using an international e-Delphi method.

METHODS: From a panel of 31 experts initially selected, 13 participated in the consensus.

RESULTS: The panel presented the following definition: "Functional training is a physical interventional approach that contributes to the enhancement of human performance, according to individual goals, in sports, daily life, rehabilitation, or fitness, and takes into consideration the specificity of the task and the unique responsiveness of each individual.".

CONCLUSION: However, redundancy of the functional training definition emerged as a relevant consideration for this conceptual and methodological advancement, and a proposal to avoid the distinction between functional training and the general concept of training was presented (i.e., no real use of functional training as a concept). It was proposed that a training program or regimen could be analyzed based on a continuum of functionality, which could support further developments in this topic.

**RELATIONSHIPS BETWEEN NEURO-MUSCULAR AND PHYSICAL FITNESS PARAMETERS IN BASKETBALL PLAYERS WITH INTELLECTUAL DISABILITIES**

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INTRODUCTION: Individuals with intellectual disabilities (ID) often exhibit lower physical fitness levels compared to their neurotypical peers, leading to negative health outcomes and a reduced quality of life (1). Limited motor control, higher obesity rates, and restricted access to sports activities further exacerbate this disparity (2). This study aims to analyse the relationship between neuro-muscular and physical fitness parameters in basketball players with ID, to provide valuable data for designing targeted intervention strategies.

METHODS: A total of 26 basketball players with ID (age 28.7 ± 9.6 yrs; body mass 77.8 ± 2.4 kg; height 1.72 ± 0.10 m, m ± SD) were assessed during a tournament organized by the Italian Federation of Paralympic Sports for Intellectual and Relational Disabilities (FISDIR). Anthropometric data (e.g., weight, height, circumferences, and skinfold thickness), strength tests (handgrip), static balance, lower-limb explosiveness (countermovement jump, CMJ), and clinical reaction time (CRT) were collected. Statistical analyses were performed using linear regression models (with Pearson's correlation coefficients calculation). The significance level was set at $p < 0.05$.

RESULTS: Higher body fat percentage was associated with lower jump height ($r = -0.40$, $p = 0.04$) and slower reaction times ($r = -0.48$, $p = 0.01$), consistent with previous research on neuromuscular efficiency in individuals with ID (3). Greater handgrip strength correlated with faster reaction times ($r = -0.41$, $p = 0.04$), underscoring the role of strength training in cognitive-motor integration (4). Additionally, BMI negatively impacted on postural balance, increasing centre-of-pressure oscillations, which aligns with findings on vestibular deficits in individuals with ID (5).

CONCLUSION: These results highlight the importance of structured training programs to reduce body fat and improve strength and coordination in individuals with ID. Considering the early onset of cardio-metabolic risks within this population, tailored interventions should be prioritized. However, future studies should aim to explore the causal relationships between training and motor skill improvements in this particular population.

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## Conventional Print Poster Presentations

### CP-MH18 Adolescents / Children

**VARIATIONS IN CHILDRENS SOCIAL AND EMOTIONAL SKILLS SCORES BY PHYSICAL ACTIVITY LEVEL: A PROPOSAL FOR A SHORT OECD SOCIAL AND EMOTIONAL SKILLS SCALE**

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INTRODUCTION: Childrens physical activity has various educational effects and improves physical fitness and health. However, children have lost interest in physical activity, and video games are the most popular form of play. Regarding educational effects, non-cognitive and cognitive skills have been emphasized recently. This also applies to physical activity. Non-cognitive skills are called social and emotional skills (SES) by the Organization for Economic Co-operation and Development (OECD), and the research results of an international comparison have recently been published. However, Japan has not participated in this survey. Therefore, there is a lack of understanding of the current situation in Japanese childrens SES, including the importance of SES as an educational effect. Thus, this study aimed to construct and validate the OECD SES scale short version and to examine the relationship between SES scores and elementary school childrens physical activity habits.

METHODS: A questionnaire comprising four items related to physical activity habits (physical activity preference, physical activity time [weekdays or weekends], number of friends to play with) and a 45-item SES scale—short version—was administered to 2223 elementary school children in Grades 4–6. The OECD SES Scale comprises 120 items, and 15 subfactors have been identified by factor analysis (OECD, 2021). Considering the survey burden on children, we created a short version with 45 items by selecting the top three items representing each factor from the published factor analysis results. We then applied factor analysis to the collected data and confirmed that the SES scale short version retains the same simple structure with 15 factors as the OECDs original dataset. A one-way ANOVA was conducted to examine the differences in each factor score and the composite score of the 45 items (SES total) based on childrens physical activity habits.

RESULTS: Factor analysis was applied to the SES Short version data, and a simple structure of 15 factors was confirmed. The total variance explained was 63.0%, and high-reliability coefficients were confirmed for all aspects. Significant differences in SES Total scores were confirmed for all items about physical activity habits. Children with better physical activity scored significantly higher for all factors except creativity and responsibility.

CONCLUSION: The short version of the SES scale was proposed to assess SES adequately. The SES total score was higher for children with better physical activity habits, and many subfactor scores were also significantly higher. This suggests that childrens physical activity is effective in increasing their SES. Conversely, because no significant differences were found in the creativity and responsibility factors, the effect of physical activity on these factors appears to be minimal.

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**THE IMPACT OF SPORT-ORIENTED SCHOOL CURRICULUM ON COGNITIVE AND MOTOR PERFORMANCE IN HIGH SCHOOL STUDENTS: A PILOT STUDY**

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INTRODUCTION: Scientific literature agrees that regular participation in structured sports activities during school benefits academic performance (1). However, Italian students remain reluctant to engage in regular physical activity. According to ISTAT, in 2021, continuous sports participation among 3-17-year-olds dropped from 51.3% to 36.2%, while sedentary behavior increased from 22.3% to 27.2% (2). Despite this decline, studies emphasize the positive impact of sports on academic success, particularly team sports, which foster discipline, time management, and dedication—skills that enhance both school performance and daily life (3). However, uncertainties remain regarding the specific effects of school curriculum and sport participation. For this reason, the present study aims to analyse high school students' profiles, comparing sport-oriented high school curriculum versus traditional curriculum ones on motor and cognitive attributes.

METHODS: 50 high school students attending 11th grade of the Italian school system (60% boys and 40% girls,) were recruited for this study. Each participant was assigned to Sport-Oriented (SOG) or Traditional (TRG) group according to the personal school curriculum. All participants must declare to practice at least a sport discipline to be involved in the study. All parents approved their attendance at this study by signing informed consent. Physical fitness was assessed with the Leger Multistage Fitness Test (aerobic fitness), 10m and 30m sprints (speed), CMJ (lower-body strength) and Reactive Agility Test (RAT) for reaction and agility. At the same time, cognitive performance was evaluated with computerized and validated battery of specific cognitive tests (3).

RESULTS: No significant differences were detected in motor profile evaluation ($p > 0,05$) except for RAT ($p < 0.05$) in favour of SOG. In addition, a trend to significance ($p = 0.061$) was detected in aerobic fitness in favour of SOG. Cognitive profile analysis underlines a significant correlation in favour of SOG for "search and selection" ($p<0.05$), working memory ($p < 0.01$), attention distribution ($p<0.01$) and attention shifting ($p<0.01$).

CONCLUSION: Sport-oriented high school students showed better cognitive performance in working memory, attention distribution, and cognitive flexibility. Motor differences were minimal, except for superior reactive agility and a trend towards better aerobic fitness. These findings suggest that a sport-focused curriculum may contribute to enhanced cognitive abilities, likely due to the combination of structured physical activity and the skills promoted through sports participation. Further research is needed to explore the long-term effects of such curricula on both academic and personal development.

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**A COMPARATIVE STUDY OF EXERCISE HABITS AND PHYSICAL FITNESS AMONG PRESCHOOL CHILDREN IN JAPAN AND KOREA**

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INTRODUCTION: In Japan and Korea, concerns have been raised about both declining physical fitness among children and the polarization of exercise habits. The gap between children who regularly engage in physical activities and those who rarely do so is widening, a trend that becomes apparent from early childhood. While exercise habits of preschool children in both countries likely differ due to variations in childcare systems and lifestyle patterns, few studies have compared the relationship between exercise habit polarization and physical fitness. Examining this relationship across both countries could provide important insights for establishing effective exercise support measures. This study aimed to investigate the actual conditions of exercise habit polarization among preschool children in both countries and clarify its relationship with physical fitness.

METHODS: The subjects were 232 Japanese children (118 boys, 114 girls, mean age 4.12±0.8 years) and 245 Korean children (120 boys, 125 girls, mean age 3.93±0.8 years) aged 3-5 years. Parents completed questionnaires about their childrens regular exercise activities and types of exercise. Physical fitness was assessed using the MKS Preschool Physical

Fitness Test, which included six items: 25m sprint, standing long jump, tennis ball throw, continuous jumping, body support duration, and ball catching. Based on the MKS test evaluation criteria, average scores were calculated and classified into three groups (high, average, low) for analysis with exercise habits.

RESULTS: Results showed that in Japan, 54.2% of 3-year-olds, 59.0% of 4-year-olds, and 78.6% of 5-year-olds regularly exercised ($p<0.01$). In Korea, 6.9% of 3-year-olds, 24.1% of 4-year-olds, and 37.5% of 5-year-olds regularly exercised ($p<0.001$). The most common activities in Japan were swimming, gymnastics, and sports club activities, while in Korea, they were Taekwondo and swimming. Regarding the relationship between exercise habits and physical fitness items, Japanese children showed significant correlations in five test items: 25m sprint ($p<0.01$), tennis ball throw ($p<0.001$), continuous jumping ($p<0.05$), body support duration ($p<0.01$), and standing long jump ($p<0.01$). Children who exercised regularly demonstrated higher fitness scores in all categories except ball catching. In Korea, only the standing long jump showed a significant correlation with exercise habits ($p<0.01$).

CONCLUSION: While the proportion of Japanese children with exercise habits increased markedly with age, Korean children showed a lower overall rate of regular exercise, with less than 40% participating even at age 5. The significantly higher physical fitness scores among children with regular exercise habits suggest that regular physical activity has broad effects on the development of basic motor skills during early childhood. Further longitudinal studies considering qualitative differences in exercise habits and cultural-social backgrounds are needed to verify these effects.

**COMPARING PHYSICAL ACTIVITY, PHYSICAL FITNESS AND MOTOR SKILLS ACROSS DIFFERENT ORGANISED AND NON-ORGANISED PROFILES IN CHILDREN AGED 3–13**

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INTRODUCTION: Childrens levels and types of physical activity vary individually and across different ages. This study aims to examine the profiles of organised sports participation and non-organised outdoor time among children aged 3–13 years. Additionally, the study explores how these profiles are associated with differences in physical activity, physical fitness, and motor skills.

METHODS: The study involved 1,115 Finnish children (50.0% girls), aged 3 to 13 years. They were assessed three times—T1 (3-7 years), T2 (6-11 years), and T3 (9-13 years)—between 2015 and 2023. The goal was to connect their participation in physical activities with their fitness and motor skills outcomes. The participation rate in sports and outdoor time on weekdays and weekends was queried via a parental questionnaire at all time points. We created profiles based on the patterns of organised sports participation and outdoor time using the latent class analysis (LCA) conducted with Mplus statistical software. LCA was conducted to identify distinct profiles, which were subsequently compared in terms of physical activity (T2, T3), physical fitness (T3), and motor skills (T1, T2). Physical activity was measured with accelerometers, and a 20-meter shuttle run test assessed physical fitness and push-ups in 60s. Motor skills were evaluated using a shortened version of the Test of Gross Motor Development – 3rd edition (TGMD-3), including locomotor skills (hopping, skipping), and object control skills (one-hand stationary dribbling, overhand throwing). Missing data was assumed to be missing at random.

RESULTS: LCA identified four distinct participation patterns: (1) multisport with high outdoor time (n=234), (2) multisport with moderate outdoor time (n=310), (3) one-sport participation with low outdoor time (n=275), and (4) non-organised sport with high outdoor time (n=296). Comparisons across these classes revealed significant differences in physical activity, physical fitness, and motor skills ($p < 0.05$).

The multisport with high outdoor time group exhibited significantly higher levels of physical activity, physical fitness and motor skills than the other classes. However, the multisport group with moderate outdoor activity also exhibited better outcomes than groups 3 and 4, though the motor skills at T2 did not show significant differences. The one-sport participation with low outdoor time group showed the lowest values of physical activity, and the non-organised sport with high outdoor time group exhibited lower levels of physical fitness and motor skills compared to the other groups.

CONCLUSION: These findings suggest that encouraging children to engage in multisport activities combined with substantial outdoor time may enhance their physical activity, fitness and motor skills. Coaches, educators, and parents should consider promoting a balanced approach to physical activity that includes both organised sports and unstructured outdoor activities to foster comprehensive motor development and overall fitness in youth.

**CHILDHOOD AEROBIC FITNESS AND NEUROELECTRIC INDICES OF INHIBITION**

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INTRODUCTION: Greater childhood aerobic fitness has been associated with cognitive and brain outcomes including greater allocation of attention and working memory resources during stimulus processing (Hillman et al., 2005). Positive associations between aerobic fitness and executive function, including inhibitory control, have also been well documented (Donnelly et al., 2016). This study investigated the relationship between aerobic fitness, attention and inhibitory control during a Go/NoGo task, which modulated stimulus processing and inhibition control demands.

METHODS: Event related potentials (ERP) and task performance were concurrently measured. Fifty-two (mean age=9.99 years +/- 0.69) preadolescent children were included based on aerobic fitness and bifurcated into higher-fit (HF; n=26, 13

females) or lower-fit (LF; n=26, 13 females) groups based on whether their VO2max fell above the 75th percentile or below the 25th percentile according to normative data (Shvartz and Reibold, 1990). Response accuracy was analyzed using independent t-tests separately for each task. P3 amplitude and latency were analyzed using a 2 (Group: HF, LF) x 7 (Site: Fz, FCz, Cz, CPz, Pz, POz, Oz) repeated measures MANOVA separately for each task.

RESULTS: For both tasks, target accuracy was lower for LF (Go: 94.76% +/- 7.59%; NoGo: 70.62% +/- 12.66%) relative to HF (Go: 98.23% +/- 2.61%; NoGo: 77.69% +/- 8.74%), t's(50)>2.199, p's<.033, respectively. The omnibus analysis for the P3-ERP during the Go task indicated an effect for fitness F(1,50)=4.354, p=0.042. For the NoGo task, a Fitness x Site interaction was uncovered, F(1, 50)=3.191, p<0.031, which was decomposed using simple effects and paired t-tests to examine group differences. Findings revealed a site effect in the HF group, with fronto-central scalp distribution, indicating the expected scalp topography for the NoGo task. No such effect was observed in the LF group.

CONCLUSION: The results indicate higher fitness was related to greater allocation of attentional and inhibitory control resources, exhibiting the expected adult-like pattern of neurolectric activation. Findings suggest higher fitness benefits to cognitive and brain health, as indicated by enhanced prefrontal inhibitory control in preadolescent children.

**SCHROTH EXERCISE ON THREE-DIMENSIONAL PARAMETERS OF THE SPINE AND PARAVERTEBRAL MUSCLES FOR ADOLESCENT IDIOPATHIC SCOLIOSIS**

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INTRODUCTION: Asynchronous growth of muscle and skeleton is a well-recognized risk factor for curve progression in adolescent idiopathic scoliosis (AIS), often resulting in a vicious cycle. Studies indicate that a reduction in the paraspinal muscle mass is the primary contributor for the disparity in growth rates between muscle and skeleton. Therefore, improving the muscle mass under spinal–pelvic alignment becomes the key for treatment. Although studies have shown that the Schroth Method could control the severity of the curves, the lack of quantification of skeletal and muscle changes during exercise limits its reproducibility, as the specificity of the deformity frequently relies on the subjective experience of the therapist.We aimed to quantify the changes in the skeletal and paravertebral muscles of patients with AIS during Schroth exercise using three-dimensional ultrasound reconstruction.

METHODS: Patients with a single type of Cobb angle in the thoracic curvature of 20°–45° were included in this cross-sectional study. We used muscle cylinder, door handle exercise, self-corrective standing, and self-corrective sitting postures to compare habitual standing with habitual sitting postures and observe changes in spinal alignment and muscle volume parameters. Metrics including paravertebral muscle volume (cm3) of the upper end vertebrae (UEV), apex vertebrae (AV), and lower end vertebrae (LEV) were captured, with simultaneous recordings of the ultrasound curve angle (UCA), ultrasound spinous process angle (SPA), and axial vertebral rotation (AVR).

RESULTS: Overall, 15 participants were included. The results showed that all four corrective postures decreased the UCA ($p < 0.05$). Self-corrective standing ($p = 0.01$) and muscle cylinder ($p = 0.01$) decreased the TSPA in patients with Rigo A. Self-corrective sitting ($p < 0.001$), door handle exercise ($p = 0.03$), and muscle cylinder ($p = 0.01$) increased the LSPA. Door handle exercise improved the AVR ($p = 0.03$). Self-corrective standing increased the muscle volume on the concave ($p = 0.03$) and the convex ($p = 0.02$) of the AV, and increased the muscle volume on the concave ($p = 0.02$) and the convex ($p = 0.04$) of the UEV. Muscle cylinder increased the muscle volume on the concave ($p = 0.02$) and the convex ($p = 0.01$) of UEV. Self-corrective sitting increased the muscle volume on the convex ($p = 0.03$) of the LEV and the convex ($p = 0.02$) of the UEV. Door handle exercise increased the muscle volume on the convex ($p = 0.03$) of AV and the convex ($p = 0.01$) of UEV.

CONCLUSION: Self-corrective standing, Muscle cylinder, Self-corrective sitting, and Door handle exercise all decreased the coronal plane angle, sagittal plane parameters, and paravertebral muscle symmetry, whereas they partially improved the horizontal plane parameters. Therefore, these postures may intensify sagittal plane and paravertebral muscle imbalances in AIS patients with Rigo A who should be cautiously treated in clinical applications.

**CORRELATES OF MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY AMONG PORTUGUESE CHILDREN IN THE REACT PROJECT: A QUANTILE REGRESSION APPROACH.**

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INTRODUCTION: There is evidence that moderate-to-vigorous physical activity (MVPA) positively affects childrens well-being and health [1,2]. Furthermore, during childhood, MVPA is associated with a diverse range of covariates [3,4]. Although children vary in their levels of MVPA, this observation is often based on group averages [5,6]. Instead of using MVPA averages, we relied on its distribution and used different percentiles (P25th, P50th, P75th) for this analysis. Therefore, we analyzed MVPA differences between boys and girls and examined whether body mass index, fundamental movement skills (FMS), physical fitness, and sleep were associated with MVPA across different percentiles.

METHODS: Children of both genders (boys: n=483; girls: n=533), aged 6-10 years, were randomly sampled from northern Portugal. Physical activity was objectively assessed (Actigraph wGT3X-BT) for seven consecutive days. The average daily duration of MVPA and sleep (min/day) was estimated over seven days. Body mass index was calculated from height and weight and expressed in z-scores (BMIz). The overall score for FMS (five object control skills) was estimated using factor

analysis, and an overall z-score for physical fitness (five tests assessing motor, musculoskeletal, and aerobic components) was calculated. Quantile regression was conducted using STATA 18 software.

RESULTS: Overall, boys were more active than girls, and MVPA declined with age. This trend was maintained even when adjusting for covariates (BMI, sleep, FMS, and physical fitness). Quantile regression revealed different effect sizes for covariates. For example, boys had more MVPA than girls (P25th, b=8.6, p<0.05; P50th, b=13.9; P75th, b=18.1), yet a similar effect size was observed for age (P25th, b=-6.4, p<0.05; P50th, b=-6,2, p<0.05; P75th, b=-6.6, p<0.05). BMIz, FMS, and physical fitness z-score also had a differential relationship with MVPA across P25th, P50th, and P75th. Sleep was not significantly associated with MVPA at any percentile analyzed.

CONCLUSION: There was a consistent decline in childrens MVPA levels across all percentiles, with the decline being more pronounced in girls. This decrease was similar across age groups and percentiles. Notably, BMI z-scores had a stronger negative association with MVPA at the upper end of the distribution, while FMS and physical fitness showed stronger positive associations. Therefore, we recommend tailoring interventions to address the decline in MVPA by adopting strategies specific to boys and girls of different ages, particularly targeting children with higher BMI, lower physical fitness, and less proficiency in FMS.

References : 1 (CDC: https://www.cdc.gov/physical-activity-basics/health-benefits/children.html); 2 (Smedegaard et al., 2016) ; 3 (Pereira et al., 2022) ; 4 (Gomes et al., 2017) ; 5 (Kretschemer et al., 2023) ; 6 (Arenas et al., 2024).

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**ASSOCIATION BETWEEN COMPLIANCE WITH 24-HOUR MOVEMENT GUIDELINES AND TEMPERAMENT TRAITS IN PRE-SCHOOL CHILDREN**

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INTRODUCTION: Temperament factors in preschoolers (surgency/extraversion, negative affectivity, and effortful control) are critical for socio-emotional behavior development. The 24-hour movement guidelines (24-HMG) for preschoolers—comprising physical activity, screen time, and sleep duration—have been shown to influence their physical and mental health development. However, the relationship between adherence to the 24-HMG and temperament factors remains underexplored. This study aimed to investigate the relationship between meeting the 24-HMG and temperament factors among preschool children.

METHODS: A convenience sampling method was used to recruit 127 preschool children (mean age = 5.54 ± 0.97 years) from public kindergartens in northern Taiwan. Parents were invited to have their children wear an ActiGraph wGT3X-BT accelerometer continuously for 24 hours over seven consecutive days to measure activity levels. Temperament factors were assessed using the Chinese version of the Children's Behavior Questionnaire–Very Short Form. Descriptive statistics and multiple linear regression analyses were performed.

RESULTS: Preschoolers who met the "Physical Activity Guidelines" were significant predictors of "surgency/extraversion" (β = 0.194, p = 0.048). Preschoolers who adhered to the "Screen Time Guidelines" (β = -0.346, p < 0.0001) and simultaneously met the "Screen Time/Sleep Guidelines" (β = -0.319, p = 0.001) significantly predicted lower levels of "negative affectivity".

CONCLUSION: Meeting the recommended 180 minutes of daily physical activity, including at least 60 minutes of moderate-to-vigorous physical activity, contributes to the development of socio-emotional behaviors such as extraversion. Additionally, preschoolers who simultaneously achieve ≤1 hour of daily screen time and ≥10 hours of sleep duration may demonstrate more positive emotional behaviors.

**MORE DAYS, GREATER HEALTH: ASSOCIATIONS BETWEEN DAILY MVPA AND CARDIOMETABOLIC RISK IN YOUTH**

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INTRODUCTION: The 2020 World Health Organization (WHO) guidelines recommend that children and adolescents achieve an average of 60 minutes per day of moderate- to vigorous-intensity physical activity (MVPA) across the week. This shift from requiring 60 minutes daily to allowing day-to-day variability reflects recent evidence. However, it remains unclear whether the number of days achieving 60 minutes of MVPA provides additional health benefits independent of the total weekly MVPA. This study investigated associations between the number of active days and cardiometabolic health risks in children and adolescents.

METHODS: Data were drawn from the International Childrens Accelerometry Database (ICAD), a pooled dataset of 21 studies involving children aged from 3 to 18 years old. Among these studies, 2 were selected, where participants wore an Actigraph device for 7 consecutive days. Individuals were categorized into 5 groups: category 0 = <420 minutes of MVPA per week (did not meet WHO guidelines), and categories 3 to 6 = met the guideline, with 1–3 days (category 3), 4 days (category 4), 5 days (category 5), and 6–7 days (category 6) of at least 60 minutes of MVPA. A clustered cardiometabolic risk score (CCMR) was computed using waist circumference, blood pressure, lipids, and glucose metabolism. For fasting participants (n = 1,308), CCMR included triglycerides, glucose, and insulin; for non-fasting participants (n = 1,998), these were excluded.

RESULTS: MVPA-adjusted models for the fasting group showed that CCMR was significantly lower in categories 3 (B = -0.989, 95% CI = -1.945 to -0.034), 4 (B = -1.852, 95% CI = -2.753 to -0.952), 5 (B = -1.856, 95% CI = -2.800 to -0.911), and 6 (B = -2.531, 95% CI = -3.728 to -1.335) compared to category 0. Post-hoc tests showed that category 6 had significantly lower CCMR than category 3 (t = 2.41, p < .05). For the non-fasting group, CCMR was significantly lower in categories 4 (B = -0.454, 95% CI = -0.838 to -0.069), 5 (B = -0.845, 95% CI = -1.238 to -0.453), and 6 (B = -0.676, 95% CI = -1.183 to -0.170) compared to category 0, but not in category 3. Wald tests showed significantly lower CCMR in categories 5 (t = 3.61, p < .001) and 6 (t = 2.59, p < .05) compared to category 3.

CONCLUSION: These findings suggest that achieving at least 60 minutes of MVPA on more days throughout the week is associated with greater reductions in cardiometabolic risk, independent of total weekly MVPA. Engaging in MVPA consistently, rather than accumulating it over fewer days, appears more beneficial for reducing health risks in youth.

**IS A WEEKEND WARRIOR PHYSICAL ACTIVITY PHENOTYPE SUFFICIENT FOR FUNDAMENTAL MOVEMENT SKILLS, PHYSICAL FITNESS, AND BODY MASS INDEX IN CHILDREN?**

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INTRODUCTION: The "weekend warrior" concept refers to engaging in concentrated exercise or sports on one or two days, typically the weekend, rather than spreading physical activity across the week as regularly active individuals do [1]. While this pattern has been positively linked to adult health outcomes [2], its impact on children's fitness and motor development is seldom explored. This study examined whether children who engage in 60 minutes of moderate-to-vigorous physical activity (MVPA) over one or two days (the "weekend warrior" group) differ in fundamental motor skills (FMS), physical fitness (PF), and body mass index (BMI) compared to three other groups: "inactive" (0 days of MVPA), "moderately active" (3–5 days of MVPA), and "active" (6–7 days of MVPA).

METHODS: This cross-sectional sample comprised 995 Portuguese children aged 6-10 years from the REACT project [3]. Physical activity was objectively measured (Actigraph wGT3X-BT) over 7 consecutive days, and MVPA was obtained. BMI was calculated from height and weight and expressed as z-scores (BMIz). Physical fitness was assessed (standing long jump, handgrip strength, shuttle-run, 50-yard dash, and pacer), and FMS (object control tasks including stationary dribble, kick, catch, overhand throw, and underhand roll) were evaluated with the Meu Educativo ® platform [4]. All test results were converted into z-scores, with their sums representing overall PF (PFz), and FMS (FMSz). A multivariable regression model was used, with sex and age as covariates.

RESULTS: The "inactive" group had lower FMSz (b=-0.32, p=0.011) and higher BMIz (b=0.67, p=0.037) compared to the "weekend warrior" group, with no differences in PFz (p>0.05). Also, no statistically significant differences (p>0.05) emerged between the "moderately active" group for FMSz, PFz, and BMIz and the "weekend warrior" group. However, the "active" group had higher FMSz values (b=0.37, p<0.001) and PFz levels (b=1.68, p<0.001) than the "weekend warrior" group but did not differ in BMIz (p>0.05).

CONCLUSION: This study suggests that children who are active for just one or two days per week ("weekend warrior" group) experience significant benefits compared to the "inactive" group (except for PF), and their outcomes are similar to those who engage in activity across three to five days ("moderately active" group) in terms of FMS, PF, and BMI. However, children who are active six or seven days ("active" group) were found to be more fit and skillful than the "weekend warrior" group. These findings highlight that while the "weekend warrior" approach offers benefits, being consistently active throughout the week is more effective, particularly for developing FMS and PF.

References: [1] Hamer, M. et al. (2017); [2] Kunutsor, S. K. et al. (2023); [3] Pereira, S. et al. (2024); [4] Garbeloto F. et al. (2024).

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## Conventional Print Poster Presentations

### CP-SH11 Psychology III - Cognition

**WORKLOAD ASSESSMENT IN TWO TYPES OF MOTOR-COGNITIVE TRAINING: A COMPARISON OF DUAL-TASK AND SYNERGISTIC TRAINING.**

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INTRODUCTION: Herold et al. (2018) [1] distinguished between two types of simultaneous motor-cognitive training: additional (dual-task [DT]) and incorporated (synergistic [SYN]). In DT, cognitive and physical task objectives differ, whereas in SYN, they align, potentially reducing workload required. As outlined in cognitive load theory, when information is complementary, attention division is unnecessary, leading to lower perceived workload (principle of contiguity). Consequently, in SYN condition, unlike in the DT condition, task execution may be facilitated and the subjective workload perceived as

lower. Nevertheless, both training appear to be equivalent in terms of brain plasticity. This study compared the perceived and objective cognitive workload in SYN and DT cognitive-motor training in healthy adults.

Method: A total of 19 participants (M=26,89) completed six exercises: 3 DT exercises and 3 SYN exercises. Each targeted a specific executive function (EF). The 6 items of the NASA-Task Load Index [2] (NASA-TLX) were completed at the end of the 6 exercises. The objective performance data collected included the number of items processed, the percentage of correct responses, and the number of errors. Cognitive load and participant performance in each exercise were compared using a one-way analysis of variance (ANOVA). The "training" factor included both DT and SYN training, while the "EF" factor covered working memory (WM), flexibility, and inhibition.

RESULTS: Preliminary results do not indicate the influence of the training modality on objective performance measures or subjective workload assessments. However, the trained cognitive function appears to be a key determinant of the perceived workload during cognitive-motor training.

Discussion: Despite the absence of statistically significant differences between the two cognitive-motor training modalities, a trend can still be observed. The mean scores on the NASA-TLX suggest a slight advantage of SYN training for the "mental demand" and "performance" items. With respect to physical demand, the added value of synergy appears to be counterbalanced by task automation in the DT condition. Concerning EF, WM exercises were perceived as more cognitively demanding, likely due to time constraints and their crucial role in workload management. Inhibition exercises were perceived as less demanding, irrespective of the training modality. It is also possible that these exercises were easier than WM exercises.

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**THE DEVELOPMENT OF YOUNG ATHLETES SELF-COMPETENCES DURING THE TRANSITION FROM PRIMARY SCHOOL TO ELITE SPORTS SCHOOL**

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Objectives

The objective of the study is to examine the progression of self-control abilities in young athletes who were identified as talents in primary schools and subsequently enrolled in 7th grade at an elite sports school. The studys findings will inform the implementation of measures to enhance support for these students, with the objective of mitigating the risk of motivation loss and subsequent dropout (Granz et al., 2019; Schröder & Knisel, 2024). The study will also draw comparisons between the performance of these young athletes and that of athletes already enrolled in upper secondary school.

METHODS: Fifty students aged between 10 and 18 years old (mean age: 15.33, SD= 3.39) took part in the study, which was based on the SSI-K3 (Kuhl & Fuhrmann, 2004). Participants were recruited from an elite sports school in Berlin and divided into two groups. Thirty-five students had been enrolled in the sports school for several years and were in their final year (mean age: 17.74, SD= 0.85). The second group (N= 15, mean age: 10.67, SD= 0.72) consists of pupils who were still attending primary school at time t1 and are in 7th grade at the elite sports school at time t2. A longitudinal study of self-control skills will therefore also be carried out for the second group, whereby the results will also be compared with the results of the older pupils as part of a cross-sectional study in order to be able to draw conclusions here too.

RESULTS: The SSI-K3 demonstrates good validity (α= .78), thus confirming the results previously reported by Kuhl & Fuhrmann (2004, α= .73-.90). The findings of the present study indicate that there are some differences in the self-competences. Specifically, there were notable differences in the area of self-access, which decreased significantly in the younger athletes (mean t1=1.94, mean t2=1.63, p=.039, d= 0.53). A cross-sectional comparison showed significant differences in the area of self-regulation (p= .008, d= .79) between the groups of older students (mean= 1.54, SD= .58) and the results of the younger athletes (mean= 1.96, SD= .38).

CONCLUSION: The findings indicate that close supervision is necessary to ensure optimal long-term support for athletes. The observed decline in self-access skills from t1 to t2 is attributed to the new and varied demands of an elite sports school, which reduce opportunities for in-depth self-awareness. The significant differences in self-regulation skills suggest that the resources available for recovery in competitive sports training are not yet fully understood. A high level of self-regulation skills has been shown to be indicative of increased performance in competitive sports (Wilson et al., 2021; Young et al., 2023). One proposed solution is to develop a concept that enables athletes to optimally reconcile the stresses of school with those of sport.

**THE IMPACT OF SUSTAINED COGNITIVE EFFORT ON BEHAVIORAL PERFORMANCE AND NEURAL RESPONSES: INSIGHTS FROM A DUAL 2-BACK TASK**

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INTRODUCTION: Cognitive effort refers to mental resources allocated to tasks requiring sustained attention, concentration, and active information processing. It is essential for complex functions such as problem-solving, decision-making, memory updating, and attentional control. Engaging in cognitively demanding tasks for extended periods can be mentally exhausting, as it places significant demands on executive functions and may lead to mental fatigue. The more complex, unpredictable, or unfamiliar a task is, the greater the cognitive effort needed to maintain performance. In mental fatigue research, cognitive effort plays a central role, as prolonged engagement in demanding tasks is linked to declining performance and impaired cognitive control. However, the underlying neural mechanisms remain poorly understood. This study examines how sustained cognitive effort affects behavioral and neurophysiological responses, focusing on event-related potentials (ERPs) and subjective perceptions of motivation, fatigue, boredom, and drowsiness.

METHODS: Seventy participants completed a 30-minute Dual 2-back (D2B) task consisting of 1,100 trials, requiring visual and visuospatial working memory updating. In each trial, a geometric figure appeared at the center, with a dot randomly positioned around it (8 possible positions). Either the figure or the dot was randomly colored red. If the dot was red, participants indicated whether its position matched that of trial n-2; if the figure was red, they determined whether it was the same as in trial n-2. Responses (Yes/No) were made using two buttons. EEG activity was recorded from 64 channels to analyze event-related potentials (ERPs) and examine mental fatigue in relation to behavioral data and self-reported cognitive states.

RESULTS: The behavioral and EEG data recorded over 30 minutes were segmented into four periods of 7.5 minutes each. Analysis of reaction times (RT) for correct responses revealed a significant decrease for "No" responses, while remaining stable for "Yes" responses throughout the task. Additionally, the error rate remained stable for "No" responses but significantly increased for "Yes" responses. Furthermore, d-prime, an index of discrimination between trials n and n-2, decreased over the course of the task. Finally, analysis of event-related potentials (ERPs) showed a significant decrease in the amplitude of the P300 component. This decrease was not correlated with any behavioral or subjective data.

Discussion: This study highlights the impact of prolonged cognitive effort on performance and neural activity. A decrease in d-prime and an increase in errors for "Yes" responses suggest a decline in stimulus discrimination. The reduction in P300 amplitude reflects diminished attentional and working memory resources. However, this decrease was not correlated with behavioral or subjective measures. This result tends to put into perspective the role of motivation in explaining the decline in performance.

**BEYOND FITT: A SCOPING REVIEW ON THE APPLICATION OF PROGRESSIVE OVERLOAD IN LONG-TERM EXERCISE INTERVENTIONS TARGETING IMPROVEMENTS IN EXECUTIVE FUNCTIONS**

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Background: Executive functions (EF) are cognitive processes essential for goal-directed behavior, comprising inhibitory control, working memory, and cognitive flexibility [1]. Physical exercise has been shown to enhance EF across the lifespan, with the effects influenced by frequency, intensity, time, and type (FITT) of exercise [2]. However, while much is known about how FITT parameters moderate the impact of exercise on EF, less attention has been given to the dynamic adjustments of these parameters over time and their influence on long-term EF improvements. Accordingly, the purpose of this scoping review was to examine recent long-term exercise intervention studies and map how the principle of progressive overload has been applied to optimize EF.

Methods: This review followed the PRISMA extension for scoping reviews [3]. A comprehensive literature search was conducted in PubMed, SPORTDiscus, and Web of Science for peer-reviewed studies published between 2014 and 2024. Eligible studies included human participants, assessed at least one core EF domain, and incorporated long-term exercise interventions. Studies were excluded if they were cross-sectional, focused on acute exercise, or lacked intervention details. Study design, intervention parameters (FITT), progressive overload parameters, EF domains, and findings were extracted from the articles.

Results: A total of 1,335 articles were identified from PubMed (n=472), SPORTDiscus (n=177), and Web of Science (n=686). After removing 842 studies (duplicates, non-English, pre-2014, and grey literature), 493 were screened. Screening, based on title relevancy, eliminated another 333 studies, leaving 160 for full-text review. Of these, 116 were excluded (abstract-only, duplicates, animal studies, and not reporting progressive overload), resulting in 44 studies included in the scoping review. The subsequent analysis revealed intensity (n=24) and type/complexity (n=16) as the most commonly overloaded parameters. Studies reporting moderate to large effect sizes most often overloaded type/complexity (n=13), followed by intensity (n=8). Only 28% of the studies retrieved for full-text review reported on progressive overload, and of those, just 34% provided a detailed account of its application, specifying the FITT parameter that was overloaded, the frequency of overload, and its magnitude. No study directly examined the effect of progressive overload on EF.

Conclusion: There is a need for research that empirically investigates how the progressive overload in exercise type/complexity and intensity impacts EF. Additionally, more comprehensive reporting on the application of progressive

overload in long-term intervention studies is essential for advancing the understanding of exercise-induced cognitive adaptations.

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**GAME-READY MINDS: A PILOT STUDY ON ACUTE EXERCISE, EXECUTIVE FUNCTION, AND ESPORTS PERFORMANCE**

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Background: Esports, especially competitive games like League of Legends (LoL), rely on core executive functions—inhibitory control (IC), working memory (WM), and cognitive flexibility (CF)—for strategic decision-making during gameplay [1,2]. Emerging evidence suggests that acute exercise enhances executive functions, potentially benefiting Esports performance [3,4]. However, the impact of different exercise modalities on LoL performance remains underexplored. This pilot study aimed to evaluate the feasibility of a protocol comprised of different exercise modalities, gather preliminary findings, and provide recommendations for future large-scale investigations.

Methods: Nine male participants (age: 27±7.28 years, BMI: 23.14±2.58, weekly moderate-to-vigorous physical activity: 153.33±96.40 min), experienced in LoL (3.50±2.78 years), completed a randomized, repeated-measures crossover protocol. Three conditions were tested: moderate-intensity cycling (EC), moderate-intensity cycling with cognitive challenges (CEC), and a sedentary control (CC). After each condition, IC, WM, and CF were tested using the Stroop Colour-Word Test, Corsi Block-Tapping Task, and Trail Making Test (Part B), respectively. LoL-specific performance, including single-attempt kills (SAK) and Jungler callouts (JC), was assessed during simulated gameplay immediately after the executive function tests. Heart rate (HR) and rating of perceived exertion (RPE) were recorded during each condition.

Results: Preliminary results indicated that IC reaction times were faster in the CEC (810.90±165.68 ms, ES=-0.54 [CI: -1.38, 0.29]) relative to the CC (875.64±102.22 ms). Similarly, WM scores were higher in the CEC (13.11±1.90 blocks, ES=0.55 [CI: -0.28, 1.38]) compared to the CC (12.22±1.72 blocks). JC scores were also higher in the CEC (80.20±18.50%, ES=0.54 [CI: -0.29, 1.37]) relative to the CC (72.12±19.08%). HR data confirmed that participants reached moderate intensity during both the EC (69.95±3.39% HRmax) and CEC (74.54±4.77% HRmax). RPE scores in the CEC (11.87±1.61) and EC (11.52±1.23) were similar (RPE for CC: 6.00±0.00). From the first to the third lab visit, improvements were observed in IC, WM, and CF.

Conclusion: Faster IC reaction times and higher WM and JC scores in the CEC warrant a larger sample investigation to assess significance and generalizability. The CEC and EC elicited moderate intensity—an intensity consistently identified in the literature as effective for enhancing cognitive outcomes [5]. Both the EC and CEC were well tolerated, with RPE scores indicating light to somewhat hard exertion. IC, WM, and CF improvements across visits suggest a learning effect, which could be better controlled by measuring pre- and post-condition differences in future investigations.

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**EXAMINING THE CONTRIBUTION OF AFFECTIVE EXERCISE EXPERIENCES IN PREDICTING PHYSICAL ACTIVITY**

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Physical inactivity remains a pertinent health issue in western nations. Approaches to understanding and promoting physical activity behaviour have traditionally been viewed from a cognitively driven perspective (e.g., the rational-education model) but new approaches are being proposed that include greater acknowledgement of affect [1]. How people feel about exercise, their prior experiences of exercise, and their feelings during exercise are proposed as important factors in future exercise behaviour. The present study sought to examine the contributions of cognitive and affective variables in accounting for physical activity behaviour measured using smartphone data. It was hypothesised that affective experiences associated with exercise would significantly contribute to the variance accounted for in weekly step count, and positive affective exercise experiences would predict a larger number of steps. To measure cognitively driven predictors of exercise, behavioural intentions and perceived behaviour control items from the Theory of Planned Behaviour [2] were recorded; to measure affective experiences of exercise, the AFFEXX questionnaire [3] was administered; measurement of physical activity was self-reported from participants who reported their daily step counts from the previous seven days as recorded by their smartphone. Data was collected online using Qualtrics. Preliminary data from 28 participants (female = 16, male = 12, mean age [SD] = 19.96 [0.79] years) indicated that cognitive and affective variables did not significantly predict weekly step counts (p = .41). Hierarchical multiple regression showed that a total of 15.4% of variance for weekly step count could be accounted for by the cognitive (12.1%) and affective (15.4%, cumulative) predictors. Behavioural intention

and affective antecedent appraisal appear the most positive predictors of physical activity. These data extend our understanding of a new instrument to account for affective exercise experiences (AFFEXX), and the use of device-based physical activity measurement in this context represents a novel contribution.

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## Conventional Print Poster Presentations

### CP-PN04 Exercise Biomarkers

**PRELIMINARY FINDINGS ON SALIVARY AND PLASMA IRISIN CONCENTRATIONS FOLLOWING HIGH-VOLUME RESISTANCE EXERCISE**

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INTRODUCTION: Irisin is a myokine mainly released in response to exercise, playing a role in energy expenditure, white adipose tissue browning, and metabolic regulation (1). While it is widely recognized that aerobic exercise consistently increases plasma irisin levels (2), the response to resistance exercise remains inconclusive. Some studies report increased irisin levels following resistance exercise, while others show no change or a decrease (3, 4). Additionally, irisin analysis is usually assessed in blood samples, which are invasive and may not always be practiced in some settings. Saliva sampling offers a non-invasive alternative, but limited research has evaluated its reliability for irisin detection to date (5). This study aimed to investigate acute irisin responses in both plasma and saliva following a high-volume resistance training session.

METHODS: Seven healthy, resistance-trained men (23.5±2.5 years; training experience: 5±3 years) were enrolled. The study involved three preliminary test sessions (10RM, TUT, 1RM) and one experimental training session (TS). The TS consisted of 30 sets performed to failure, with a time under tension (TUT) of 5-1-2-1, emphasizing eccentric movements. Blood and saliva samples were collected at baseline (T0), 15 minutes (T1), 24 hours (T2), and 48 hours post-exercise (T3). Plasma and salivary irisin levels were measured by ELISA, while plasma creatine kinase (CK) and visual analogue scale (VAS) levels were analyzed as indirect markers of muscle damage. Nonparametric statistical tests (Friedman and Pearson correlation) were applied, with significance set at $p<0.05$.

RESULTS: Plasma irisin levels significantly increased between T0 and T1 (10.44 ± 0.9 to 11.38 ± 1.4 ng/mL, $p<0.05$). Similarly, salivary irisin levels rose significantly from 0.051 ± 0.006 to 0.053 ± 0.008 ng/mL ($p<0.05$). CK values peaked at T2, confirming markedly exercise-induced muscle damage ($p<0.001$). Also, VAS values peaked at T2 to then decrease at T3, suggesting that muscle soreness was higher 24 h after exercise. A significant correlation was observed between percentage changes in plasma and salivary irisin ($\rho= 0.86$, $p<0.05$), suggesting a potential link between the two biological fluids in irisin release kinetics.

CONCLUSION: This pilot study is the first to suggest a concurrent increase of plasma and salivary irisin following high-volume resistance exercise in trained men. The correlation between plasma and salivary irisin suggests that saliva sampling may serve as a viable and non-invasive method for assessing irisin responses to resistance exercise. Future research should investigate the increase of salivary irisin concentration in larger cohorts and different training modalities.

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**OPTICAL PARAMETERS AND MUSCLE OXYGENATION LEVELS AT DIFFERENT INTENSITIES OF MUSCLE CONTRACTION ASSESSED BY TIME-DOMAIN NEAR-INFRARED SPECTROSCOPY IN RELATION TO SKINFOLD THICKNESS.**

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INTRODUCTION: Near-Infrared Spectroscopy (NIRS) allows non-invasive assessment of tissue oxygenation and provide insights into skeletal muscle metabolism and fatigue in sports and health context. For these reasons, NIRS devices have

recently gained attention and popularity. Most NIRS devices (i.e. based on continuous wave technique) assume constant optical parameters of the tissue investigated (i.e., differential path length factor (DPF)) which influence hemodynamic measurements' accuracy. However, the DPF differs between individuals, measurement sites, adipose tissue under the probe and potentially exercise intensity. More advanced time-domain (TD) NIRS enable real-time DPF retrieval and could therefore improve measure accuracy with significant impact on NIRS applications. This study investigated the evolution of DPF and tissue oximetry values at different intensities of muscle contractions and examined their relationship with skinfold thickness (ST).

METHODS: Ten healthy subjects (6F, 4M, BMI: 18.2-28.8) performed a knee extensor isometric contraction protocol. A 2-min baseline was followed by a warm-up and an initial maximum voluntary contraction (MVC). Subjects were then asked to perform 10s contractions at 25, 50, 75 and 100% of their MVC. Muscle oxygenation (MO) variables at the vastus lateralis were continuously monitored using the NIRSBOX tissue oximeter (PIONIRS, Italy). DPF and the evolution of MO variables (e.g. muscle oxygen saturation (StO2)) were determined as the peak responses (min/max) reached during a 20s window from the onset of contraction. DPF across intensities were compared using repeated measures ANOVA and the relationships between ST and both DPF and MO parameters were investigated by Pearson correlations.

RESULTS: The group mean ST was 14.3mm (range: 7.3-21.9mm). DPF at baseline was correlated with ST ($R^2$=0.66, $p<0.01$). The minimum measured DPF decreased with exercise intensity ($p<0.05$) and stabilised at 75% of MVC. Individual slopes of the decrease in DPF were not correlated to ST ($p<0.05$). Additionally, there was no significant correlation between ST and StO2 at baseline ($p>0.05$) and the overall change of minimum StO2 from baseline across all intensities ($p>0.05$). All other NIRS parameters showed the same behaviour relative to ST.

CONCLUSION: DPF is a key factor in tissue oximetry measurement, varying dynamically during exercise, particularly with contraction intensity. ST appears to strongly influence DPF which could lead to measurement errors if not considered. In our study using TD-NIRS oximetry, ST did not hinder the tracking of MO variables. Our findings, which need to be validated across a broader range of ST levels, are likely due to TD-NIRSs ability to directly measure DPF, which helps to account for the optical effects of local ST.

**SEASONAL VARIATIONS IN BONE MINERAL CONTENT, BONE MINERAL DENSITY AND BLOOD MARKERS IN MALE AND FEMALE ELITE-SUBELITE FOOTBALL PLAYERS**

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INTRODUCTION: Bone mineral content (BMC) and bone mineral density (BMD) are crucial factors related to the risk of bone fractures, a severe injury, leading to long recovery periods. Blood markers like osteocalcin, PINP, and β-CTX-I reflecting bone metabolism, balancing between bone formation and bone resorption. It was hypothesized that BMD, BMC, and bone markers would fluctuate between preseason and competitive periods, with elite players demonstrating more stable values due to long-term skeletal adaptations, whereas sub-elite players, especially females, would show greater variability due to differences in training load and competition exposure.

METHODS: This study examined BMD, BMC, osteocalcin, PINP, and β-CTX-I changes from early preseason to competitive seasons in elite and sub-elite male football players and sub-elite female players. Players from one professional male football team (Danish 1st tier), two sub-elite female teams (Danish 2nd tier), and three sub-elite male teams (Danish 3rd tier) participated in the study. Laboratory testing occurred in January (winter preseason), in March (competitive season for elite male players but the final part of preseason for sub-elite players) and summer (August/September for the elite male team and in June for the female teams). Testing involved whole-body dual-energy x-ray absorptiometry (DXA) scans to determine total and regional BMD and BMC (323 observations), and venous blood samples taken immediately before the scan for osteocalcin, PINP, and β-CTX-I (273 observations) that were analyzed using mixed models and independent t-tests for comparisons between different periods, gender and competitive levels.

RESULTS: BMD fluctuated in elite male players, decreasing in summer (1.41±0.09 g/cm²) compared to January (1.50±0.10 g/cm², p=0.008) and March (1.50±0.10 g/cm², p=0.006), primarily in the upper body. Additionally, elite male players had higher BMD (1.50±0.10 g/cm²) than sub-elite male players (1.39±0.08 g/cm², p=0.001). However, sub-elite male players had higher BMD (1.39±0.08 g/cm²) and BMC (3607±361 g) than sub-elite female players (1.31±0.09 g/cm², 2786±317 g, p=0.001). Blood markers did not significantly vary across periods, but gender differences were found in sub-elite players: males had higher β-CTX-I (1049±527 ng/L) than females (500±260 ng/L, p=0.001). Sub-elite males had higher osteocalcin (32±15 µg/L) and β-CTX-I (1049±527 ng/L) than elite males (osteocalcin: 25±11 µg/L, p=0.009; β-CTX-I: 659±434 ng/L, p=0.001).

CONCLUSION: Elite male players have denser bones and require less remodeling, likely due to years of high-intensity training and structured recovery. In contrast, sub-elite players may experience greater fluctuations and higher turnover markers due to a more varied and less structured training load. This highlights the importance of load management and tailored training to support bone health throughout an athletes career.

**ADIPOCYTOKINES' RESPONSES TO ACUTE EXERCISE IN ELITE ATHLETES: RELATIONSHIP WITH BODY FAT PERCENTAGE**

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INTRODUCTION: Adipocytokines, also known as adipokines, are signaling molecules secreted by adipose tissue that play a role first in regulation energy metabolism, but also, reproductive, bone, muscle , immune function and inflammation. In elite athletes, the response of adipocytokines to acute exercise can provide insight into their metabolic health, exercise adaptations, and recovery mechanisms. Because exercise training improves the hormonal status, there is interest in the effects of exercise on adipocytokines' responses to acute exercise in elite athletes and whether these peptides may provide better understanding of how exercise improves health. The purpose of this study was to investigate adipocytokines' responses to high-intensity acute exercise in athletes with different body fat amount and sedentary controls.

METHODS: Sixteen athletes with body fat percentage (BF%) <12%, fifteen athletes with BF%≥12% and sixteen sedentary young normal weight subjects participated in this study. After anthropometric measurements, all subjects were exposed to the high-intensity exercise test on the treadmill to examine the acute adipocytokine's response. Blood samples were taken before (basal levels), immediately after the exercise test, as well as in the 30 minutes of recovery. Separated serum and/or plasma were used for the hormone (insulin, leptin, adiponectin and visfatin) ELISA analysis.

RESULTS: In athletes with BF%<12%, basal leptin concentration was significantly lower compared to sedentary controls and athletes with BF%≥12% ($p<0.05$). No significant changes were found in the basal level of adiponectin and visfatin between groups. In all three groups, insulin concentration increased significantly after exercise and stayed higher throughout the recovery period ($p<0.05$). There were no significant postexercise and recovery changes in adiponectin concentration ($p>0.05$). In sedentary controls, leptin concentration was significantly reduced after exercise and decreased more in recovery period ($p<0.05$). No differences in leptin concentration over time were observed in athletes' groups ($p>0.05$). In athletes with BF%≥12%, visfatin concentration increased significantly after exercise, but reduced in recovery period ($p<0.05$). In controls, visfatin concentration was significantly reduced and stayed lower throughout the recovery period ($p<0.05$). No differences in visfatin concentration over time were observed in athletes with BF%<12% ($p>0.05$).

CONCLUSION: Our findings show leptin and visfatin, but not adiponectin responses to acute exercise. High-intensity acute exercise elicited an inverse visfatin response in athletes BF%≥12% and sedentary controls. Also, these results suggest that leptin is altered after acute exercise only in sedentary controls. It seems that athletes' body fat is more resistant to high-intensity exercise-induced energy deficit.

**SALIVARY PH AS A NON-INVASIVE MARKER FOR PHYSICAL ACTIVITY AND PHYSICAL FITNESS LEVELS IN SCHOOLCHILDREN.**

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INTRODUCTION: Salivary pH has been related to athletic performance as a proxy of body's metabolic responses during physical exertion. However, studies in children analysing the association between salivary pH with physical activity and physical fitness are scarce. The purpose of this study was to investigate the relationship between physical activity, fitness, and salivary pH in schoolchildren.

METHODS: Eighty-seven primary schoolchildren were included in the study. Salivary pH was obtained using a universal indicator pH paper test (One+Step). Minutes per day spent in moderate-to-vigorous physical activity (MVPA) were measured with a triaxial accelerometer (Actigraph) and used to create and compare tertiles. Physical fitness was assessed by the handgrip strength (handgrip dynamometer) and agility (10 × 5 m shuttle run test). The collected data was analysed by SPSS version 29.

RESULTS: We found a significant inverse correlation between time spent in MVPA and salivary pH ($r = -0.398$, $p < 0.001$). Children with lower MVPA levels (36.37 ± 0.86 minutes/day) had salivary pH levels 15% higher than more active children (86.39 ± 15.29 minutes/day), with mean pH values of 7.11 ± 0.86 and 6.17 ± 0.70, respectively. Interestingly, salivary pH also correlated with physical fitness measures, exhibiting a negative association with handgrip strength ($r = -0.348$, $p < 0.001$) and a positive association with time to complete the 10 x 5m shuttle run test ($r = 0.267$, $p = 0.038$). Linear regression analysis, using physical activity and fitness measures as independent variables, revealed that only MVPA showed a significant negative association with salivary pH ($\beta = -0.345$, $p = 0.005$). The adjusted R-squared for the model was 17.9%.

CONCLUSION: Taken together, our results show that a more alkaline salivary pH was related to lower physical activity levels. Moreover, children with lower MVPA levels had salivary pH levels 15% higher than more active children. These findings may help the monitorization of practicing more physical activity to optimize health. Finally, salivary pH may be a non-invasive and useful health indicator, which is especially important for the paediatric population.

**RELATIONSHIP BETWEEN EXHALED AND SKIN GAS ACETONE CONCENTRATION DURING MAXIMAL EXERCISE**

KATO, R., YAMADA, K., MATSUDAIRA, H., IDE, D., OCHIAI, A., OGURI, H., YAMAMOTO, K., MIURA, Y., YOSHIGA, M., CHOI, Y., SHIMIZU, K., FUNAHASHI, N., TOMITA, A., SAITOU, K., MIYAZAKI, M., TSUDA, T., ITOH, H.
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INTRODUCTION: Ketone bodies are composed of acetoacetic acid (AcAc), β-hydroxybutyric acid (βHB), and acetone, which are produced in the mitochondria of the liver. AcAc and βHB are consumed as energy sources, but acetone is not used by the body as an end product of metabolism and is eliminated through expiration and skin [1]. Previous study has reported

that exercise increases acetone concentrations in exhaled breath and skin gas. This is attributed to enhanced fatty acid oxidation in the mitochondria of the liver during exercise due to increased oxygen uptake [2]. However, little is known about the relationship between acetone concentrations in exhaled breath and skin gas before and during exercise. Therefore, this study aimed to investigate the relationship between acetone concentrations, excretion of acetone in exhaled breath and skin gas acetone concentrations during the maximal exercise.

METHODS: Eight healthy male students (23.9 ± 1.7 years; mean ± SD) consumed incremental maximal cycling exercise that reached 100% HR(HRmax) within 30 minutes after starting. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (200mL) was introduced for 60 sec and collected in a sampling bag at rest, 5, 10, 15, 20, 25, minutes during exercise, and immediately after exercise. Exhaled breath samples were also collected at the same time, furthermore ventilation volume, oxygen uptake was simultaneously measured using a gas analyzer (Cardio Coach PRO MC-2200). Acetone concentration was analyzed by gas chromatography.

RESULTS: The incremental maximal exercise significantly increased the concentration (ppm) and excretion (mol/min) of acetone in exhaled breath with increasing exercise intensity. The acetone concentration in skin gas (ppm) also increased similarly. Thus, significant positive correlations were observed between acetone concentration in exhaled breath and skin gas ($r=0.6312$, $p<0.0001$, $n=64$), as well as between acetone excretion in exhaled breath and acetone concentration in skin gas ($r=0.8973$, $p<0.0001$, $n=64$) following the maximal exercise.

CONCLUSION: This study confirmed a significant positive relationship between exhaled acetone excretion and skin gas acetone concentration during the maximal exercise. Th1ese results of this study indicated that changes in skin gas acetone concentrations before and during exercise could potentially serve as indicators of ketone body production in the liver and markers of whole-body acetone excretion.

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**RELATIONSHIP BETWEEN EXHALED ACETONE EXCRETION AND OXYGEN CONSUMPTION DURING SUBMAXIMAL EXERCISE**

TOMITA, A., SAITOU, K., YAMADA, K., IDE, D., MATSUDAIRA, H., OGURI, H., KATO, R., OCHIAI, A., YAMAMOTO, K., MIURA, Y., YOSHIGA, M., CHOI, Y., SHIMIZU, K.2, FUNAHASHI, N.3, TSUDA, T.2, ITOH, H.2

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INTRODUCTION: Ketones (β-hydroxybutyrate, acetoacetate and acetone) are generated in mitochondria of the liver, mainly from the oxidation of fatty acids, and are exported to peripheral tissues, such as the brain, heart, kidney, and skeletal muscle for use as energy fuels (Laffel 1990). Previous study has reported that exercise increases acetone concentrations in exhaled breath and skin gas (Yamai et al. 2009). This is attributed to enhanced fatty acid oxidation in the mitochondria of the liver during exercise due to increased oxygen uptake. However, no one has confirmed the relationship between acetone concentration in exhaled breath and oxygen consumption during exercise. Therefore, this study aimed to investigate the relationship between acetone concentration, excretion of acetone in exhaled breath and oxygen consumption during submaximal exercise.

METHODS: Eight healthy male students (23.9 ± 1.7 years; mean ± SD) performed 30 minutes of incremental cycling exercise that reached 50% HRmax approximately 25 minutes after starting. Exhaled gas samples were continuously collected at rest, 5, 10, 15, 20, 25, 30 minutes during exercise, and 5 minutes after exercise. The concentration of acetone in the exhaled breath was measured by gas chromatography, and oxygen consumption and energy expenditure (kcal/min) were calculated using a gas analyzer (Cardio Coach PRO MC-2200).

RESULTS: The incremental exercise at 50% HRmax significantly increased the concentration (ppm) and excretion (mol/min) of acetone in exhaled breath with increasing exercise intensity. There was a significant relationship between excretion of acetone in exhaled breath and oxygen consumption before and during exercise ($r = 0.9205$, $p<0.001$, $n=64$). Moreover, a significant correlation ($r=0.9163$, $p < 0.001$) was also observed between the acetone excretion in exhaled breath and energy expenditure before and after exercise.

CONCLUSION: This study confirmed that changes in exhaled breath acetone excretion related oxygen consumption and energy expenditure during submaximal exercise. These results suggest that the excretion of acetone in exhaled breath was revealed to be not only an indicator of fatty acid oxidation in the mitochondria of the liver but also a potential marker of oxygen consumption and energy expenditure during submaximal exercise.

**CHANGES IN EXHALED ACETONE AND SKIN GAS NITRIC OXIDE CONCENTRATION DURING MAXIMAL EXERCISE**

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INTRODUCTION: Nitric oxide (NO) [1] is known as an endothelium-derived vasorelaxant factor and is catalyzed by NO synthase (NOS), which is produced by three known enzymes: endothelial-type NOS (eNOS), neural-type NOS (nNOS) and induced-type NOS (iNOS). During exercise, increasing NO production facilitate blood flow in muscle tissues, muscle energy metabolism, and mitochondrial respiration. Chirpaz-Oddou et al. [2] reported that although the concentration of NO in exhaled breath decreases during maximal exercise with incremental loading, NO output in exhaled breath reflects aero-

bic metabolism. However, no one has confirmed the relationship between NO concentration in exhaled breath and skin gas NO concentration during exercise. Therefore, this study aimed to investigate the relationship between NO concentration, excretion of NO in exhaled breath and skin gas NO concentration during maximal exercise.

METHODS: Subjects were 10 healthy male students (23.3 ± 0.98: Mean ± SD) who rested in the supine position for 30 min and then underwent incremental pedaling exercise. The exercise started at 60w load and 60 rpm, and the load and rpm were increased every 2 minutes, with each subjects protocol set to reach HRmax within 30 minutes. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (200mL) was introduced for 60 sec and collected in a sampling bag at rest, and during exercise. Exhaled breath samples were also collected at the same time, and furthermore, ventilation volume and oxygen uptake were simultaneously measured using a gas analyzer (Cardio Coach PRO MC-2200). NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Japan).

RESULTS: The incremental maximal exercise significantly decreased the concentration of NO in exhaled breath (μmol/l) compared to the resting values, however, excretion of NO in exhaled breath (μmol/min) significantly increased with increasing ventilation volume compared to the resting values during the exercise. Furthermore, the maximal exercise significantly increased skin gas NO concentration (μmol/l) compared to the resting values with increasing exercise intensity. A significant relationship was found between excretion of NO in exhaled breath and skin gas NO concentration before and during exercise ($r = 0.858$, $p<0.001$, $n=60$).

CONCLUSION: This study confirmed that NO concentration in skin gas related to exhaled breath NO excretion during maximal exercise. These results indicated that skin gas NO concentration could be an indicator of total NO production in the body via eNOS, iNOS, and nNOS, as well as a marker of whole-body NO excretion during exercise.

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**EXPLORING THE CHANGES IN CONCENTRATIONS OF BLOOD BIOMARKERS THROUGHOUT A SEASON OF RUGBY UNION IN UNIVERSITY-LEVEL FEMALE PLAYERS**

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INTRODUCTION: Rugby union is a high-contact sport, leading to the risk of head injury. Previous research focusses on concussion, including the diagnosis and recovery. However, there is little research that investigates the effects of sub-concussive head impacts or cumulative head impacts. A sub-concussive head impact involves insufficient impact to cause clinical symptoms to be present (1), however, repeated sub-concussive head impacts can lead to long-term health concerns (2). How the accumulation of such impacts affects the levels of blood-based biomarkers proposed to support the diagnosis of concussion is unknown. This study examined the changes in concentrations of blood-based biomarkers associated with concussion in a group of rugby union players during a playing season.

METHODS: Ten female university-level rugby union players were recruited (age 20.0±1.8 years) via the University of Birmingham Concussion Clinic. Participants completed pre-season baseline tests using the Sport Concussion Assessment tool 6th Edition (SCAT6) and provided a blood sample, which was repeated following 8 weeks of training and games. Blood samples were then batch analysed using Single Molecular Array to quantify glial fibrillary acidic protein (GFAP), neurofilament light chain (NfL), total Tau and ubiquitin C-terminal hydrolase (UCH-L1) concentrations. Paired t-tests were used to assess changes across this 8-week period.

RESULTS: Overall, there were no group-level changes in concentrations of any blood biomarker (all $p>0.23$). Interestingly, the one participant in this cohort that had a concussion during this 8-week period (at week 4, then followed the return to play protocol, returned to play at week 7) had elevated levels of NfL (up 141% vs 6% for remaining participants ($n=9$)) and UCH-L1 (up 58% vs a group decrease of 15%) after 8 weeks. Total number of SCAT6 symptoms were similar between time points ($p=0.30$), including the participant with higher NfL and UCH-L1 data (5 vs. 0 total symptoms, for initial vs 8 weeks respectively).

CONCLUSION: Findings demonstrate that across a short rugby union season there were no significant changes in blood-based biomarkers linked with concussion. Nevertheless, elevated levels were observed in the context of a recent concussion, albeit in only one case, which highlights the potential for longer-term effects persisting beyond the resolution of symptoms. Future research should implement the use of impact monitoring tools alongside biomarker measures to better track sub-concussive head impacts and their potential impact on brain health outcomes.

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**EFFECT OF ASHWAGANDHA (WITHANIA SOMNIFERA) SUPPLEMENTATION ON BLOOD LEVELS OF BIOCHEMICAL MARKERS OF POST-EXERCISE RECOVERY IN YOUNG, HEALTHY MEN**

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INTRODUCTION: Ashwagandha is an herbal plant with potential health properties. Due to its wide range of phytochemicals, ashwagandha root extract is thought to be useful in treating a variety of conditions, including neurodegenerative diseases and cognitive/memory impairment. However, little is known about its potential to regulate anti-inflammatory and antioxidant pathways under high intensity exercise. The purpose of this study was to evaluate the effects of 8-week ashwagandha supplementation (600 mg/day) on blood markers of oxidative stress and inflammation in healthy male non-athletes undergoing an high-intensity interval training (HIIT).

METHODS: The study was performed in randomized, double-blind, placebo-controlled manner (placebo group, P, n=20; ashwagandha group, A, n=18). HIIT was performed on a rowing ergometer (3 sessions/week, 5-7 sets of 1.5 minutes in each session, at a load of 85-95% of maximum aerobic power, with rest intervals between sets of 1.5 minutes). Before (term 1) and after (term 2) the 8-week intervention, participants completed maximal graded exercise test (GXT) on rowing ergometer. Blood samples from the ulnar vein were obtained prior to (pre) and 5 min after (post) GXT, as well as after 24-hour recovery period (24h). Serum levels of total antioxidant capacity (TAC), total oxidant status (TOS), interleukin 6 (IL-6), tumor necrosis factor α (TNFα), interleukin 10 (IL-10), as well as heat shock proteins (HSP70, HSP27) and creatine kinase (CK) were determined. Moreover, the activity of antioxidant enzymes: superoxide dismutase (SOD) and glutathione peroxidase (GPx) were measured in erythrocytes.

RESULTS: In both terms of the study, similar GXT-induced changes in pro- and anti-inflammatory markers were observed in both groups, i.e. an increase in IL-6, IL-10 and HSP70 post, followed by a decrease in IL-6 and HSP70 at 24h ($p< 0.0001$). No significant changes were observed in TNFα and CK levels ($p>0.05$). As a result of 8-week HIIT, a decrease in HSP27 pre, while an increase in SOD pre and TAC at 24h were found (changes in term 2 vs term 1, in both groups, $p<0.05$). This indicates the need to mobilize antioxidant defence due to increased free radical production. Indeed, oxidative stress (an increase in TOS post) was particularly pronounced in term 2, with a significant change in P group alone ($p<0.05$). Meanwhile, ashwagandha supplementation reduced oxidative stress, as in term 2, group A showed lower levels of TOS post, SOD at 24h and GPx at 24h compared to P group ($p <0.05$). In addition, in term 2, there was a reduction in anti-inflammatory IL-10 at 24h in P ($p< 0.05$) but not in A group ($p>0.05$).

CONCLUSION: Ashwagandha supplementation can modulate the antioxidant and anti-inflammatory response to an intense exercise/training program in young men. This indicates the potential of ashwagandha to accelerate post-exercise recovery in physically active individuals. However, these results need to be confirmed by further studies in a group of competitive athletes.

## Conventional Print Poster Presentations

### CP-PN05 Energy Restriction

**CONTINUOUS GLUCOSE MONITORING – A NOVEL TOOL FOR BEHAVIOUR CHANGE IN RELATIVE ENERGY DEFICIENCY IN SPORT (REDS)?**

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INTRODUCTION: Relative Energy Deficiency in Sport (REDs) is a multi-factorial clinical condition associated with profound adverse long-term health and performance consequences. The predominate treatment for REDs is to increase energy availability (EA) via increasing energy intake (EI), with the athlete understanding their own EA equation playing a key role in their recovery. However, knowledge alone may not be enough to create the required behaviour modifications around increasing EI and/or improving EA across the day. Yet, there is a dearth of evidence regarding behaviour change to increase EA in those with, or at risk of REDs. This descriptive qualitative study investigated the acceptability of continuous glucose monitoring (CGM) in athletes clinically diagnosed with REDs, and how biofeedback from CGM may play a role in creating the required behaviour change for the recovery of REDs.

METHODS: Females (n=8, 26.8 ± 6.4 years) with a diagnosis of REDs by an experienced medical specialist, participated in a seven-day trial whereby they wore an unblinded CGM sensor and were instructed to scan the sensor at least every eight hours. Participants were provided with only minimal information on what to expect in their glucose readings; no specific education was given as to how their glucose readings might reflect nutritional timing or choices. Participants also recorded their exercise data each day and their dietary intake for four days of the trial. A semi-structured interview guide was used to collect qualitative data to gain an understanding of the participants' experience of wearing a CGM. Data were analysed using thematic analysis inductively for key themes.

RESULTS: Two main themes emerged from the data. The first theme, "Acceptable but aware", captured the participants' experience of wearing the CGM during their recovery of REDs. Participants found it easy to use, predominately unobtrusive, and showed low to no anxiety with regards to the continuous access to their interstitial glucose levels. The second theme, "Engagement with the data", portrayed the spectrum to which participants connected with the CGM data and identified the potential of CGM to impact nutrition behaviour in the recovery of REDs, particularly in response to exercise.

CONCLUSION: The CGM appeared to provide an 'objective permission' to some participants to change their nutritional intake behaviours. This was predominately regarding fuelling before training, having linked their subjective feelings to the objective metrics on the CGM. However, there is a clear need to ensure individuals understand the CGM data, particularly around exercise, to be able to make meaningful change. CGMs do not appear to create anxiety in those diagnosed with REDs. With an accompanying education, CGM may have a potential role in creating behaviour change with regards to nutrition around exercise.

**OVERNIGHT FAST ALTER MOTOR UNIT ACTIVATION PROPERTIES IN HUMAN: DOUBLE-BLIND RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Energy utilization in skeletal muscle during contraction depends on muscle fiber type. Slow twitch fibers have higher fat oxidation capacity, while fast-twitch fibers are greater glycolytic metabolism. Previous studies have shown fat oxidation during low-intensity exercise increases after overnight fast, a phenomenon linked to changes in central nervous system (CNS) that enhance hormone secretion promoting lipid breakdown. Since muscle fibers are innervated by motor neurons, fast-induced changes in CNS also alter motor unit activation properties. We hypothesized that during low-intensity exercise after an overnight fast, the activity of motor units (MUs) with lower recruitment thresholds, which have muscle fibers with higher fat oxidation capacity, is enhanced. The present study aimed to investigate the effects of overnight fast on motor unit activation properties and its recruitment threshold dependency.

METHODS: Eighteen adults participated in this study. After an overnight fast, participants performed measurements in the morning under two conditions in a double-blind, randomized controlled design. In non-intake condition (NIN), participants had a jelly containing 0 kcal and intake condition (IN), they had a jelly containing about 450 kcal. Two conditions were provided on separated days for each participant. On each day, respiratory exchange ratio (RER) during knee extension-flexion exercise at about 20% of VO2peak, maximal voluntary contraction (MVC) strength of knee extension, high-density surface electromyography (HDsEMG) from the vastus lateralis at 30% of MVC, and evoked twitch torque of knee exten-sors were measured. HDsEMG signals were decomposed into individual motor unit action potentials, and motor unit firing rate (MUFR) and recruitment thresholds (MURT) were calculated. Only MUs tracked between two days/ conditions were analyzed. Shapiro–Wilk tests were performed to check the normality of all variables, followed by paired t-test or Wilcoxon

signed-rank test. To investigate threshold-dependent changes in MU between conditions, Spearmans rank correlation analysis was performed on the changes in MUFR and MURT (NIN-IN) and MURT.

RESULTS: RER was significantly lower in NIN than that in IN ($p<0.01$). There were no significant differences in MVC strength and evoked twitch torque between two conditions. A total of 116 MUs were tracked and analyzed. MUFR and MURT were significantly lower in NI than that in IN ($p=0.03$, $p=0.02$). The change in MUFR from NIN to IN and MURT was not significantly correlated ($p > 0.05$), but the change in MURT from NIN to IN and MURT were significantly correlated ($\rho=0.28$, $p<0.01$).

CONCLUSION: The present study showed overnight fast with no energy intake enhanced fat oxidation during low-intensity exercise in the morning and enhancement of MUs recruitment with relatively lower recruitment threshold. Our results suggest alterations in energy metabolism induced by overnight fast is accompanied with changes in motor unit activation properties.

**BODY COMPOSITION ADAPTATION DURING HIGH ALTITUDE TREK**

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INTRODUCTION: High-altitude trekking is characterized by changes in body composition. However, how body composition (BC) varied is still debated [1] . This study aimed to evaluate the short-term BC changes through two different field methods according to the somatotype of participants.

METHODS: A group of 12 healthy young adults (6m and 6f, with mean age of 26.4 y BMI of 22.9kg/m2) participated in a scientific expedition (20 days) up to the Pyramid Lab in the Himalayas (5050m). BC was evaluated through bioimpedance analysis (BIA), skinfold equations, sum of skinfold, and corrected girth at three times: before, at peak altitude, and four days after the trek. Somatotype was calculated for each participant. Energy and protein daily intake were evaluated through three food diaries, recorded on the same day as BC. All anthropometric measurements were performed according to the International Society of the Advancement of Kinanthropometry (ISAK) protocol [2].

RESULTS: Body weight dropped during the hypoxic trek from 69.1kg at baseline (T0) to 67.4kg at peak altitude (T1) to 68.2kg once back in Kathmandu (T2). A reduction of fat mass percentage (FM%) estimated was observed mainly from Durnin and Womersley equation (21.1 to 19 to 19.5%, $p<0.001$) than from BIA (18.5 to 17.1 to 17.8 %, $p=0.425$). FM% estimates comparison from BIA and Durnin and Womersley equation resulted in a mean bias of 2.7 (95%CI 1.3- 6.7), at T0, 1.83 (95%CI 0.9-4.6) at T1 and 2 (95%CI Lower -1.9, Upper 6.1) at T2. Therefore, we considered the sum of skinfolds as a key variable to monitor fat massa changes during HA expedition; that variable changes from 80.1 mm to 71.7 to 71.6, thus evidencing a reduction ($p<0.001$) of subcutaneous body fat as a result of the hypoxic trek. Free fat mass estimated from BIA remained more stable during expedition ($p=0.177$), similarly to the corrected girth (0.092), utilized as indicators of skeletal muscle mass. The somatotype representative of trekkers changed from Endomorphic-mesomorph (3.1-3.4-2.5) to balanced mesomorph (2.9-3.5-2.4). At T0 the somatotype mean for male and female trekkers was balanced mesomorph (2.7-4.3-2.2) and balanced endomorph (3.7-2.8-2.4); differences in the reduction of FM% estimated from Durnin and Womersley equation and the sum of skinfold was found between male and female ($p=0.005$). The mean energy intake was 2423 and 1926 kcal/day for men and women, and the protein intake was 99 and 75 g/day, respectively.

CONCLUSION: The relatively low energy and protein intake and the reduction in body weight and FM% obtained during the hypoxic trek were in line with the BC adaptation in the literature [1]; instead, skeletal muscle mass was preserved. The different somatotype at baseline between the two sexes can explain the greater reduction in FM% and the sum of skinfolds in females over males.

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**THE EFFECT OF WITHIN-DAY ENERGY DISTRIBUTION ON LEAN BODY MASS AND BODY FAT IN ATHLETES**

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INTRODUCTION: Nutritional habits have a considerable effect on exercise performance as they determine both acute energy availability for sport activities, and long-term changes in body composition (BC) (muscle mass (MM) and fat mass (FM)). The aim of the study was to summarizes the available evidence on the effects of within-day energy balance on FM and MM in athletes.

METHODS: The systematic search strategy executed via the databases of Embase, PubMed, Scopus, SportDiscus and Web of Science using the combination of the following terms: meal frequency, eating frequency, feeding frequency, meal pattern, eating pattern, feeding pattern, meal distribution, eating distribution, feeding distribution, within-day energy balance, within-day energy deficit, body composition, lean mass, muscle mass, and athletes. Inclusion criterion were: athletes, over 14yrs, report data on the BC and energy balance within a day, full text, peer-reviewed papers and published in English language.

RESULTS: The search identified 3831 unique papers; 20 were suitable for full text assessment and 7 papers were included in the systematic review. From the seven papers two used meal frequency as an indication of energy distribution, while

five calculated hourly energy surplus and deficit to determine within-day energy balance. The average score on the PEDro scale checklist was 4 and none of the included studies was of poor (score less than 4) quality. Findings revealed that within-day energy balance is a significant factor in the regulation of body composition in athletes, and that negative within-day energy balance may impair muscle protein synthesis and promote fat accumulation. During food restriction (weight cutting), a more frequent meal schedule may help preserve LM and reduce FM by maintaining a higher metabolic rate and stimulating protein synthesis. During weight gain, a large 24-hour energy surplus ensures continuous positive energy balance, and the timing and the frequency of meals are not as important.

CONCLUSION: Assessment of hourly, rather than daily energy balance would assist with the development of tailored approaches to target energy balance to enhance performance and BC of athletes. Consuming high glycemic index carbohydrate and protein rich snack within ~30 minutes after exercise seems beneficial to replenish glycogen stores and promote muscle remodeling. Large 24-hour energy surpluses may be sufficient for athletes aiming for lean mass gain, as meal timing and frequency become less critical in such scenarios.

**DESIRE TO LOSE WEIGHT AND EATING HABITS AMONG FEMALE PHYSICAL EDUCATION STUDENTS IN JAPAN**

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INTRODUCTION: national health campaign,"Health Japan 21"was established by the Ministry of Health, Labour and Wel-fare in Japan to outline nutrition and dietary objectives, including reducing underweight prevalence among young wom-en, increasing vegetable intake, and improving fruit intake. Over 20% of women in Japan have a BMI below 18.5 and are underweight; many women consider their ideal body type as skinny. For women in their 20s, being underweight (BMI<18.5 kg/m²) may lead to reduced bone mass, sarcopenic obesity, and decreased ADLs in later life. Preference for thinness, inadequate energy intake due to weight loss efforts, and insufficient vegetable and fruit consumption pose seri-ous challenges for female athletes. However, the relationship between desire to lose weight and eating habits among female athletes has not yet been elucidated. This study aimed to clarify the relationship between desire to lose weight and eating habits among female college students in physical education.

METHODS: Using Google Forms, a survey was conducted in January 2025 with 1,421 students from Japan's Women's College of Physical Education; 588 valid responses (41.4%) were received. The questionnaire included items on height, current/ideal weight, exercise habits, desire to lose weight, and eating habits. Items on eating habits included skipped meals, cereal intake frequency, and Dietary Variety Score (DVS; 0–10 points). To examine the relationship between desire to lose weight and other factors, the participants were divided into two groups based on an ideal BMI of 18.5. The desire to lose weight was set at less than the ideal BMI 18.5 kg/m². Those with ideal BMI <18.5 kg/m² were categorized as the desire to lose weight (DLW) group (n=178), while those with ideal BMI ≥18.5 kg/m² were in the non-desire to lose weight (NDLW) group (n=410). Height, current/ideal weight, current BMI, and DVS were analyzed using a t-test, while other items were analyzed using a chi-square test. The significance level was set at 5%.

RESULTS: The average BMI was 20.9, with 8.5% (n=50) having a BMI below 18.5. Exercise frequency did not differ significantly between the DLW and NDLW groups; 39.3% and 22.9% of the DLW and NDLW groups specialized in cheerleading/dancing, respectively (p<0.001). Conversely, 12.4% and 37.8% of the DLW and NDLW groups specialized in ball games, respectively (p<0.001). Both groups had low DVS scores, averaging 2 points (p=0.089), with no significant differences in individual food group intake. However, grain intake frequency differed significantly, with 64.1% of the DLW group and 52.2% of the NDLW group reporting "eating every meal" (p=0.013).

CONCLUSION: In this study, 30.3% of participants expressed a desire to lose weight. This desire was linked to sports category and grain intake frequency. In aesthetic sports such as cheerleading and dancing, nutritional education that involves eating staple foods (bread, rice, or noodle) at every meal is necessary.

**DIETARY INADEQUACIES AMONG BRAZILIAN AMATEUR AND ELITE ATHLETES: A NARRATIVE REVIEW**

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INTRODUCTION: Despite dietary guidelines emphasizing the importance of adequate nutrition, carbohydrate restriction and insufficient energy intake (IE) are commonly observed among athletes. This review aims to evaluate dietary adequacy among Brazilian amateur and elite athletes (Tiers 2–5) aged over 18 years, comparing energy and macronutrient intake adequacy across sex, sports, and Tier.

METHODS: A search was conducted in PubMed, Web of Science, LILACS, SciELO, and Scopus databases using specific MeSH terms to identify studies assessing mean energy and macronutrient intake inadequacy. Studies without Tier classification were excluded.

RESULTS: A total of 877 studies were identified and 22 studies met the eligibility criteria. They included 328 males and 143 females aged 18-55 years. Among 471 adults, 68.36% were classified as Tier 2, 15.07% as Tier 3, 15.28% as Tier 4, and 1.27% as Tier 5. Dietary intake over multiple days was assessed in 12 studies. Only two studies observed adequate dietary intake. In the other 20 studies, nutritional inadequacies were observed at different levels across sexes, Tiers, and sports. Adequate energy and macronutrient intake were observed in female team sports Tier 5 (1 study). Among Tier 4 athletes, insufficient carbohydrate intake was observed in all 4 studies, except for females in endurance sports (n = 6) and combat sports (n = 4). Intake above the recommended levels was observed for energy in females (n = 6) and protein and fat in males (n = 28) and females (n = 6) in endurance sports. Insufficient EI was observed only in male (n = 12) and female (n = 12) weightlifters. In Tier 3, all three studies observed adequate EI. However, carbohydrate intake was insufficient in males (Crossfit®, n = 6 of 13, endurance sports, n = 6 of 37) and females (Crossfit®, n = 6 of 12, endurance sports, n = 9 of 9). In endurance sports, mean protein and fat intake above the recommended level was observed for both sexes. For less trained individuals (Tier 2, 14 studies), only one study observed adequate mean energy and carbohydrate intake in both male (n = 6) and female (n = 3) endurance athletes. One study showed adequate carbohydrate intake in both male (n = 2) and female (n = 2) Crossfit® athletes.

CONCLUSION: Brazilian athletes present a high prevalence of energy and carbohydrate inadequacy. Even with adequate energy intake, the risk of carbohydrate deficiency remains in Tiers 3 and males Tier 4, mainly due to higher protein and/or fat consumption. Despite the increase in energy and carbohydrate intake recommendations with training level, less-trained athletes (Tier 2) show the highest carbohydrate and EI inadequacy, possibly due to lower awareness of their nutritional needs or limited access to tailored support, mentioned in only one study with Tier 2 individuals. These findings highlight the need for a comprehensive nutritional approach considering energy and macronutrient balance while addressing sex, sports, and Tier.

**INTERMITTENT FASTING ENHANCES PHASE ANGLE AND $VO_2$MAX IN ATHLETES: A PRELIMINARY STUDY**

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INTRODUCTION: Intermittent fasting (IF) has been proposed as a strategy to optimize metabolic flexibility, enhance fat oxidation, and improve aerobic performance. However, its effects on cellular integrity (assessed via phase angle, PhA) and maximal oxygen consumption ($VO_2$max) remain underexplored in trained individuals. Given the metabolic adaptations induced by fasting, we hypothesize that IF can positively influence these parameters, leading to improved athletic performance.

METHODS: Previously twenty-eight volunteers underwent bioelectrical impedance analysis (Tanita MC-780MA) and incremental treadmill tests (Cosmed) to assess their body composition and aerobic capacity. Next, participants were divided into two groups: an IF group (16 hours fasting, 8 hours feeding during 8 weeks) and a control group (regular diet during 8 weeks). PhA and $VO_2$max are assessed before and after 8 weeks in the control and IF group. These data analyses are currently in progress.

RESULTS: Our data show a positive correlation between PhA and $VO_2$max, with athletes participants displaying higher PhA values and higher $VO_2$max levels (PhA =7,35 ± 0,19, VO2 = 55,62 ±1,62 ml/min/kg, N=15 ) while less physical active participants showed lower values (PhA =6,67 ± 0,31, VO2 = 41,39 ± 1,53 ml/min/kg, N=13 ). Additionally, we observed that individuals with higher PhA values also presented increased Intracelular water levels, suggesting a relationship between cellular hydration, membrane integrity, and aerobic performance. These findings indicate that PhA could serve as a biomarker for endurance capacity and metabolic efficiency in athletes. This ongoing study investigates the effects of a 16:8 intermittent fasting protocol on PhA and $VO_2$max in physically active individuals. Participants are divided into two groups: an IF group (16 hours fasting, 8 hours feeding) and a control group (regular diet).

CONCLUSION: Our initial data support the hypothesis that IF could enhance PhA, ICW, and $VO_2$max, likely due to improved mitochondrial function, cellular hydration, and metabolic substrate utilization. Further analysis will determine whether

these adaptations are significantly influenced by intermittent fasting, potentially providing a novel nutritional strategy for optimizing sports performance.

## Conventional Print Poster Presentations

### CP-PN06 Supplements

**THE EFFECTS OF ACETIC ACID SUPPLEMENT AND VOLUNTARY WHEEL RUNNING ON GUT-MICROBIOME IN OVARIECTOMIZED MICE**

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INTRODUCTION: There exists a correlation between a healthy physiological state and the diversity of gut microbiome. Menopause-induced deteriorations in whole body metabolism, including insulin resistance and obesity, negatively contribute to microbial diversity. Firmicutes including UCG009 is associated with enhanced energy storage leading to metabolic dysfunction and obesity. Acetic acid supplement or exercise intervention has been somewhat documented for its beneficial effects on gut microbial composition. However, the combined influence of acetic acid supplement and exercise intervention on gut microbiome remains unknown. The purpose of the study was to investigate 1) whether menopause negatively influences gut microbial diversity including firmicutes abundance; and 2) whether the combined treatment of acetic acid and exercise rescues this microbial dysbiosis , and which specific bacteria is related to this rescuing effect .

METHODS: This 15-week study used female C57BL/6J wild type mice (n=40, 8 weeks old), which were randomly assigned to Sham (SHM), ovariectomy (OVX), ovariectomy with exercise (OVXE), ovariectomy with acetic acid (OVXA), and ovariectomy with exercise and acetic acid (OVXAE) groups. Gut microbial diversity including abundance profiling in phylum level was accessed using Next Generation Sequencing (NGS). Beta diversity using Bray-Curtis Index and Unweighted UniFrac Index measured diversity differences between groups. Phylogenetic cladogram was used to analyze the group difference in specific bacteria.

RESULTS: In the abundance of firmicutes, OVX exhibited a tendency for an increase compared to SHM. However, OVXA showed no difference compared to SHM (SHM: 50.6%; OVX: 57.2%; OVXE: 52.0%; OVXA: 50.6%; OVXAE: 56.5). In microbial diversity, while there was no difference between SHM and OVX, acetic acid supplement groups (OVXA and OVXAE) showed greater diversity compared to SHM and OVX ($p < 0.05$). In phylogenetic cladogram analysis, compared to OVX, OVXA and OVXAE had lower level of UCG009 and Akkermansia ($p < 0.05$).

CONCLUSION: Ovariectomy, a model of menopause, tended to increase the relative proportion of Firmicutes. Acetic acid supplement partially maintained the Firmicutes proportion in ovariectomized mice. The noteworthy finding of the study is that, independent of exercise intervention, acetic acid supplement showed a significant, beneficial effect on microbial diversity in ovariectomized mice. Future research should explore the potential role of UCG009 in protecting against the menopause-related metabolic dysfunction.

**THE EFFECT OF ORAL CONTRACEPTIVES ON EARLY ADAPTATION IN SKELETAL MUSCLE TO A RESISTANCE TRAINING PROGRAM**

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INTRODUCTION: Estrogen, a primary female sex hormone, plays a key role in the adaptation of muscle after exercise (1,2). Possible mechanisms for the estrogen-muscle interaction include regulating satellite cells, which are important in repair and remodelling of muscle, and inhibiting muscular inflammation after exercise (1,3). Estrogen exerts its effects through acting on estrogen receptors located on skeletal muscle (4). How synthetic female sex hormones, such as the ones found in oral contraceptive pills (OCPs), impact skeletal muscle after exercise, including fibre size, lean body mass, and the satellite cell response remains unknown. The purpose of this study was to determine the effect that OCP use has on the response to the early phases of a resistance training program.

METHODS: Twenty-eight healthy, young females (21.2 ± 1.1 years, 64.5 ± 4.0 kg) were recruited and categorized as either OCP users (n=14) or naturally cycling (n=14). Each participant underwent a four-week resistance training protocol. Muscle characteristics (fiber cross sectional area, fiber type), strength, lean body mass via DEXA scanning, as well as satellite cell content were evaluated using immunofluorescent staining.

RESULTS: There were no significant differences between OCP users and naturally cycling individuals with respect to fiber cross sectional area, fiber type, strength gains, and satellite cell content after 4 weeks of resistance training ($p>0.05$). OCP users gained significantly more lean body mass as measured by DEXA compared to naturally cycling individuals ($p<0.05$), but both groups improved lean leg mass, equally, with training ($p=0.01$).

CONCLUSION: OCP use does not differentially impact fiber cross sectional area, fiber type, strength, and satellite cell content compared to naturally cycling individuals after 4 weeks of resistance training. The results obtained from this study further simplify inclusion criteria for future muscle physiology studies aiming to recruit female participants.

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**ARGININE-CITRULLINE SUPPLEMENT INCREASE QUADRICEPS MUSCLE BLOOD FLOW ACCOMPANYING WITH INCREASING SKIN GAS NITRIC OXIDE CONCENTRATIONS FOLLOWING MAXIMAL RUNNING EXERCISE**

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INTRODUCTION: The combination of oral L-arginine and L-citrulline immediately and synergistically increases plasma arginine and nitrite/nitrate (NOx) concentrations more than either citrulline or arginine alone (1,2). Nitric oxide (NO) is the most important endothelium-derived relaxing factor, which plays a pivotal role in modulating smooth muscle tone (3). During exercise, increasing NO production facilitate blood flow in muscle tissues, muscle energy metabolism, and mitochondrial respiration, therefore previous human study has reported that oral arginine-citrulline supplement improved exercise performance due to increase NO bioavailability (1). However, there is little data concerning the effect of arginine-citrulline supplement on skin-gas NO concentration during exercise. The present study examined to confirm the effect of arginine-citrulline supplement on blood flow of active muscles and skin-gas NO concentrations following maximal running exercise.

METHODS: A double-blind randomized placebo-controlled 2-way crossover study was employed. Ten healthy male students (23.0 ± 0.5 years; mean ± SD) consumed arginine-citrulline supplement (VELOX Charge: Kyowa Kirin Co., Ltd., Japan) or placebo orally 1 h before incremental maximal running exercise exhausting within 30 min. The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (250mL) was introduced for 100 sec and collected in a sampling bag at rest and 0, 5, 10, 15, 30 min recovery of the exercise. The skin-gas NO concentration was measured by a chemiluminescence analyzer (Pico-Device Co., Ltd., Japan). Blood flow measured using a laser tissue blood flow meter from non-dominant hand skin surface (Omegaflo, Omega Wave, Japan).

RESULTS: The arginine-citrulline supplement significantly ($p<0.05$) increased running time and distance compared to the placebo. Maximal exercise in this study significantly increased skin-gas NO concentration ($p<0.05$) and blood flow ($p<0.001$) after the exercise compared to the resting values. Significant higher levels were observed in skin-gas NO concentration ($p<0.001$) and blood flow ($p<0.001$) in the supplemental condition compared to the placebo. Moreover, there were significant relationships between skin-gas NO concentration and blood flow both in supplemental ($r = 0.5676$, $p<0.001$) and placebo ($r = 0.6050$, $p<0.001$) conditions.

CONCLUSION: Significantly higher levels of skin-gas NO concentration has indicated that the arginine-citrulline supplement increased NO production and NO bioavailability in the whole body during the maximal exercise. As a result, blood flow, energy metabolism, and mitochondrial respiration in active quadriceps muscle during the maximal running exercise facilitated by the arginine-citrulline supplement, consequently improved exercise performance (1).

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**INTRAMUSCULAR FAT INFILTRATION IS ATTENUATED IN A MUSCLE-DEPENDENT MANNER FOLLOWING ESTRADIOL SUPPLEMENTATION IN A CHEMICALLY-INDUCED OVARIAN FAILURE MODEL OF MENOPAUSE.**

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INTRODUCTION: Menopause-associated changes in skeletal muscle composition, including increased intramuscular fat can impair muscle contractility and performance. While ovariectomized models have shown an increase in intramuscular triglyceride content in skeletal muscles, this model does not mimic the natural transition to menopause that occurs in humans. Therefore, in the present study, we investigated the gradual menopausal transition using a VCD-induced ovarian failure mouse model, which better represents human menopausal hormonal profiles and physiological responses.

Specifically, we determined the effects of VCD-induced ovarian failure on intramuscular fat accumulation in slow-type (soleus) and fast-type (extensor digitorum longus; EDL) muscles, as well as the ability of estrogen replacement following the development of menopause to attenuate intramuscular fat accumulation.

METHODS: Female CD1 mice (n=19; 78-105 days old) were assigned to one of 3 groups: age-matched controls, VCD, or VCD + estrogen replacement (VCD+E2). VCD treatment (160 mg/kg) was administered for 15 days. Estrogen replacement (0.16 ug/day of 17-beta-estradiol, administered via subcutaneous pellet) began after confirmation of ovarian failure and continued for 8 weeks. Soleus and EDL muscles were harvested, flash-frozen, cryosectioned (10μm), and stained with Oil Red O. Sections were imaged at 20x magnification and intramuscular lipid content was quantified using colour thresholding analysis in ImageJ.

RESULTS: There was an interaction of group × muscle for intramuscular fat ($p<0.05$). For the soleus muscle, there was no significant difference between groups. However, in the EDL muscle, intramuscular fat content was ~190% and ~90% greater in the VCD group compared with Control and VCD+E2 groups, respectively ($p<0.05$), with no difference between Control and VCD+E2 groups ($p>0.05$).

CONCLUSION: We observed a muscle-dependent effect of decreased estradiol levels following ovarian failure on intramuscular fat accumulation with the fast-type EDL showing marked increases in fat content which was reversed following estrogen supplementation. While the soleus appeared to be protected from ovarian failure-induced intramuscular fat accumulation. These fiber-type specific differences highlight the complexity of effects of estrogen deficient states on skeletal muscle.

**PHARMACOKINETICS OF KEY MICRONUTRIENTS IN THE FOUNDATIONAL NUTRITION SUPPLEMENT AG1**

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*AG1*

INTRODUCTION: The interaction of nutrients in multi-ingredient supplements can be complex and may alter the absorption and bioavailability of nutrients following consumption. Pharmacokinetic data regarding micronutrient absorption when consumed in combination with other ingredients is scarce. The purpose of this randomized clinical trial was to define the absorption parameters of key micronutrients in AG1, a foundational nutrition supplement containing vitamins, minerals, probiotics, and phytonutrients, following acute consumption.

METHODS: A randomized, double-blind placebo-controlled crossover trial was conducted in 16 healthy males (n = 8; 27.4 ± 8.9 yrs; 81.5 ± 11.8 kg) and females (n = 8; 33.1 ± 9.7 yrs; 68.9 ± 6.0 kg) to measure the plasma appearance of key nutrients over 8 hours after acute AG1 consumption. Following a screening visit, participants reported to the laboratory after a 10-hour overnight fast and consumed 1 serving (13 g) of AG1 or placebo (maltodextrin matched for taste and appearance) mixed in 10 oz of water in a randomized, counterbalanced, crossover fashion separated by a one week washout period. Serial resting blood samples were subsequently taken over an 8-hour period (before and 30-, 60-, 90-, 120-, 180-, 240-, 360-, and 480 min post ingestion) and key circulating nutrient levels were assessed (folate, calcium, zinc, vitamin C, biotin, nicotinamide, pyridoxine, riboflavin, thiamin). Area under the curve (AUC) over the 8-hour period was calculated to assess the extent to which these nutrients were absorbed into the bloodstream and became available for use in the body. Repeated measures ANOVAs and paired t-tests were used to analyze the time course of nutrient availability between conditions. Additionally, product tolerability and adverse events were monitored following ICH-GCP guidelines.

RESULTS: Compared to the placebo, AG1 consumption resulted in a significantly higher AUC ($p < 0.05$) for folate, calcium, zinc, vitamin C, biotin, nicotinamide, riboflavin, and thiamin over the course of 8 hours. A trend ($p = 0.075$) for higher pyridoxine AUC was found in the AG1 treatment compared to placebo and pyridoxine concentrations were significantly elevated ($p < 0.05$) within 30 minutes following AG1 vs. placebo. There were no adverse events reported in either condition and both products were well tolerated.

CONCLUSION: These data demonstrate that all vitamins and minerals that were measured in AG1 were absorbed and entered circulation following consumption. Collectively, the results of this study validate the ability of AG1 to effectively increase circulating nutrient levels, indicating good bioavailability, and the potential to provide a meaningful physiological benefit to human health.

**CARNITINE SUPPLEMENTATION: SAFETY CONSIDERATIONS**

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INTRODUCTION: L-carnitine is a naturally occurring compound synthesized from lysine and methionine, playing a crucial role in energy metabolism by facilitating the transport of long-chain fatty acids into the mitochondria for β-oxidation. While endogenous production and dietary intake from animal-based sources are typically sufficient for maintaining physiological levels, supplementation has gained popularity, particularly among athletes seeking to optimize performance and recovery.

In sports, L-carnitine supplementation is primarily associated with enhanced endurance, improved fat metabolism, reduced muscle damage, and accelerated post-exercise recovery. Studies suggest that L-carnitine may contribute to glycogen sparing by increasing fatty acid utilization, thus prolonging time to exhaustion and delaying fatigue. Additionally, its

role in reducing oxidative stress and inflammation has been linked to improved muscle recovery following intense physical activity. The safety of L-carnitine supplementation has been a subject of debate. At recommended doses (500–2000 mg/day), L-carnitine is generally well tolerated, with mild gastrointestinal discomfort being the most common side effect. Despite the widespread use of carnitine in sport, data on its safety comes mainly from clinical reports.

METHODS: The data obtained were extrapolated from the Eudravigilance database. EudraVigilance, managed by the European Medicines Agency (EMA), is a system for monitoring the safety of medicines within the European Economic Area (EEA). It collects and analyzes reports of suspected adverse reactions to authorized medicines.

RESULTS: The results show that there are approximately 238 adverse reactions, reported mainly in Italy (n = 168). 107 concern those aged between 18 and 64, 58 for those over 65. 145 concerned women and 88 concerned men. Among the adverse reactions reported, 67 concerned skin reactions, 55 gastrointestinal reactions, 56 general disorders and administration type; 51 the nervous system and 31 psychiatric pathologies.

CONCLUSION: Carnitine remains a popular supplement among endurance athletes, while side effects are generally mild, population should consider dosage, individual tolerance, and dietary habits before supplementation, further research is needed to clarify its long-term effects.

**ACUTE KETONE MONOESTER SUPPLEMENTATION INCREASES THE OXYGEN COST OF SUBMAXIMAL EXERCISE: A SYSTEMATIC REVIEW AND INDEPENDENT PARTICIPANT DATA META-ANALYSIS**

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INTRODUCTION: Ketone monoester supplement (KES) ingestion rapidly induces nutritional ketosis and has been reported to increase, decrease, or have no effect on oxygen uptake (VO2) during matched-work exercise. This could depend on many factors including: KES dose and the resulting change in blood ketone body concentration (i.e., ΔKB), exercise intensity, duration and type; participant training status; substrate oxidation rate and respiratory exchange ratio (RER); nutritional state (e.g. fasted vs. fed, co-ingestion of other nutrients); and biological sex. The equivocal existing data regarding the effect of KES ingestion on exercise VO2 may be due to between-study differences in the factors listed above, the magnitude of the effect, and statistical power to detect potentially small changes.

METHODS: The present systematic review and independent participant data meta-analysis (IPD-MA) asked the review question(s): (1) Does acute ingestion of a KES affect exercise efficiency/economy? (2) Can the variance in question 1 be explained by participants cardiorespiratory fitness, supplement dose, timing and the corresponding blood ketone concentration, co-ingestion of a KES with carbohydrate, exercise intensity, exercise duration, exercise modality, biological sex, and/or nutritional state? (PROSPERO ID: CRD42024573290). A systematic search using PubMed revealed 140 studies, 12 of which were randomized, crossover studies that involved the acute ingestion of a KES or a ketone-free control before work-matched exercise in endurance-trained adults. Individual participant data (n=134) were made available for inclusion from 11 of these studies from four independent laboratories. Outlier data were removed, per model assumptions, including if exercise VO2 was not measured at steady state, exercise duration was >60 min, RER was >1.00, or the absolute change in exercise VO2 in KES vs. control (ΔVO2) was >400 mL/min. A "one-step" IPD-MA was performed with a linear-mixed effects regression model using forward-selection. The outcome was ΔVO2 and random effect was participants nested within studies nested within labs. Exercise duration, KES dose, and absolute workload were not included in the model due to significant correlations with other purported modifying factors breaking model assumptions.

RESULTS: ΔVO2 was not different than zero when not considering modifying factors (mean[95% confidence intervals], +9[-46 to +66] mL/min, p=0.76). ΔVO2 was related to ΔKB (+15[2 to 29] mL/min/mM, p=0.042) and an interaction between ΔRER and relative exercise intensity (+29[7 to 50], p=0.009). There were no significant associations between ΔVO2 and carbohydrate co-ingestion (p=0.55), fasting status (p=0.64), sex (p=0.66), exercise type (p=0.33), or maximal VO2 (p=0.63).

CONCLUSION: In conclusion, KES ingestion increased VO2 during submaximal constant-load exercise, more so when blood ketone bodies were higher and at higher relative exercise intensities.

**MORINGA OLEIFERA LEAF EXTRACT MITIGATES DEXAMETHASONE-INDUCED MUSCLE ATROPHY IN C2C12 MYOTUBES**

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INTRODUCTION: Muscle atrophy occurs in various physio-pathological conditions, including severe muscle injury, disuse, hormone imbalances, cancer, sepsis, and aging. A common feature of these conditions is the presence of cellular oxidative damage and pro-inflammatory processes. Dexamethasone (DEXA) is a synthetic glucocorticoid that is widely used as an anti-inflammatory agent. However, chronic DEXA treatment can lead to side effects such as diabetes mellitus, obesity and, ultimately, muscle atrophy.

There is ongoing research aimed at identifying tools to counteract muscle atrophy and improve the quality of life for affected individuals. Among the promising approaches, the use of plant-based extracts has garnered significant attention. In particular, Moringa oleifera leaf extracts (MOLE) has been shown to support muscle cells metabolism 1 and mitigate the negative effects of oxidative stress 2.

METHODS: In this study, we investigated the effects of MOLE on DEXA-induced muscle atrophy and the underlying mechanisms in C2C12 myotubes.

RESULTS: Exposure to 100 micromolar DEXA for 24 hours induced muscle atrophy, as evidenced by increased levels of the specific markers as MuRF-1 and Atrogin-1, and reduced levels of myosin heavy chain (MHC).

MOLE (0.15 mg/mg dried powder) was administered either concomitantly, or 24 hours before or after DEXA exposure.

MOLE treatment was effective in reducing atrophy markers and improving the status of C2C12 myotubes, as reflected by increased MHC levels and fiber size in all experimental conditions involving DEXA.

Interestingly, the most pronounced effects were obtained when MOLE was administered to cells that had already undergone DEXA treatment.

CONCLUSION: In conclusion, these findings suggest that MOLE can alleviate DEXA-induced muscle atrophy in C2C12 myotubes by reducing atrophic markers and restoring the proper myotubes phenotype.

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**IRISIN AMELIORATES PALMITIC ACID-INDUCED HEPATIC LIPID ACCUMULATION BY SUPPRESSING ENDOPLASMIC RETICULUM STRESS ACTIVATION**

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INTRODUCTION: Palmitic acid is considered to play a dominant role in the development of non-alcoholic fatty liver disease (NAFLD), including the progression of endoplasmic reticulum (ER) stress and NLRP3 inflammasome activation, ultimately leading to hepatic lipid accumulation. Combined resistance and aerobic exercise training is considered the most optimal approach for treating NAFLD, and its reversal effect may be linked to myokine production, particularly irisin. However, the effects of different exercise intensities on irisin production and its role in PA-induced NAFLD remain unclear. Therefore, we aim to investigate whether irisin can reverse PA-induced hepatic lipid accumulation by suppressing ER stress and NLRP3 inflammasome activation.

METHODS: Hepatocytes were treated with palmitic acid alone or co-cultured with varying concentrations of irisin. Protein expression levels were analyzed by Western blot, and lipid accumulation in hepatocytes was assessed using Oil Red O staining. Cell viability was determined using the MTT assay. Data are presented as mean ± SD. One-way ANOVA was used to compare differences between groups, with a $p\text{-value} < 0.05$ considered statistically significant.

RESULTS: Results showed that palmitic acid significantly increased the protein expression of p-PERK and p-IRE1α (ER stress biomarkers), which in turn activated TXNIP and NLRP3, leading to accelerated hepatic lipid accumulation via the ACC-FAS signaling pathway. Moreover, palmitic acid induced cell death. To investigate the potential protective effects of irisin, we co-treated cells with low, medium, and high doses of irisin to mimic the exercise-induced irisin production from skeletal muscle. We found that co-treatment with a low dose of irisin did not ameliorate palmitic acid-induced hepatic lipid accumulation. However, medium and high doses of irisin effectively reduced the ER stress response and NLRP3 activation while preventing lipid accumulation by suppressing the ACC-FAS pathway in hepatocytes, particularly at the high dose of irisin. Nevertheless, none of the irisin doses prevented palmitic acid-induced cell death.

CONCLUSION: We summarized that a high concentration of irisin can reduce palmitic acid-induced ER stress and NLRP3 activation, thereby diminishing lipid storage in hepatocytes through the downregulation of the ACC-FAS signaling pathway.

## Conventional Print Poster Presentations

### CP-PN07 Respiration and Gas Exchange

**BREATH RETRAINING IN RUNNERS USING LOCOMOTOR-RESPIRATORY COUPLING: A PILOT STUDY**

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INTRODUCTION: Breathing strategies such as Locomotor-Respiratory Coupling (LRC) have the potential to improve ventilatory efficiency and running performance (Harbour et. al, 2022) but have scarcely been reported in field or intervention

experiments. It is unknown if digital technologies can guide runners to learn LRC during exercise, and what physiological consequences result.

METHODS: Ten female runners completed an outdoor 5k time trial and indoor treadmill test to exhaustion. Runners were familiarized to LRC via a smartphone application (Harbour et. al, 2024) and completed 10 runs independently with the application over four to six weeks. The 5k and treadmill test were repeated after the intervention without LRC specific instruction.

Hexoskin smart shirts (Carre Technologies, CAN) were used to detect breathing pattern and LRC. A Suunto smartwatch was used to measure running pace outdoors, while spiroergometry (Cosmed, L.L.C., Rome, Italy) was used indoors. Questionnaires were asked regarding rating of fatigue, breathlessness, and flow. Pre and post-intervention data was compared using paired signed rank tests and Cohen's d effect sizes.

RESULTS: Participants expressed greater degrees of LRC in the post-tests, utilizing mostly 4:1 steps per breath in the outdoor run. Outdoors, runners decreased breathing rate while increasing diaphragmatic contribution (p=0.02, d=1.2) and pulse-respiration quotient (p=0.03, d=0.68) despite no change in running pace (p=0.58). During the indoor run, participants expressed higher tidal volume (p=0.03, d=1.3) especially at VO2max where breathing rate was lower (p=0.04, d=-0.30). No meaningful changes were observed in VO2max, ventilatory efficiency, or questionnaire responses.

CONCLUSION: This study demonstrates that LRC can be habituated over a 4-6 intervention period, resulting in changes to breathing pattern in field and indoor maximal conditions. Further investigations are needed using control comparisons and incorporating data from the intervention period.

**CIGARETTE SMOKING SLOWS DOWN THE CARDIORESPIRATORY AND METABOLIC KINETICS DURING MODERATE EXERCISE IN YOUNG PHYSICALLY ACTIVE MALES**

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INTRODUCTION: Cigarette smoking (CS) is the leading preventable cause of death, causing systemic changes that harmfully impact cardiovascular and pulmonary function at rest and during exercise. Indeed, nicotine overstimulates the sympathetic nervous system, tar alters O2 diffusion, and carbon monoxide reduces O2 transport and extraction (1). Although these effects are well-established in sedentary, middle-aged smokers (SM) with pulmonary disease, limited and controversial studies have focused on young SM without comorbidities (2). Hence, the aim of this study was to evaluate the cardiorespiratory and metabolic kinetics during moderate exercise in young, physically active SM without known lung or cardiovascular disease. It was hypothesized that, despite their brief smoking history and good fitness level, which could mitigate the negative CS effects, SM would exhibit slower kinetics, due to early alterations in oxidative stress, autonomic response and O2 delivery.

METHODS: The study enrolled 10 physically active SM (age: 21±2 yr., body mass: 78±6 kg; stature: 1.79±0.07 m; 12±5 cigarette/day for 6±2 yr.; mean±SD) and 12 non-smokers (CTRL; age: 24±3 yr., body mass: 78±9 kg; stature: 1.80±0.08 m) matched for age and exercise habits. Participants completed an incremental test (25W/2 min) on a cycle ergometer to determine the maximum pulmonary oxygen uptake (V'O2max). After pulmonary evaluation, participants performed four 6-min square wave tests at 90% first ventilatory threshold VT1 (3). The time constant (t) for expiratory ventilation (V'E), VO2, heart rate (fH) and cardiac output (Q') during the increasing (on-phase) and decreasing (off-phase) transients was assessed using a mono-exponential model.

RESULTS: Static lung volumes were similar between SM and CTRL; however, SM had lower peak expiratory flow (-21%; P=0.004) and maximal voluntary ventilation (-12%; P=0.004). Additionally, SM had lower V'O2max (3657±325 vs 3397±316 ml·min-1 for CTRL and SM, respectively; P=0.037) and mechanical power at VT1 (201±26 vs 185±16 W for CTRL and SM respectively; P=0.045). During the on-phase, t in SM was longer for fH (+24%; P=0.006), V'O2 (+40%; P=0.009), V'E (+49%; P=0.018) and Q (+22%; P=0.024). Similarly, during the off-phase SM showed longer t for fH (+37%; P=0.014), V'O2 (+20%; P=0.004), V'E (+35%; P=0.045) and Q' (+51%; P=0.020).

CONCLUSION: These results demonstrate that CS negatively impacts cardiorespiratory and metabolic kinetics at moderate exercise, thereby elevating cardiovascular risk in SM, despite their young age, relative short smoking history and physical fitness level.

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**CARDIORESPIRATORY AND OXYGEN UPTAKE KINETICS DURING A SQUARE-WAVE TRANSITION: THE IMPACT OF CIGARETTE SMOKING IN YOUNG, PHYSICALLY ACTIVE MALE ADULTS**

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INTRODUCTION: Cigarette smoking (CS) has a detrimental impact on cardiorespiratory and metabolic response to exercise. Indeed, CS alters the sympathetic drive of the autonomic nervous system, increases airway resistance and oxidative stress, and impairs oxygen delivery (1). It is well-reported a diminished cardiorespiratory fitness in sedentary, middle-aged smokers (SM) with pulmonary disease, index of higher cardiovascular risk. By contrast, limited and controversial studies exist on CS effects in young, physically active SM with a short history of CS (2). Thus, the study aims to investigate the impact of CS on cardiorespiratory and metabolic kinetics during the onset of a square-wave moderate exercise in this population.

METHODS: Ten SM (age: 22±2 yrs, body mass: 78±6 kg, stature:1.79±0.07 m, 11±5 cigarette/day for 6±2 yrs; mean±SD) and 11 non-smokers (CTRL; age: 23±1 yrs, body mass: 78±8 kg, stature: 1.80±0.09 m) completed a pulmonary function evaluation. Then, they performed an incremental step test to assess cardiorespiratory and metabolic variables at peak exercise and the two ventilatory thresholds. Lastly, participants performed four 6-minute square-wave exercise (90% of the first ventilatory threshold) to assess the kinetics of expiratory ventilation (VE), oxygen uptake (VO2) and heart rate (fH) responses. Breath-by-breath values of all these variables were averaged and then fitted by a bi-exponential function to determine the amplitude (AMP) and the time constant (tau) of the cardiorespiratory and metabolic kinetics.

RESULTS: Static lung volumes were similar between groups. However, SM showed a reduced peak expiratory flow (8.4±1.8 vs 10.5±1.8 l·s-1, respectively; P=0.01) and lower maximum voluntary ventilation (168±14 vs 191±23 l·min-1; respectively, P=0.01) compared to CTRL. At peak exercise, despite similar VO2 (3384±318 vs 3623±333 ml·min-1; for SM and CTRL, respectively), SM exhibited lower mechanical power output (253±21 vs 278±27 W, respectively; P=0.01) and VE (125±11 vs 139±11 l·min-1, respectively, P=0.02). In addition, SM reached ventilatory threshold earlier than CTRL. During constant moderate exercise, SM displayed prolonged VO2 phase I (tau: 17±9 vs 12±4 s for SM and CTRL, respectively; P=0.03) and reduced phase II amplitude (886±301 vs 1111±295 ml·min-1, for SM and CTRL, respectively; P=0.05). Moreover, SM exhibited a slower fH response during phase II (61±18 vs 48±13 s, respectively; P=0.03).

CONCLUSION: The longer cardiorespiratory kinetics demonstrate that CS alters the cardiorespiratory and metabolic responses to exercise even in young, asymptomatic SM with a relatively short smoking history.

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**DIFFERENCES IN BASAL VENTILATORY FUNCTION BASED ON TRAINING STATUS AND SEX**

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INTRODUCTION: The respiratory system does not adapt in response to repetitive physical training as well as other systems such as the cardiovascular or musculoskeletal (1,2). This could lead to the respiratory system limiting performance in highly trained individuals (2). However, there are studies in the literature showing that athletes have better ventilatory function [forced vital capacity (FVC) and forced expiratory volume in 1 second (FEV1)] than sedentary individuals (3,4). To date, the relationship between training status and ventilatory function showed an association between VO2max and both FEV1 and FVC (5). Unfortunately, the participant's VO2max was rather low, which prevented a clear understanding of what happens to ventilatory function in individuals with a higher VO2max, i.e., those with a higher likelihood of experiencing ventilatory limitation when exercising at high intensities. Hence, the aim of determining whether ventilatory function differs between individuals presenting a wide range of training status.

METHODS: We examined 198 males (M: 41±10yrs, 74.0±8.1kg, 175.2±6.5cm, 18.5±6.8%fat) and 60 females (F: 37±14yrs, 59.1±8.4kg, 164.7±6.1cm, 25.7±8.6%fat) who performed different spirometry tests to assess ventilatory function (FVC and FEV1). The spirometry tests were thoroughly explained and demonstrated by the technician, following the ATS/ERS Task Force Recommendations (6). The training status of the participants was determined based on VO2max (5), dividing them into low, medium or high training levels according to VO2max tertiles.

RESULTS: A main effect of training status was found on FVC ($p<0.001$; $\eta2p=0.063$) and FEV1 ($p=0.003$; $\eta2p=0.045$). Pairwise comparisons showed a lower FVC in low training status (M: 4.8±0.7L; F: 3.37±0.67L) than in the medium (M: 5.14±0.69L; F: 3.87±0.49L; $p=0.026$; $d=0.527$) or high (M: 5.53±0.68L; F: 3.98±0.53L; $p<0.001$; $d=0.88$). Whereas FEV1 showed a lower FEV1 in the low training status (M: 3.91±0.61L; F: 2.78±0.57L) than in the high (M: 4.58±0.59L; F: 3.39±0.53L; $p=0.002$; $d=0.737$). Both FVC ($p<0.001$; $\eta2p=0.211$; $d=1.64$) and FEV1 ($p<0.001$; $\eta2p=0.197$; $d=1.57$) were found to be lower in females than in males.

CONCLUSION: Baseline ventilatory function was higher in individuals with greater training status, with differences in FVC observed between low and medium training levels, but not in FEV1. These findings emphasize the importance of considering training status when assessing respiratory function. Additionally, females exhibited lower ventilatory function than males across all relative training status levels, indicating a sex-related difference independent of training status.

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**COMPETITION-PHASE BREATHING STRATEGIES IN SPORTS: A SCOPING REVIEW**

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INTRODUCTION: Breathing strategies in sports involve both slow-paced (4-10 breaths/min) and fast-paced (>20 breaths/min) breathing, showing distinct physiological and psychological effects on performance. While these techniques are widely used across different competition phases, their integrated impact remains poorly understood, particularly regarding phase-specific adaptations and sport-specific requirements.PURPOSE: To systematically map the evidence regarding slow- and fast-paced breathing strategies across competition phases, analyzing both physiological and psychological outcomes in competitive sports

METHODS: PubMed, Web of Science, and Scopus were searched from inception to September 2024. Studies examining voluntary breathing strategies in competitive sports were included. Two independent reviewers screened articles following JBI methodology. Data were categorized by breathing type (slow/fast), competition phase, physiological outcomes (HRV, blood pressure, oxygen delivery), and psychological outcomes (anxiety, focus, arousal).

RESULTS: Of 612 identified articles, 45 met inclusion criteria. Pre-competition studies (n=21) showed slow breathing enhanced parasympathetic activity and reduced anxiety, while fast breathing improved activation states. During-competition research (n=15) revealed sport-specific breathing patterns adaptations, with endurance athletes utilizing both techniques based on competition demands. Post-competition studies (n=9) demonstrated recovery optimization through slow breathing protocols. Only 12% of studies examined integrated breathing approaches across all phases.

CONCLUSION: This review unveils a promising frontier in sports performance enhancement through phase-specific breathing strategies. The evidence suggests that tailored combinations of slow and fast breathing techniques could revolutionize how athletes prepare, perform, and recover. Future research integrating these approaches could transform current training paradigms, particularly in developing sport-specific protocols that optimize both physiological and psychological outcomes.

**CREWS STUDY: GAS EXCHANGE IS MILDLY IMPAIRED ACROSS A SINGLE WILDFIRE SUPPRESSION SHIFT**

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INTRODUCTION: An increase in the severity of global wildfires necessitates examination of the associated health risks, particularly in wildfire personnel. Exposure to particulate matter from smoke and ash (respirable PM, less than 4 microns in aerodynamic diameter) as well as soil (respirable crystalline silica as alpha quartz, RCS) have previously been linked to acute respiratory dysfunction and are common exposures in the wildfire suppression milieu. Despite evidence of chronic reductions in diffusion capacity of the lungs in firefighters who responded to a multi-day fire event, which was correlated with estimated particulate matter exposure, gas exchange across a single shift of wildfire suppression has not been previously examined. Therefore, we tested the hypotheses that 1) gas exchange would be impaired across a single shift of wildfire suppression and 2) this impairment would be associated with increased personal exposure to smoke-derived PM and RCS exposure.

METHODS: To do this, we conducted personal air sampling for respirable PM and RCS in 32 wildland firefighters (31M/1F; Age: 30.8+/-8.5; BMI: 25.5+/-3.0) from the British Columbia Wildfire Service across 10 days of wildfire suppression with concurrent pre- and post-shift measurements of gas exchange. Smoke-derived PM was calculated by subtracting RCS from respirable PM. Alveolar-arterial oxygen difference was estimated using a validated noninvasive pulmonary gas exchange monitor (MediPines Gas Exchange Monitor; MediPines Corp., Yorba Linda, CA).

RESULTS: We found that the estimated alveolar-arterial oxygen difference (oxygen deficit) was increased from pre- to post- (3.4+/-4.9 vs 6.2+/-6.6 mmHg, p=0.01) wildfire suppression shift (average shift length: 8.9+/-2.4 hours). This was supported by a reduction in oxygen saturation (pre vs. post: 97.6+/-0.8% vs 96.3+/-1.3%, p<0.0001), suggesting a mild impairment in gas exchange associated with acute wildfire suppression. The time weighted averages for smoke-derived PM (0.65+/-0.5 mg/mg^3) and RCS (17.9+/-15.8 ug/m^3) were near - but did not exceed - occupational exposure limits (respirable PM: 0.7 mg/m^3; RCS: 25 ug/m^3). Neither smoke-derived PM (p=0.18) nor RCS (p=0.97) were not correlated with the impairment in gas exchange.

CONCLUSION: However, this lack of correlation may be due to disparities in environmental exposure versus biological dose and does not account for changes in ventilation or potential lag time between exposure and physiological response.

Future research is needed to determine the mechanism(s) and implications of the cross-shift impairments in gas exchange observed in wildland firefighters.

**ASSESSMENT OF OXYGEN UPTAKE KINETICS MEASURED USING THE MIXING CHAMBER METHOD DURING INCREMENTAL EXERCISE**

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INTRODUCTION: The mean response time (MRT), which reflects the speed of the oxygen uptake (VO2) kinetics at the transition from rest to exercise, is one of the indicators of aerobic exercise capacity [1]. Although the breath-by-breath method is known to be most suitable for the assessment of VO2 kinetics, the mixing chamber method may also be applicable when high-frequency sampling is performed (e.g., at 5-s intervals). This study aimed to assess VO2 kinetics measured using the mixing chamber method during incremental exercise and to examine its relationship with the maximal oxygen uptake (VO2max) and the lactate thresholds (LT1 and LT2).

METHODS: Fifty-seven Japanese middle- or long-distance runners (44 males, 13 females) performed a multi-stage incremental treadmill running test at a slope of 1%. Each stage consisted of 3 minutes of running followed by 1 minute of rest, with running speed increasing by 20 m/min per stage until the blood lactate concentration (BLa) exceeded 4 mmol/L. The initial running speed was set between 210–250 m/min based on sex and specialty. After the BLa exceeded 4 mmol/L, subjects rested for 3 minutes before performing an additional incremental exercise test to assess VO2max, where running speed increased by 10 m/min every minute to exhaustion. Throughout the test, VO2 was continuously measured using the mixing chamber method with a sampling frequency of 5 s (AE-310S, Minato, Japan). MRT was calculated by fitting a mono-exponential function to the VO2 data of each stage. LT1 and LT2 were determined respectively at the fixed BLa of 2 and 4 mmol/L.

RESULTS: MRT was 36.1 ± 5.5 s at the first stage and increased significantly at the stages where the BLa exceeded LT1 (42.0 ± 6.8 s, $p < 0.05$) and LT2 (41.9 ± 7.9 s, $p < 0.05$). The mean VO2max was 72.9 ± 5.9 ml/kg/min. There was no significant correlation between MRT of each stage and VO2max. A negative correlation was observed between the first-stage MRT and the relative exercise intensity at LT1 (81.0 ± 4.8% VO2max, $r = -0.41$, $p < 0.05$) and LT2 (90.8 ± 3.6% VO2max, $r = -0.29$, $p < 0.05$), but no correlation was found with the MRT of other stages.

CONCLUSION: The increase in MRT with higher exercise intensity is consistent with previous studies [1, 2], indicating that the MRT observed in this study is similar to that obtained by using the breath-by-breath method in relation to exercise intensity. There was no correlation between MRT and VO2max, and this study did not demonstrate a relationship between VO2 kinetics and maximal aerobic capacity. However, the negative correlation between first-stage MRT and relative LT1 and LT2 intensity indicates that individuals with higher relative LT intensity tend to have a shorter MRT during low-to-moderate intensity exercise. Therefore, these results suggest that assessment of VO2 kinetics with the mixing chamber method may provide insight into aerobic exercise capacity.

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**BIOENERGETICS OF THE V̇O2 SLOW COMPONENT BETWEEN EXERCISE INTENSITIES AND DOMAINS**

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INTRODUCTION: V̇O2 slow component (V̇O2sc) is a slowly developing increase in V̇O2 above predicted values during heavy and severe exercise domains. In the heavy, the V̇O2sc has been attributed to a prolonged shift from anaerobic to aerobic energy sources rather than to an augmented cost of locomotion. Whether a delayed metabolic shift and/or a loss of efficiency of locomotion explains the V̇O2sc in the severe domain is under debate. Purpose: by determining the total cost of exercise, accounting for the anaerobic and aerobic energy sources, we hypothesized that i) a loss of efficiency is present in severe intensities only while a delayed metabolic shift will explain the V̇O2sc in heavy, ii) the size of the V̇O2sc will be larger with larger early anaerobic contribution and the resulting bigger decrement in its contribution over time.

METHODS: 25 young adults (10 females) performed 9-min constant exercises at the lower and upper range of moderate, heavy, and severe. For each intensity, we calculate: i) V̇O2sc as the excess V̇O2 beyond the 3rd min, ii) aerobic (V̇O2 – restV̇O2 – V̇O2 of ventilation) and anaerobic contribution (O2 equivalent of lactate accumulation) determining the cost of exercise (AdjO2Eq) for the 0-3, 3-6, and 6-9 time segment (mL·3min-1), and iii) the decrement slope in the anaerobic contribution beyond the 3rd min. The energetic contributors and AdjO2Eq were compared across intensities and time segments by a two-way RM-ANOVA. Correlation analyses were performed between V̇O2sc and 0-3min anaerobic contribution and its decrement slope.

RESULTS: V̇O2sc increases with intensity ($p<0.001$), however, the cost of exercise remains stable in moderate and heavy (6-9 = 3-6min, mean differences: -6 ±123 mL·3min-1 AdjO2Eq; $p>0.10$ for all intensities) as a result of a decreasing anaerobic mirrored by increasing aerobic contribution over time (respectively, 6-9 vs 3-6min mean differences: -47 ±107 mL·3min-1 and +42 ±130 mL·3min-1 O2Eq; $p<0.05$ for all comparisons). Conversely, in severe, the increasing aerobic was larger than the decreasing anaerobic contribution (respectively, 6-9 vs 3-6min mean differences: +525 ±297mL·3min-1 and -94 ±344 mL·3min-1 O2Eq; $p<0.001$ for all comparisons) resulting in an increased cost of exercise (6-9 > 3-6min, mean differences:

+431 ±365 mL·3min-1 AdjO2Eq; p<0.001 for both intensities). Lastly, the VO2sc was strongly correlated with the 0-3min anaerobic contribution (r2=0.80, p<0.001) and its decrement slope (r2=0.67, p<0.001).

CONCLUSION: In the heavy, VO2sc can be explained by a delayed metabolic shift between energy sources, while in the severe, an increased cost of exercise suggests the emergence of a true loss of efficiency. Moreover, the size of the VO2sc can be partially related to the size of the early anaerobic contribution and the resulting decrease during phase III of the oxygen uptake kinetics (i.e., beyond the 3rd min), suggesting being affected by the metabolic shift.

**DIFFERENCES IN VO2MAX-MEASUREMENTS BETWEEN BREATH-BY-BREATH AND ADAPTIVE MIXING CHAMBER MODE IN THE COSMED QUARK CPET**

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INTRODUCTION: Maximal oxygen consumption (VO2max), accepted as a descriptive measure of aerobic capacity, is widely used to monitor training-induced adaptation, predict sports performance, or classify athletic populations. Automated metabolic analyzers are commonly used to determine VO2max, with results that might be influenced by the analyzer's technological approach. Therefore, we aimed to determine differences in VO2max measures between the breath-by-breath (BxB) and the recently introduced adaptive mixing chamber approach (AMC) of the COSMED Quark CPET (Rome, Italy).

METHODS: Eighteen trained to highly trained participants (n=8 female, age 30 ±7 years, peak power 417 ±88 W, VO2max 59.3 ±4.9 mL/kg/min) performed a maximal ramp test on a bike ergometer (Lode Excalibur, Groningen, Netherlands). The ramp protocol started at 40 W and increased by 20-40 W per minute, depending on the participants self-reported fitness. To minimize intra-individual biological variability and inter-device measurement differences, all tests were performed using two identical Quark CPET metabolic analyzer units customized for simultaneous measurement. One unit was equipped with the AMIS 24 (COSMED, Rome, Italy) for AMC mode, and the other operated in BxB mode, with mode distribution counterbalanced between units. VO2max was calculated as the highest 30-second rolling average for both modes, with BxB data corrected for additional dead space of the customized setup beforehand. Mode differences reported as means with 95% confidence intervals (95% CI) were analyzed using paired Student's test and effect sizes were calculated using Cohen's d.

RESULTS: VO2max (-2.15% 95% CI [-3.60;-0.67]), carbon dioxide output (VCO2)@VO2max (-4.10% 95% CI [-5.80; -2.37]), and minute ventilation (VE)@VO2max (-11.54% 95% CI [ -14.12;-7.85]) were significantly lower in BxB vs. AMC mode, with effect sizes ranging from moderate to large (Cohen´s d -0.613-1.402).

CONCLUSION: During simultaneous measurements of two COSMED Quark CPET units in a bike ergometer ramp test, we obtained significantly lower VO2max values in BxB vs. AMC mode. The VO2max difference may be caused by time delay issues reported for BxB systems, occurring especially at high ventilation rates. In contrast, AMC mode addresses this by adjusting the mixing chamber size based on the ventilation per breath, potentially reducing time delays and enhancing measurement validity, especially at high ventilation rates as seen in a population of elite athletes. In the absence of the Douglas bag method as a reference, we emphasize that the observed inter-mode differences in VO2max for the COSMED Quark CPET do not directly indicate higher validity of the AMC vs. BxB mode, and results should not be generalized to other devices. However, our results highlight the importance of reporting the device and technological approach used for VO2max measurements, as these factors should be considered when comparing results across studies and laboratories

**LISTENING TO MUSIC WHILE RUNNING ALTERS VENTILATORY EQUIVALENTS FOR OXYGEN (VE/VO2) AND CARBON DIOXIDE (VE/VCO2): A PILOT STUDY**

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INTRODUCTION: Music listening while exercising has been associated with several positive effects including higher compliance with exercise programs, increased endurance, reduced rate of perceived exertion (RPE), and other psychological benefits. To date, it is still unclear whether listening to music while running alters the ventilatory responses to exercise and the energy expenditure.

METHODS: This pilot study with randomly ordered, repeated exposures to no music and up-tempo music (120 beats per minute; song track "Moves like Jagger" by Maroon 5) at moderate-high volume (85 decibels) while running on a treadmill for 15-minute stints at 8 km/h was carried out enrolling young (18-30 years old) casual runners. Outcome measures included ventilation, VO2 consumption, VCO2 production as well as ventilatory equivalents for oxygen (VE/VO2) and carbon dioxide (VE/VCO2), all assessed by open circuit ergospirometry. Blood lactate was also measured at the start and at the end of each running stint and five minutes into the recovery phase. RPE was measured using a Borg 6-20 scale every 5 minutes during the test. Running biomechanics was assessed by a photocell, optoelectrical system to determine space-time parameters of the running cycles.

Main effects of Condition (music/no music), Gender (male/female) and Condition*Gender interaction were tested by repeated measures ANOVA (RM ANOVA).

RESULTS: Complete data were obtained from 13 physically active volunteers (7M, 6F). None of the participants reported adverse events or injuries associated with the study procedures. RM ANOVA with Bonferroni adjusted pairwise comparisons revealed significant increases in ventilatory and gas exchanges measurements when running with music compared to running in physiological conditions. More specifically, ventilation increased by 5.2% (from 71.8 to 75.5 L/min; p=0.04), VE/VO2 by 6.5% (from 24.7 to 26.3; p=0.04), and VE/VCO2 by 3.1% (from 29.3 to 30.2; p=0.03). Blood lactate measured five minutes after the end of the running stints showed higher concentrations following the music condition (2.7 mmol/L) compared to running without music (2.3 mmol/L), whereas RPE was 3.3% lower at the end of the test with the music stimulation, although neither reached statistical significance (p=0.067; p=0.091, respectively).

Space-time descriptors of running biomechanics were also found to change during music compared to no-music condition. Largest changes involved step length, which decreased by a significant 4.6% (from 91 to 87 cm; p=0.002) and correlated significantly with ventilatory changes (all r coefficients ≥0.5, p<0.01). The observed changes were comparable between male and female participants.

CONCLUSION: Music stimulation led to ventilatory and blood changes compatible with higher rate of effort. The association of these alterations and the observed biomechanics changes suggests that music listening may reduce the efficiency of running, despite not increasing the rate of perceived exertion.

## Conventional Print Poster Presentations

### CP-PN08 Endurance, Interval Training and Caffeine

**THE RELATIONSHIP BETWEEN BODY TEMPERATURE AND SLEEP PARAMETERS IN FEMALE LONG-DISTANCE RUNNERS**

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INTRODUCTION: For athletes, daily condition assessment is important for maintaining exercise performance. Although several markers for the assessment (e.g., exercise performance, scores of subjective feelings, hormones, resting heart rate) are proposed, a factor that affects recovery process is sleep related variables. While body temperature fluctuations may affect diurnal fluctuations in sleep-related hormones such as cortisol and melatonin (Kräuchi., et al., 2006; Hickie et al., 2013), changes in nocturnal body temperature and sleep quality following daily training have not been elucidated sufficiently in endurance athletes. Therefore, the aim of the present study was to investigate the relationship between skin temperature rhythm at the night and sleep parameters in female long-distance runners. We hypothesized that the day with strenuous training would alter nocturnal skin temperature and sleep quality compared to the day without training.

METHODS: Eleven female long-distance runners were evaluated skin temperature (proximal site) and sleep parameters for 7 consecutive days. Skin temperature was measured continuously every 5 min by attaching the button-type thermometer on the area of the groin using a seal. Sleep parameters were measured using an actigraphy, including sleep efficiency, total sleep time, sleep latency, and wake time after sleep onset (WASO). During the measurement period, the data were compared between two conditions: a day when strenuous training was conducted (TR) and a day when training was not conducted (REST).

RESULTS: The total sleep time in TR was significantly longer than in REST (447.6 ± 60.5 min vs. 360.2 ± 45.3 min; P<0.05). Skin temperature was significantly higher on TR compared with REST at 10 min and 20 min after bedtime (P < 0.05). At 60 min, skin temperature was significantly lower on TR compared with REST (P < 0.05). From 90-130 min, skin temperature was significantly elevated compared with the value of bedtime (P < 0.05).

CONCLUSION: The strenuous training affected the body temperature rhythm during night and total sleep time in female long-distance runners.

**CAFFEINE SUPPLEMENTATION DID NOT OPTIMIZE MUSCLE STRENGTH AND MUSCULAR ENDURANCE IN HEALTHY, PHYSICALLY ACTIVE MEN AND WOMEN: A DOUBLE-BLIND, RANDOMIZED, CROSSOVER, PLACEBO-CONTROLLED CLINICAL TRIAL.**

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INTRODUCTION: Caffeine (CAF) reduces perceived fatigue and effort by antagonizing adenosine receptors and is widely recognized as an ergogenic aid. In women, hormonal fluctuations due to the menstrual cycle or oral contraceptive use may influence CAF metabolism, potentially modifying its ergogenic effects. However, few studies have directly compared the effects of CAF on men and women. This study aimed to investigate the ergogenic effects of CAF on recreationally active women and men.

METHODS: This was a crossover, double-blind, randomized, placebo-controlled clinical trial. Participants were selected based on eligibility criteria and randomly allocated in a crossover design to receive either CAF or a placebo (PLA). Thirty minutes after meal ingestion, participants consumed CAF (6 mg.kg-1) or PLA. Muscle strength (MS) was assessed for handgrip (HGS), quadriceps femoris (QF), gluteus medius (GMe), gluteus maximus (GMa), biceps brachii (BB), triceps bra-

chii (TB), deltoid (D), latissimus dorsi (LD), and pectoralis major muscle (PMM). Muscle endurance was evaluated using the push-up test (PUT) and the static squat test (SST).

RESULTS: A total of 50 individuals were contacted, but only 14 (seven men, seven women) participated. The mean age was 24.0±6.3 and 25.7±3.20 years for women and men, respectively; mean BMI was 24.2±2.83 kg/m2 and 25.0±2.92 kg/m2, respectively. Body fat percentage was 25.9±3.30% for women and 17.3±4.16% for men. No increase was observed in right-hand HGS (p=0.400; n2ρ=0.065), with a mean difference (MD) of -1.95kg for women (p=0.736) and -0.48 kg for men (p = 0.995). Similarly, left-hand HGS remained unchanged (p=0.994; n2ρ=0.000), with MDs of -0.129kg for women (p=1.000) and -0.112kg for men (p=1.000). QF MS was not affected (p=0.455; n2ρ=0.047), with MDs of -4.42 kg for women (p=0.576) and -0.72 kg for men (p=0.996). Similarly, no increase was found in GMa MS (p=0.213; n2ρ= 0.126), with MDs of -2.8 kg for women (p = 0.603) and -1.33kg for men (p = 0.930). CAF did not improve GMe MS (p=0.702; n2ρ=0.013), with MDs of 0.924 kg for women (p=0.847) and -0.294 kg for men (p=0.994). BB MS remained unchanged (p=0.670; n2ρ=0.016), with MDs of 0.548 kg for women (p=0.923) and -0.005 kg for men (p=1.000). No increase was found in PMM MS (p=0.622; n2ρ=0.021), with MDs of 1.01 kg for women (p=0.579) and -1.57 kg for men (p=0.235). D MS was also unaffected (p=0.424; n2ρ= 0.054), with MDs of 0.301 kg for women (p=0.990) and -1.48 kg for men (p=0.485). CAF supplementation did not improve SST performance (p=0.522; n2ρ=0.035), with MDs of -5.80 s for women (p=0.259) and 3.03 s for men (p=0.742). Similarly, PUT performance remained unchanged (p=0.714; n2ρ= 0.012), with MDs of -0.477 s for women (p=0.984) and 1.18 s for men (p=0.812).

CONCLUSION: CAF supplementation did not enhance MS or muscular endurance in healthy adult women and men. Possible reasons for not observing an effect of CAF include sample size, the type of test applied, and the CYP1A2 CC genotype.

**EVALUATING THE EFFECT OF NEW ZEALAND BLACKCURRANT POWDER AND CAFFEINE INTAKE ON HIGH-INTENSITY INTERMITTENT EXERCISE PERFORMANCE**

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INTRODUCTION: Intake of New Zealand blackcurrant (NZBC) powder and extract has shown to increase fat oxidation during exercise and improve running and cycling performance in recreationally active individuals. Acute consumption of caffeine has shown to sustain higher speeds during a high-intensity intermittent running protocol. Thus, combining NZBC with caffeine may provide an additive or a synergistic effect to improve exercise performance.

METHODS: Fourteen recreationally active males (29.5±9.3 yrs, VO2max 48.8±4 ml·kg-1·min-1) participated in a double blind, randomised controlled crossover trial with each participant taking part in four main trials (>7-day washout between trials): placebo (PLA), placebo + caffeine (CAFF), NZBC drink, and NZBC + caffeine drink (NZBC-CAFF). Each main trial was divided into two visits across two consecutive days. On the afternoon of Day 1, participants consumed either PLA or NZBC and completed a ~90-min cycling protocol at ~60% maximal power output. Substrate oxidation was assessed using breath by breath indirect calorimetry. On Day 2 of the trial, participants consumed one of the four experimental beverages and took part in the ~90 min modified Loughborough Intermittent Shuttle Test (m-LIST), and changes in sprint speed and distance covered were evaluated. During both trials, blood samples were taken before, during and immediately after the exercise to measure plasma free fatty acids (FFA) concentration.

RESULTS: Consumption of the NZBC drink had no effect on substrate oxidation during the cycling protocol. However, there was a trend for energy expenditure to be lower in the NZBC compared to PLA group (p=0.076, η2=0.111). Plasma FFA concentration increased with time during cycling (p<0.001) and was higher with NZBC intake compared to PLA (p=0.035). For the m-LIST trial, there was a trend for the NZBC-CAFF and CAFF groups to sustain higher sprint speed from blocks 1 to 6 compared to NZBC and PLA groups (p=0.099, η2=0.259). Plasma FFA concentrations increased with time during the m-LIST (p<0.001) and there was a trend for plasma FFA concentrations to be higher in CAFF and NZBC-CAFF (p=0.066, η2=0.755) compared to the other groups.

CONCLUSION: While the intake of caffeine showed a trend for faster sprint times when consumed acutely, consumption of the NZBC drink alone did not offer similar benefits. This was the first study to observe a trend and a significant increase in plasma FFA levels during high-intensity intermittent running and cycling in recreationally active males with acute intake of NZBC with and without caffeine. The increase in plasma FFA concentrations during cycling with no changes in substrate oxidation following acute consumption of the NZBC drink, further highlights the need for investigating different intervention strategies (dose and duration) for insights on fat metabolism during exercise.

**EFFECT OF TOTAL LOAD OF STEPS DURING A MARATHON ON MARATHON-INDUCED MUSCLE DAMAGE AND INFLAMMATION**

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INTRODUCTION: We have previously shown that a reduced pace during the end of a marathon is related to blood muscle damage and inflammation markers, which in turn are associated with the total number of steps taken during the race. We hypothesized that the total load of steps during the marathon might influence these damage and inflammation mark-

ers. The aim of this study was to estimate the total load of steps during a marathon and clarify its effect on muscle damage and inflammation.

METHODS: Twenty-two healthy non-professional runners (15 men, 7 women, average age 23.2 ± 1.7 years old) who participated in the 43rd Tsukuba Full-Marathon race (Tsukuba-city Japan) were recruited as volunteers. They ran with a GPS watch which has a built-in accelerometer. Stride rate and stride length were obtained from the watch. Serum muscle damage markers (serum creatine kinase activity, etc.), inflammation markers (serum CRP, etc.) as well as muscle soreness were measured before, immediately after, and the one day after the marathon. The distance covered during a 12-minute run was measured beforehand. Additionally, on non-race days, a walking load system was used to measure the load on the soles of the feet at the marathon running speed. The total load was estimated by multiplying the load per step by the total number of steps during the marathon.

RESULTS: The ratio of change in pace from the second segment of the marathon (5–10 km) to the final segment (35–40 km) showed a negative correlation with serum creatine kinase (CK) activity. The total load during the marathon showed a positive correlation with finish time of the marathon, body weight, body mass index (BMI), and total number of steps during of the marathon, and a negative correlation with stride length during the marathon and the distance covered during a 12-minute run. In men, the total load during the marathon showed a positive correlation with serum CRP levels one day after the marathon.

CONCLUSION: he total load during the marathon is related to body weight and total number of steps during the marathon, and runners with longer stride lengths had lower total loads during the marathon. Runners with high level of total load during a marathon may influence marathon-induced skeletal muscle inflammation. It is suggested that men, who weigh more than women, have a larger total load during the marathon, which may increase skeletal muscle inflammation. Since we measured the load in a fresh state other than race days, it is possible that the load would be higher under the fatigued conditions typical during the marathon itself. This remains a subject for future research.

**RACE WALKING METABOLIC COST INCREASES LINEARLY WITH SPEED**

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INTRODUCTION: The metabolic cost (C, J/(kg m)), the energy needed to move one kilogram of body mass along one meter, is an important physiological factor also for performance prediction and monitor. Indeed, according to di Prampero's model (1) performance velocity is given by the ratio of the oxygen consumption fraction and C. In running, C is speed independent (at least up to 5 m/s), in walking C show a U-shape profile and it becomes higher than running at about the walk-run transition speed (1). Race walking is an Olympic discipline of the athletics since the early '900. It is supposed to be a walk, by the rule, although performed at speeds typical of running (3.5-4.5 m/s) (2). The aim of this study was to compute race walking C as a function of speed.

METHODS: Eight international-level race walkers (5 men: 1h20'48"±2'51" 20 km PB, with the Olympic champion; 3 women: 1h33'15"±2'50" 20 km PB) were asked to race walk at increasing speed steps (3.2-4.4 m/s) for 4 minutes, while gas exchanges were collected by a metabolic cart. C was calculated as the net oxygen consumption multiply by energy equivalent of oxygen and divided by race walking speed. Linear hierarchical regression analyses were performed adopting the speed as independent variables and C as dependent variable.

RESULTS: C increased as a function of speed in all athletes, although with different slopes and intercepts. The linear mixed-effect model with random intercepts for speed nested within subjects showed a significant main effect of speed (β=0.732; SE=0.084; F=75.3; P<3.0×10^-10) explaining 93.7% of the variance (conditional R^2=0.937). The C vs. speed relationship can thus be described by this linear equation: C = 0.73×v +2.15 (with v in m/s).

CONCLUSION: Race walking Cost is higher than running at each speed, and the difference increases as a function of speed. It is also higher than walking, but the slope is lower than the extrapolated walking parabolic profile. Albeit the adherence to the rule, C can be a determinant for the maximal race walking speed that can be sustained during an official (aerobic) competition: with 65 ml/(kg min) of oxygen consumption, a top speed of about 4.3 m/s can be reached by race walking, whereas it would be almost 5.8 m/s by running.

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**DOES CAFFEINE AFFECT WOMENS ENERGY THROUGH GENES? THE IMPACT OF CYP1A2 GENOTYPE ON ACUTE CAFFEINE EFFECTS ON MAXIMAL STRENGTH, MUSCLE POWER, AND STRENGTH ENDURANCE IN ADORA2A C ALLELE CARRIERS.**

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INTRODUCTION: Although the effects of caffeine may be influenced by both ADORA2A and CYP1A2 polymorphisms, previous studies on women have analyzed these genetic variants separately. Consequently, it remains unclear how their combined influence modulates the acute effects of caffeine on physical performance. This study aimed to investigate the impact of the CYP1A2 genotype on the acute effects of a 3 mg/kg dose of caffeine on maximal strength, muscle power, and strength endurance in ADORA2A C allele carriers.

METHODS: Fourteen resistance-trained women (AA homozygotes: n = 8; C-allele carriers: n = 6) of the CYP1A2 gene participated in a randomized, double-blind, placebo-controlled, counterbalanced, crossover trial. Each participant completed three experimental sessions under the following conditions: (a) no supplementation (control, CON); (b) ingestion of a placebo (PLAC), and (c) ingestion of 3 mg/kg of caffeine (CAF). During each session, participants performed the following tests: (a) a one-repetition maximum (1RM) test in the bench press exercise; (b) three sets of three repetitions of an explosive bench press exercise at 50% 1RM; (c) a countermovement jump (CMJ), and (d) a strength endurance test in the bench press exercise at 50% 1RM. Saliva samples were analyzed to determine each participant's genotype for the -163C > A polymorphism in the CYP1A2 gene (rs762551) and the 1976T > C polymorphism in the ADORA2A gene (rs5751876). Differences in 1RM, strength endurance, and CMJ were analyzed using a two-way ANOVA with repeated measures (3 conditions × 2 genotypes). Differences in mean and peak velocity were analyzed using a three-way ANOVA (3 conditions × 3 sets × 2 genotypes).

RESULTS: The two-way repeated-measures ANOVA indicated no significant main effect of condition, condition × genotype, and condition × set interaction for 1RM, strength endurance and CMJ ($p>0.05$ for all). The three-way repeated-measures ANOVA revealed a significant main effect of condition for peak bar velocity ($p = 0.036$), but no significant main effect of condition for mean bar velocity, nor condition × genotype or condition × set interactions for both variables ($p>0.05$ for all). Post hoc indicated significant increases in peak velocity between PLAC and CAF condition ($p=0.025$; 1.26±0.17 m/s vs 1.34 ± 0.23 m/s; Effect Size = 0.37, Delta = - 6.35%).

CONCLUSION: Caffeine supplementation at an absolute dose of 3 mg/kg did not significantly enhance maximal strength, strength endurance, or jump performance in resistance-trained women who are ADORA2A C allele carriers. However, a significant acute improvement in muscle power during the bench press exercise was observed following caffeine ingestion. Notably, the ergogenic response to acute caffeine intake was not influenced by CYP1A2 polymorphism. Thus, women who are ADORA2A C allele carriers may still experience some performance benefits from caffeine supplementation, regardless of their CYP1A2 genotype.

**HIGH VS. LOW TORQUE IN ALL-OUT SHORT SPRINTS: A PHYSIOLOGICAL COMPARISON**

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INTRODUCTION: Short sprint interval training (sSIT) can enhance both aerobic and anaerobic fitness through various protocols, with sprinting bouts lasting ≤10s (Boullosa et al. 2022). However, the limited available evidence does not allow a comprehensive understanding of the acute psycho-physiological effects of applying different torques during cycling sSIT protocols with very short "all out" sprints (Samozino et al., 2007). This study aims to evaluate the impact of high (HT) versus low (LT) torques on neuromuscular performance, cardiometabolic, and perceptual responses during a sSIT session of 5-s sprints.

METHODS: Fifteen physically active individuals (22 ± 2 years; 23,5 ± 1,8 IMC kg/m²). After familiarization and determination of HT and LT with a graded sprinting test, 15 physically active individuals completed, in random order, 2 sSIT sessions (12, 5-s sprints on a cycle ergometer) with HT and LT. Physiological (i.e. surface electromyography [sEMG], oxygen consumption [VO2], HR, blood pressure, and muscle oxygenation [SmO2]), and perceptual parameters (i.e. affective valence [FS]) were assessed during sessions and acute recovery.

RESULTS: The mean RMS amplitude was higher in LT (p=0.004). However, FS was higher in the HT condition (p = 0.01). Mean RMS, Mean VO2, HR, RPP, and FS increased across sets in both groups (p < 0.001). However, mean RMS, mean and peak VO2, and HR showed no significant main effect or interaction. No differences were found in deoxygenation and reoxygenation rates or peak BLa concentrations between conditions.

CONCLUSION: Torque variations influence neuromuscular engagement and perceived effort but do not significantly alter acute metabolic and cardiovascular responses during sSIT. This suggests that torque adjustments can be used to modulate neuromuscular and perceptual demands without affecting overall cardiometabolic load, providing a strategy to tailor sSIT protocols for more specific training goals.

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## Conventional Print Poster Presentations

### CP-PN09 Sleep, Fatigue and Extreme Exertion

**INFLUENCE OF TIME OF THE DAY OF EXERCISE ON CARDIORESPIRATORY FITNESS IN ADULTS – A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Current guidelines for exercise include recommendations about Frequency, Intensity, Time (duration), and Type of exercise (FITT), but not for time of the day. This is surprising considering the well-known impact of the circadian timing system on human health [1] and the well-documented diurnal variations in peak oxygen uptake (VO2peak) [2] as well as many other physiological outcomes. A recent meta-analysis [3] showed that to this date no study has investigated the effect of exercising around noon or the late evening on VO2peak. While some studies have investigated the effect of exercising in the morning or afternoon, they show several methodological limitations. The aim of this study was to investigate the effect of exercising at different times of the day on VO2peak.

METHODS: Participants completed cardiopulmonary exercise tests using a ramp protocol on a cycle ergometer to determine VO2peak before being randomly allocated to an exercise time at which they exercised three times a week for 12 weeks. Exercise times were 8:00, 12:00, 16:00 or 20:00. Nutrition, sleep and physical activity were closely monitored during the intervention period to control for confounding factors. The same exercise test was done after the intervention to compare post-intervention VO2peak values between the four groups adjusted for baseline values using analysis of covariance. VO2peak was confirmed using pre-specified verified criteria for RERmax in those participants that did not show a VO2-plateau.

RESULTS: Participants' (n=59, 42% female) mean (standard deviation – SD) age was 68.3 (4.9) years and body mass index was 24.2 (2.9) kg/m2. Baseline VO2peak (mL/kg/min) values of the groups were 29.4 (6.9) for 8:00, 32.3 (5.2) for 12:00, 29.2 (5.6) for 16:00, and 32.5 (5.8) for 20:00, respectively. The observed mean differences (mL/kg/min) (95% confidence interval [95%CI]) for exercising at 8:00 compared to 12:00, 16:00, and 20:00, were -1.1 (-4.7; 2.5), -0.2 (-4.4; 4.0), and 0.3 (-3.3; 3.9), respectively. For the comparison of 12:00 compared to 16:00 and 20:00 it was 0.9 (-3.3; 5.2) and 1.4 (-2.0; 4.9), and for 16:00 compared to 20:00 it was 0.5 (-3.7; 4.7).

CONCLUSION: In contrast to our hypothesis, we found no evidence that the timing of exercise impacted the changes in VO2peak during the exercise intervention period. The well-known diurnal variation in physical performance, thus might not affect long-term adaptations to physical exercise.

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**CARDIORESPIRATORY FITNESS OF CONCORDIA CREW MEMBERS LIVING IN EXTREME ENVIRONMENT FOR ELEVEN MONTHS**

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INTRODUCTION: Long-duration space missions are characterized by prolonged isolation and confinement in extreme environments. In these living conditions, astronauts face desynchronisation of the circadian rhythms with relevant consequences of physical and mental health [1]. In Antarctica, crew members of Concordia station are exposed to environmental conditions (hypobaric hypoxia, absence of sunlight) and lifestyle changes (isolation, confinement, modification of daily physical activity) similar to astronauts, resulting an ideal experimental setting to test human physiological adaptations and circadian rhythms alteration [2,3]. As physical activity levels and changes in cardiorespiratory fitness seem to play a pivotal role on circadian rhythms [4], we aimed to evaluate how prolonged exposure to Antarctic extreme environment affects cardiorespiratory fitness of crew members living at Concordia station for eleven months.

METHODS: Twenty-four male subjects (age: 39±11 ys, height: 177±8 cm, weight: 79±10 kg) were recruited. Before flying to Concordia (BDC), participants performed i) a ramp incremental cardiopulmonary test (CPET) up to exhaustion on a cycloergometer and ii) two constant work rate (CWR) exercise at 40% (MOD) and 70% (HVY) of peak work rate (Wpeak). At Concordia station, participants performed MOD and HVY tests on monthly base. Pulmonary ventilation (V'E), oxygen consumption (V'O2) and carbon dioxide production (V'CO2) were monitored. Heart rate (HR) was recorded. Rate of perceived exertion (RPE) using 6-20 Borg Scale and blood lactate were collected before and at the end of exercise. Two-way ANOVA for repeated measures was used to evaluate changes in cardiorespiratory fitness, using time and intensity (MOD vs HVY).

RESULTS: At BDC, Wpeak and V'O2peak were 244±38 W and 35.8±5.4 ml*min-1*kg-1, respectively. Peak values of HR (174±14 bpm), RER (1.40±0.11), RPE (16±2) and lactate (10.6±1.7 mM) confirmed exhaustion. MOD was performed at 101±16 W. HR was 123±11 bpm and RPE was 10±2. HVY was performed at 173±25 W. HR was 155±38 bpm and RPE was 14±2. At Concordia, MOD and HVY work rate were reduced of about 25% due to hypoxic environment. HR and RPE were higher in HVY vs MOD at all time points ($p<0.05$). No time effect or time x intensity interaction were observed ($p>0,05$) for both HR and RPE. In MOD, HR (109±14 bpm) and RPE (9±2) were not affected between visits. Also for HVY, HR (131±15 bpm) and RPE (13±2) were not affected among visits.

CONCLUSION: Cardiovascular and perceptual responses to MOD and HVY exercises were not affected by eleven months at Concordia station. Thus, cardiorespiratory functions seems unaltered during prolonged confinement and hypoxia suggesting that other environmental stressors may alter circadian rhythms.

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**EFFECT OF REDUCED-EXERTION HIGH-INTENSITY INTERVAL TRAINING ON CARDIORESPIRATORY FITNESS: A META-ANALYSIS**

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INTRODUCTION: Regular aerobic exercise plays a pivotal role in improving cardiorespiratory fitness (CRF) and preventing cardiovascular morbidity and mortality. Despite the clear health benefit of regular aerobic exercise of 150 minutes or more per week, many adults do not perform recommended amount of aerobic exercise due to time constraints. Recently, reduced-exertion high-intensity interval training (ReHIT) has been proposed as a time-efficient alternative. The effects of ReHIT on CRF remain inconclusive due to the limited number of studies with small sample sizes conducted to date. Without comprehensive analyses, it is difficult to determine the effects of ReHIT on CRF and cardiovascular disease (CVD) risk factors, and the minimum required amount of exercise. Therefore, the aim of this meta-analysis was to evaluate the effects of ReHIT on changes in CRF, a CVD risk factor, in sedentary adults.

METHODS: The literature search was performed using two electronic databases including the PubMed and Web of Science from Oct 10 2024 to Dec 5 2024. We included the studies that focus on:

(a) sedentary adults, (b) ReHIT, (c) comparison with control (CONT) group or moderate-intensity continuous training (MICT) group, (d) CRF, and (e) randomized controlled trials (RCT).

The criteria for ReHIT were as follows:

(a) total duration of session: ≤10 minutes, (b) mode of exercise: Cycling, (c) minimum period ≥ 4 weeks.

RESULTS: Total eight studies were included in this meta-analysis. The random effects meta-analysis revealed that ReHIT group demonstrated significantly higher VO2peak, a marker of cardiorespiratory fitness, than untrained CONT group (effects size = 0.972; 95% CI= 0.185-1.759, p = 0.015; I2 =74%). However, there was no significant difference in VO2peak in comparison with MICT group (effect size = 0.110; 95% CI = -0.518 to 0.737, p = 0.731; I2 = 61%). Additionally, there were no significant effects on body weight reduction in either CONT (effects size = -0.525; 95% CI= -1.387-0.337, p = 0.337; I2 =79%) or MICT group (effects size = -0.237; 95% CI= -0.915-0.441, p = 0.493; I2 =65%).

CONCLUSION: The findings of this meta-analysis indicates that ReHIT can be an effective alternative for the typical moderate-intensity aerobic exercise with 150 minutes or more per week for improving CRF and reducing CVD risk in habitually sedentary adults. However, it seems difficult to expect additional health benefits through weight loss since the absolute amount of exercise in ReHIT is relatively low.

**A NIGHT WITH 6 HOURS OF SLEEP RESTRICTION WORSENS PERFORMANCE IN RODENTS UNDERGOING PERIODIZED RESISTANCE TRAINING.**

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INTRODUCTION: Physical exercise is a powerful physiological and biomolecular stimulator capable of promoting various physiological responses. The physiological responses arising from physical exercise depend on the training load imposed between each session. Studies carried out in humans and animal models prove that sleep restriction has significant consequences on physical performance.

METHODS: Thirty 60-day-old male Wistar rats were used, divided into four groups (Sedentary Control (SC; N = 5), Sedentary Sleep Restriction (SRS; N = 5), Trained Control (TC; N = 10), and Trained Sleep Restriction (SRT; N = 10)). The animals were subjected to an initial maximal strength test, followed by a periodized strength training protocol lasting six weeks. Subsequently, the animals were subjected to a period of six hours of sleep restriction, with reassessment of the maximum strength test.

RESULTS: The present research found an increase in the total body mass of all animals at the end of the six weeks of study. Six hours of sleep restriction was able to reduce the strength capacity of the TRS group by 18.4% compared to the TC group. There were no significant differences in glycogen values between the experimental groups for either the plantaris muscle or the soleus muscle. There was no significant difference in CLOCK protein concentrations in the plantar and soleus muscles. The work also demonstrated a significant difference in 15 metabolites from the anaerobic glycolysis pathway through metabolomic analysis.

CONCLUSION: We conclude that sleep restriction attenuates the performance of maximal strength capacity in trained animals, also demonstrating that the training process reduces the impact of sleep restriction on performance, altering several metabolites of the anaerobic glucose pathway.

**ACUTE FATIGUE, CELLULAR STRESS, AND SIGNALING RESPONSES TO POWER-ORIENTED VS. STRENGTH-ORIENTED RESISTANCE EXERCISE**

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INTRODUCTION: Maximal strength training and power training can result in partly similar but also distinct adaptations (1), mediated by the acute responses to exercise (2). Understanding these acute responses is important for optimizing training strategies and adaptation. Previous work has observed greater acute neuromuscular fatigue and slower recovery after strength- compared to power training (3). Nonetheless, comparisons of cellular stress and signaling following such training protocols remain largely unexplored. This study compared acute neuromuscular fatigue, cellular stress, and signaling responses following strength versus power training sessions.

METHODS: Twenty-six resistance-trained sub-elite female handball players were randomized into strength-oriented (SO: n = 13, 20 ± 3 yrs, 171 ± 6 cm, 69 ± 8 kg) or power-oriented (PO: n = 13, 21 ± 3 yrs, 171 ± 6 cm, 65 ± 7 kg) training groups. After completing a 12-week training period, we measured acute changes in neuromuscular fatigue, heat shock proteins, and intramuscular signaling responses, immediately before and 1-1.5 hours after time-matched training sessions. SO performed heavy squat and split squat (3 x 5 repetitions, 85% 1RM, 1 rep in reserve), whereas PO performed squat jump (4 x 5, 50% 1RM), body weight split squat (3 x 5), drop jumps (3 x 10), and box jumps (3 x 5). Neuromuscular assessments included quadriceps maximal isometric force and rate of force development (RFD: 20 ms peak and six-time intervals; 0-30 up to -250 ms), and countermovement jump height (CMJ). Muscle biopsies were taken from vastus lateralis. Results are reported as mean changes with standard deviations and were analyzed using independent t-tests and Pearson correlation.

RESULTS: Acutely after the training sessions, no group differences were observed in quadriceps force loss (p = 0.16), RFD (p = 0.16-0.98), or jump height (p = 0.11). Both groups reduced quadriceps force (SO: -10 ± 5%; PO: -6 ± 6%) and jump height (-12 ± 6%; PO: -8 ± 6%), all p < 0.01. Changes in force and CMJ correlated (r = 0.37, r2 = 0.14, p = 0.04). No changes were observed in RFD peak (SO: -13 ± 24%, p = 0.09; PO: -4 ± 21%, p = 0.50) or across all RFD intervals (SO: -6 to -11% ± 16-38%,

p = 0.10-0.71; PO: 0 to -8% ± 12-37%, p = 0.14-0.79). Muscle biopsies are still being analyzed, and the results will be presented at the conference.

CONCLUSION: Strength-oriented and power-oriented training resulted in acute neuromuscular fatigue, indicating that both groups experienced training stress, with no between-group differences. Despite a moderate correlation, the low r-squared value suggests MVC and CMJ should not be used interchangeably to assess neuromuscular fatigue. The RFD results did not reveal fatigue, possibly due to higher test variability. Muscle biopsy analyses will reveal possible difference in stress between type I and II fibers and signaling responses.

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**OPTIMIZING SLEEP IN OFFSHORE SAILING TEAMS: IMPACT OF SHIFT MANAGEMENT AND HOURS OF SLEEP ON PERFORMANCE AND FATIGUE**

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INTRODUCTION: Sleep is crucial for sports performance, especially in endurance sports like offshore sailing regattas. Unpredictable environmental conditions and the need for prolonged alertness over days or weeks make sleep management challenging. This is even more complicated in crew racing, where individual sleep must align with team dynamics and race demands. Despite growing interest in optimizing sleep, research on sleep strategies in offshore sailing is limited. This study aims to (a)explore the influence of sleep on team performance and perceived effort, (b)assess the impact of shift management based on chronotypes and evaluate sleep patterns post-competition

METHODS: The study was conducted on 65 participants (47±14.6 yrs) during the 151 Miglia-Trofeo Cetilar 2024. Crews were divided in 2 groups based on boat characteristics. Before regatta, participants completed a pre-race questionnaire and the Psychomotor Vigilance Task (PVT). After the regatta, participants repeated the PVT, filled out a post-race questionnaire and wore actigraphs to monitor sleep in the following week. Descriptive statistics, chi-square tests, ANOVA, Pearson's correlation, paired t-tests for comparisons, and multivariate regression models were used for analysis

RESULTS: The sample included 13 E-Type, 34 N-Type, and 18 M-Type chronotypes. After the regatta, participants reported an average sleep duration of 5.84 hours (±3.53), perceived sleep quality of 4.90 (±2.82), physical and mental fatigue of 4.95 (±1.97) and 6.05 (±2.04) out of 10, respectively. Higher-ranked teams had larger (p= 0.001) and younger crews (p= 0.03), but older participants had greater experience (p= 0.001) and lower perceived mental effort (p= 0.005). Higher rankings were also associated with less sleep (r= 0.473, p= 0.006), increased perceived physical effort (p= 0.04), and greater mental effort. Post-regatta sleepiness (ESS) was lower in M-type (p= 0.02). PVT declined with better rankings (p= 0.008), fewer navigation hours (p= 0.006), and higher physical exertion (p= 0.003). Longer reaction times (RT) were associated with fewer sleep hours (p= 0.04), more errors (p= 0.01), and greater physical exertion (p= 0.02). Pre- and post-race comparisons showed no significant differences in PVT (t= 1.94, p = 0.06), but ESS significantly increased post regatta (t= -3.34, p= 0.001). Chronotype had no significant effect on sleep timing preferences in the regatta (p= 0.93), nor on post-race mid-sleep point (MSP) (p= 0.94), though higher physical exertion was associated with a delayed MSP (r= 0.40, p p=0.03). Comparison between similar boats showed that higher-ranked teams slept less (4.27h vs.7.7h, p= 0.003) and favored self-managed sleep shifts (p= 0.006)

CONCLUSION: Teams with self-regulated sleep shifts performed better, suggesting rigid schedules are less effective. Optimal sleep management over duration is probably key in endurance sports. Future research should explore how personalized sleep strategies can enhance both individual and team performance.

**RUNNING AGAINST THE CLOCK: THE ROLE OF VOLUNTARY EXERCISE IN CIRCADIAN RE-ENTRAINMENT AFTER LIGHT-DARK CYCLE INVERSION**

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INTRODUCTION: Core body temperature (CBT) is a key marker of circadian synchronization, reflecting behavioral, metabolic, and environmental adaptations. Disruptions in CBT rhythms, as seen in shift workers or jetlag, indicate circadian misalignment and can have significant health consequences. Exercise is a potent non-photic zeitgeber that may facilitate circadian realignment, but its role in re-entrainment after abrupt phase shifts remains unclear. This study examined whether voluntary exercise accelerates the re-entrainment of CBT and metabolic rhythms in mice subjected to a 12-hour light-dark cycle inversion (LDI).

METHODS: Fifteen C57BL/6J mice underwent LDI and were divided into sedentary controls (CTRL) and running wheel (RW) groups. CBT was continuously recorded using implanted temperature-monitoring capsules, and metabolic parameters were assessed via metabolic cages.

RESULTS: RW mice exhibited a faster re-entrainment of CBT compared to CTRL mice, with higher Percentage of Rhythm (PR) and Amplitude (AMP) values during early recovery (T2). Interestingly, RW mice initially displayed a greater disruption post-LDI (lower PR at T1), suggesting that unstructured physical activity may act as a conflicting signal, temporarily exacerbating

misalignment. Nevertheless, exercise accelerated recovery, as RW mice achieved a CBT phase peak closer to the new light-dark cycle target. $VO_2$ rhythms in RW mice also trended toward faster realignment.

CONCLUSION: These findings highlight the dual role of exercise as a zeitgeber, capable of both disrupting and accelerating circadian realignment depending on timing and context. Voluntary exercise may thus serve as an effective intervention to restore circadian synchrony and metabolic homeostasis in individuals experiencing circadian disruption.

**ACID-BASE BALANCE DURING ACCLIMATIZATION AT MODERATE ALTITUDES IN ELITE BIATHLETES**

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INTRODUCTION: The regulation of acid-base balance during the early stages of acclimatization at high altitudes is well studied. During the first 12 hours of acclimatization, arterial pH increases due to hyperventilation and carbon dioxide washout. This respiratory alkalosis is subsequently compensated by renal elimination of bicarbonate ions ($HCO_3^-$), gradually restoring arterial pH to normal levels. Metabolic compensation is typically completed within 24 hours at low to moderate altitudes. However, data on acid-base status beyond this initial period remain scarce. Moreover, most studies have been conducted in simulated conditions or at higher altitudes, often with non-elite athletes. In this study, we aimed to monitor the acid-base balance of nine top elite biathletes on the third day after arrival at two different moderate natural altitudes and compare it to their acid-base status at low altitude.

METHODS: A group of elite biathletes (5 males, age = 27.4 ± 4.0 years, VO2max = 69.7 ± 3.6 ml/kg/min; 4 females, age = 27.3± 3.8 years, VO2max = 59.2 ± 3.8 ml/kg/min) underwent morning arterial blood sampling to assess acid-base balance at low altitude (600 m) and on the third day after arrival at training camps at 1700 m and 2000 m. Additionally, plasma erythropoietin (EPO) concentration was measured 24 hours after ascent.

RESULTS: On the third acclimatization day, no significant differences in acid-base balance were detected between the two altitudes. Although arterial pH remained similar to that at low altitude, other parameters showed significant changes at moderate altitudes. The arterial partial pressure of oxygen ($pO_2$) was significantly lower at 1700 m (8.62 ± 0.17 kPa, $p < 0.01$) and 2000 m (9.07 ± 0.15 kPa, $p < 0.01$) compared to 600 m (9.95 ± 0.16 kPa). The arterial partial pressure of carbon dioxide ($pCO_2$) was significantly reduced at 1700 m (3.91 ± 0.08 kPa, $p < 0.01$) and 2000 m (3.96 ± 0.07 kPa, $p < 0.01$) in comparison to 600 m (4.76 ± 0.05 kPa). Blood bicarbonate ion concentration decreased by approximately 15%. Although the available data are limited, a significant negative correlation was found between plasma EPO concentration 24 hours after ascent and the decrease in blood bicarbonate ion concentration on the third day ($r = -0.64$; $p < 0.05$).

CONCLUSION: To our knowledge, this is the first study to monitor acid-base balance at a later stage of acclimatization in elite athletes at training camp venues under natural conditions. No significant differences in acid-base balance were observed between 1700 m and 2000 m. By day three, metabolic compensation was ongoing but insufficient to restore arterial oxygen levels to low-altitude values. Persistently low bicarbonate, a key blood buffer, could impair anaerobic performance in the subsequent days. The correlation between the 24-hour EPO response and the magnitude of metabolic compensation suggests an interconnection between erythropoiesis and acid-base regulation of the hypoxic stress.

**THE EXERCISING BODY OVER 300 KM/H: PHYSIOLOGICAL AND ENVIRONMENTAL DEMANDS IN AUTO RACING DRIVERS**

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INTRODUCTION: There is a common misconception that drivers have a little role in their sport, compared to the importance of their vehicle. Nonetheless, data suggest that usually these athletes compete with heart rates, sweat rates, and gravitation forces that can be compared to those found in other sports, or even in astronauts. Despite motorsports are among the largest spectator sports in the world, and despite the peculiar characteristics of these competitions, only a few studies have investigated the physiological and psychological responses of these athletes, maybe due to the "extreme" contexts where they perform.

METHODS: Electronic databases were searched to retrieve published manuscripts that analyzed cardiovascular, respiratory, metabolic, neuromuscular or environmental parameters in auto racing drivers. All the different auto racing categories were included. Main findings were then extracted and reported. In addition, to provide a novel environmental physiology perspective, environmental and weather data were retrieved from official databases regarding the race day of the Formula 1 (F1) 2023, and a thermal risk map based on the universal thermal climate index (UTCI) was created.

RESULTS: Nineteen studies were found clearly reporting data regarding the metabolic, cardiovascular and/or thermoregulatory responses to driving. Oxygen consumption during driving has been reported usually being between 22 and 39 mL.kg-1.min-1, and peak heart rate can range from 88 to 197 b.min-1, with a large variability depending on the type of car, competition, speed and circuit, and environmental conditions. In F1 some data suggest that mean heart rate can be 77% of the maximum. Dehydration can further pose a challenge to these athletes, typically exceeding 1 L.h-1. Thermal strain is of particular relevance in this sport, as drivers face increases in core body temperature of 1.7 – 2.5 °C/h-1, in closed cockpit temperature up to 66 °C and physiological strain index (PSI) > 6. On 22 F1 racing events, 7 were classified as "moderate risk", and 1 was at "strong risk".

CONCLUSION: This review supports the definition of the auto racing driver as an athlete competing at high-intensity and in extreme conditions typically characterized by the need of fast and strong neuromuscular responses, the capacity to resist to high accelerations (> 3.5 g), resulting in high metabolic demands, cardiovascular responses, and the necessity to cope

with the increased body temperature and fluid losses. In the context of a changing world, with the challenges posed by global warming and climate change, it might be become even more important to promote studies and bring even more sports science and medicine "in the paddock".

## Conventional Print Poster Presentations

### CP-PN10 Nutrition and Performance

**OMEGA -3 INDEX AND ITS IMPACT ON SELECTED PARAMETERS OF MUSCLE STRENGTH IN ATHLETES – A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Omega-3 fatty acids, eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are essential nutrients that play a crucial role in modulating inflammation, supporting muscle recovery, and promoting adaptation to physical exercise. The Omega-3 Index (O3I), defined as the percentage of EPA and DHA in erythrocyte membranes relative to total fatty acids, is a reliable marker of the bodys omega-3 status. Numerous studies have emphasized the benefits of omega-3 supplementation for muscle repair and inflammation reduction; however, little attention has been given to natural changes in O3I resulting from structured, long-term training interventions, particularly in the context of strength training where adaptive changes in muscle tissue occur.

The aim of this study was to determine the impact of a 12-week strength training intervention on O3I levels in athletes and to examine the relationship between changes in O3I and selected muscle strength parameters. O3I levels were assessed before and after the training intervention to determine whether training adaptations were associated with modifications in O3I that could potentially influence muscle function.

METHODS: In this study, young adults (aged 18–30 years) with less than one year of training experience were randomly assigned to either a training group (n=35) or a control group (n=11). The training group completed 36 sessions over 12 weeks (three sessions per week), while the control group maintained their regular lifestyle without additional training. All participants performed identical exercises with controlled total volume and average intensity to ensure consistency across sessions. A minimum attendance of 90% was required. O3I levels were measured at baseline and after the intervention, and muscle strength was assessed using a Kistler force platform (evaluating peak force, relative peak force, and force at 150, 200, and 250 milliseconds) and the Biodex system (measuring maximum muscle torque of the knee and elbow joints at 95° and 135°).

RESULTS: Results showed that O3I values did not differ significantly between the training and control groups, with both groups exhibiting levels below the recommended optimal range. Changes in O3I after the 12-week strength training intervention were associated with a slight increase in maximum muscle torque in the knee and elbow joints; however, these correlations were relatively weak. No significant changes were observed in other muscle strength parameters.

CONCLUSION: The results indicate that participants in the training group exhibited similar O3I values compared to the non-training group. While there is some correlation between O3I and muscle strength parameters, it is relatively weak and requires further research to better understand the mechanisms underlying this relationship. Additionally, educating athletes on the importance of omega-3 fatty acids and their potential impact on performance and recovery should be emphasized as part of their nutritional guidance.

**IMPACT OF MEAL SEQUENCING ON ENERGY METABOLISM, PERFORMANCE, AND RECOVERY IN ENDURANCE ATHLETES IN HOT, HUMID CLIMATES**

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INTRODUCTION: Recent studies suggest meal sequencing as an effective way to stabilize postprandial blood glucose and insulin levels. However, its effects on energy metabolism and fatigue recovery in endurance athletes are unknown. This study explores the impact of meal sequencing on endurance athletes in challenging conditions, aiming to improve training and competition strategies.

METHODS: Eleven male cyclists (16±1.45 years, BMI 22.4±1.95) were randomly assigned to either a mixed meal (Mix) or protein/fat before carbohydrate (PFC) pattern, with a 7- day washout. After a 12-hour fast, subjects had breakfast, rested for two hours, cycled for two hours at 70% VO2max, and completed a 7km sprint in a hot, humid room. Lunch was consumed 30 minutes post-sprint, followed by four hours of rest before re-entering the hot room for an exhaustive cycling at 85% VO2max. Basal measurements were taken before breakfast. Post-meal glucose was monitored every 15 minutes using the Abbott FreeStyle Libre, and metabolic data were collected every 30 minutes using a cardiopulmonary function tester. During cycling, glucose, heart rate, core temperature, subjective fatigue levels, and gas were collected at regular intervals. Venous blood was drawn immediately, 30 minutes, and 120 minutes post-lunch for NEFA, insulin, and GLP-1 analysis.

RESULTS: Meal sequence did not significantly impact blood glucose levels or AUC between groups, though PFC showed a trend toward higher glucose levels. Key differences emerged at multiple time points: glucose rose faster initially but declined afterward in Mix, while PFC surpassed Mix 45 minutes to one hour post-meal, remaining higher for up to four hours and into cycling. RER and carbohydrate energy supply ratio showed significant interaction effects. Post-7K sprint, PFC trended toward higher carbohydrate energy supply rates, ratio, and RER. At 30 minutes post-lunch (LH30), PFC had a lower RER and higher fat energy supply ratio and rate, though not statistically significant. Insulin levels were significantly higher in Mix immediately post-lunch (LH0), but PFC showed a greater increase at LH120. GLP-1 levels showed no significant differences. PFC had a smaller decrease in NEFA at LH30 compared to Mix. Fatigue indicators and cycling performance revealed no significant differences (7K: Mix 636±55, PFC 631±26; 85% VO2max: Mix 524±168 , PFC 590±191 seconds), though PFC trended toward longer cycling times at 85% VO2max, with mixed individual performance outcomes.

CONCLUSION: The PFC meal pattern helps reduce postprandial insulin and glucose fluctuations, enhances fat oxidation for energy, and sustains stable glucose levels over time. This stability may support prolonged energy during exercise and delays fatigue. Furthermore, after exhaustive exercise, this pattern may boost muscle glycogen resynthesis by extending insulin stimulation, enabling rapid recovery and improving subsequent endurance performance.

**COMPARATIVE ANALYSIS OF CARBOHYDRATE DELIVERY SPEEDS OF A GLUCOSE-FRUCTOSE ENERGY BAR, A MALTODEXTRIN-BASED GEL, AND GLUCOSE-FRUCTOSE HYDROGEL IN ATHLETES**

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INTRODUCTION: Carbohydrate (CHO) supplementation during exercise is crucial to optimise athletic performance. Energy gels and bars are commonly used to provide rapid CHO by rapid digestion, absorption, and oxidation. While the effects of different sugar compositions – such as simple versus complex sugars and combinations of sugars, such as glucose-fructose – can influence digestion rates, how popular supplements perform in practice is less understood. This study examined the speed of delivery of three popular CHO supplements: a glucose-fructose-based energy bar (Voom Pocket Rocket; VOOM), a maltodextrin-based gel (SIS Go Isotonic; SIS), and a glucose-fructose hydrogel (Maurten Gel 160; MAU).

METHODS: Sixteen healthy male Tier 2 runners, cyclists, and triathletes (mean ± SD) (aged 23 ± 4.2 years; height 182.03 ± 6.5 cm; weight 79.5 ± 8.3 kg; BMI 23.81 ± 1.2 kg/m²) completed a modified 60-minute oral glucose tolerance test at Lancaster University's Human Performance Laboratory. This preregistered trial (NCT06375577) was approved by Lancaster University Medical School Research Ethics Committee (LMS-24-Dean-1). A baseline blood sample was taken following a 2-hour fast, before providing 45 g of CHO from VOOM, SIS, or MAU. Venous blood samples were taken at 5-minute intervals via antegrade-venous cannulation for 60 minutes for glucose and electrolytes (sodium, potassium, chloride). Substrate utilisation was assessed through indirect calorimetry via the respiratory quotient (RQ). Data were analysed for normality using Shapiro-Wilk. Parametric data was analysed via repeated measures ANOVA, while non-parametric data were analysed using the Friedman test. Significance was defined as $p < 0.05$.

RESULTS: CHO oxidation per 5-minute interval was different between CHO supplements ($p = 0.03$), with VOOM exhibiting greater mean CHO oxidation (2.1 ± 0.3 g·min−1) compared to SIS (1.5 ± 0.4 g·min−1) and MAU (1.7 ± 0.3 g·min−1). Total CHO oxidation was significantly greater in VOOM than SIS (24.6 ± 7.4 g vs 17.8 ± 8.6 g, respectively, $p = 0.01$) but not MAU (MAU 20.1 ± 6.4 g, $p > 0.05$). Conversely, total fat oxidation was suppressed to a greater extent for VOOM than SIS (SIS 9.5 ± 3.4 g, VOOM 7.37 ± 2.29 g, $p = 0.007$) but not MAU (8.45 ± 3.36 g, $p > 0.05$). The mean RQ was greater for VOOM (0.86 ± 0.06) than MAU (0.84 ± 0.07) and SIS (0.83 ± 0.07) ($X2 (38) = 187.8$, $p < 0.0001$). No significant differences were observed in mean peak glucose (VOOM 6.6 ± 1.2 mmol/L, MAU 6.2 ± 1.1 mmol/L, SIS 6.4 ± 1.15 mmol/L) and time to glucose peak (VOOM 31.3 ± 14.0 min, MAU 39.1 ± 12.3 min, SIS 33.1 ± 11.1 min) or in electrolyte levels across supplements ($p > 0.05$).

CONCLUSION: These results suggest that the VOOM glucose-fructose Pocket Rocket delivers CHO as quickly, or perhaps even quicker, than maltodextrin or glucose-fructose energy gels, providing athletes with an effective alternative for carbohydrate supplementation.

**PLACEBO EFFECT ON REPEATED SPRINT TRAINING IN HIGHLY TRAINED SWIMMERS IN SPRINT EVENTS.**

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INTRODUCTION: Caffeine has been shown to enhance swimming performance. Previous meta-analysis has found that caffeine ingestion significantly improved swimming times in both short-distance and moderate-to-long distance events (1). In elite male freestyle swimmers, a moderate dose of caffeine (3 mg/kg) improved repeat-sprint ability, particularly in the middle sprints of a 6x75-m set (2). Interestingly, the placebo effect of caffeine can also contribute to performance improvements in sports. In a recent systematic review anaerobic capacity and endurance performance were improved by the consumption of both, caffeine and placebo perceived as caffeine (3).

METHODS: A randomized, counterbalanced experimental design was used to evaluate the effects of a placebo (PLA), capsule reported as caffeine, versus no intake (CON) in 2 interval sessions separated by 7 days. Six highly trained swimmers participated in this study. Each session consisted of 6x25-m sprints at maximum intensity with 2' of recovery, followed by 50-m all-out. Swimming times, countermovement-jump (CMJ) and subjective effort (RPE) were recorded. Side

effects were assessed via a questionnaire. Statistical analysis (SPSS v28.0) applied t-tests, Wilcoxon tests, and Cohen's d, with significance set at p<0.05.

RESULTS: No significant differences were found in the total time for 6x25-m test (75.1±3.8 vs. 77.0±3.8, p=0.297, d=0.50), in the average times of each 25-m repetition (12.52±0.6 vs. 12.52±0.8, p=0.987, d=0.006), and in 50-m times (27.85±1.3 vs. 27.90±1.4, p=0.825, d=0.087) between PLA and CON conditions. No significant differences (p>0.05) were observed between PLA and CON conditions for RPE POST 25-m (6.83±0.8 vs. 7.17±0.8, p=0.363, d=0.408) and RPE POST 50-m (7.83±0.8 vs. 8.67±0.5, p=0.093, d=0.848). Furthermore, there were no significant differences between PLA and CON conditions for the CMJ in the speed loss between the PRE and POST of each session when compared across conditions (2.65±3.0 vs. 5.13±2.33, p=0.072, d=0.826). No significant differences were found in side effects.

CONCLUSION: In conclusion, the belief of having ingested caffeine did not improve performance in swimmers during 6x25-m sprints with 2 minutes of recovery, followed by a 50-m sprint, CMJ, RPE and side effects. We recommend coaches to incorporate caffeine supplementation into swimmers plans before competitions.

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**VARIABILITY IN INTERSTITIAL GLUCOSE RESPONSE TO AN ACUTE CHANGE IN ENERGY AVAILABILITY IN ENDURANCE ATHLETES**

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INTRODUCTION: To determine whether an acute change in energy availability (EA) causes perturbations in interstitial glucose in athletes.

METHODS: Using a randomized crossover design, five trained endurance athletes (n = 3 men, 26.4 ± 7.5 y, VO2 max 53.1 ± 4.7 mL·kg-1·min-1), completed a morning high-intensity interval cycling session (AM HIT; 6 × 5 min @ 85% VO2 max) and an afternoon steady-state cycling session (PM SS; 80 min @ 63% VO2 max) under dietary conditions of either (1) high energy availability (HEA: 42.6 ± 3.8 kcal·kg-1 FFM·d-1, 10.0 ± 1.4 g·kg-1·CHO) or (2) low energy availability (LEA: 11.3 ± 2.4 kcal·kg-1 FFM, 5.2 ± 0.3 g·kg-1·CHO) following 3 days of dietary harmonization (DH; 46.1 ± 1.5 kcal·kg-1 FFM·d-1, 8.3 ± 0.6 g·kg-1·CHO). Interstitial glucose data was measured with Freestyle Libre 2 continuous glucose monitors (Abbott Diabetes Care, Chicago IL; CGM's) with 15-min epochs to determine glycemic variability, calculated as mean interstitial glucose (MG), mean amplitude of glycemic excursions (MAGE), and coefficient of variation (CV).

RESULTS: CGM-derived overnight MG was lower during LEA and HEA compared to DH (LEA 4.5 ± 0.3 mmol·L-1 HEA 4.9 ± 0.1 mmol·L-1 vs 5.5 ± 0.4 mmol·L-1; P = 0.01, d > 1.9). MAGE was lower in the LEA trial compared to HEA, although this was not statistically significant (1.7 ± 0.7 mmol·L-1 vs 2.1 ± 0.3 mmol·L-1, P = 0.26, d = 0.8).

CONCLUSION: Contrary to our hypothesis, perturbations to overnight glucose variability occurred in both LEA and HEA conditions which may be related to changes in daily training load compared with athletes' habitual training.

**MEDITERRANEAN DIET AND ATHLETIC PERFORMANCE IN ELITE AND COMPETITIVE ATHLETES: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Nutrition is a key factor for achieving and maintaining optimal sports performance. Evidence showed that an adequate and individualised dietary pattern able to meet the energy, macro- and micro-nutrient needs of athletes is fundamental to optimising training adaptations, improving performance, preventing illness and injuries and supplying pre-during-post training periods. Mediterranean Diet (MD) has been widely reported to be a model of healthy eating for its contribution to a favourable health status and a better quality of life. Due to its anti-oxidant and anti-inflammatory effects, injury and illness prevention role, vascular and cognitive function enhancement, MD may represent the reference dietary pattern for athletes. This review aimed to investigate whether MD could impact performance in adult elite and competitive athletes from various disciplines.

METHODS: A systematic literature review (PROSPERO: CRD42023459039) was performed based on the PRISMA method. The search was conducted in PubMed/Medline, Scopus, Web of Science, and the Cochrane Library in October 2024. Inclusion criteria: healthy competitive/elite athletes (<18y) performing at least 6 hours/week of physical activity. The risk of bias was assessed using the RoB 2.0 Cochrane tool for randomized-controlled trials, Robins-I tool for non-randomized studies and the Newcastle Ottawa Scale for observational studies. A subgroup meta-analysis was conducted. Data were expressed as standardised mean difference, with a 95% confidence interval, to uniform the units used for different performance outcomes. Random-effects models were applied with p<0.05 considered statistically significant.

RESULTS: Were included 9 studies (192 participants; males 65.6%), published between 2015 and 2023. The article's sample size ranged from 10 to 43 athletes performing different sports (beach handball, canoe polo, CrossFit, football, handball, volleyball, kickboxing, and running). MD adherence was assessed using various tools (KIDMED, MEDAS-14, MDAS), and through monthly phone interviews. Results varied from low to high adherence to the MD. 5 studies reported an MD impact on athletic performance; 80% of these studies reported a positive effect including improvements in anaerobic/aerobic power, explosive strength, and body fat percentage. The meta-analysis showed no significant overall effect of the MD on performance outcomes [SMD 0.00 (CI -0.26; 0.25)].

CONCLUSION: Although some individual studies report positive effects of MD on specific performance parameters, the meta-analysis found no significant overall impact. Nevertheless, the MD may still offer potential benefits for athletes, warranting further investigation. To enhance the reliability of future research, studies should standardise dietary assessment methods and incorporate longer intervention periods to more accurately assess the long-term effects of the MD on athletic performance.

**ASSOCIATIONS BETWEEN NUTRITIONAL PROFILE, BODY COMPOSITION, MUSCLE STRENGTH, EXECUTIVE FUNCTIONS AND SPORT PERFORMANCE IN ÉLITE JUDO ATHLETES**

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INTRODUCTION: Judo is a combat sport with weight categories. Many athletes resort to rapid weight loss to gain an advantage against lighter opponents [1]. The consequences are dehydration, decreased strength, aerobic and anaerobic performance [2-3].

This study aimed to asses correlations between national performance ranking, anthropometric measurements, nutritional profile, body composition, muscle strength and executive functions (EFs) in élite judokas.

METHODS: Twenty-seven athletes (14 males and 13 females; age = 19.5 ± 2.0 years) were recruited from Banzai Cortina of Rome. Height, Body Weight (BW) and Body Mass Index (BMI), physical fitness (countermovement jump, handgrip test (HG), dynamic and isometric chin up test) and cognitive functions (Digit Span (DS) and Flanker) were evaluated. Adherence to the Mediterranean Diet (MD) was assessed via questionnaire. Bioimpedance analysis determined nutritional and hydration status, Muscle Mass (MM), Fat Free Mass (FFM) and Total Body Water (TBW).

RESULTS: MD adherence was moderate in both males (7.6±1.8) and females (8.5±1.3). All athletes had normal hydration (72.7-74.3%), while nutritional values were higher ($p<0.01$) in males (1136±124 mg 24h/htm) than in females (798±67 mg 24h/htm). In males, MD adherence correlated with age ($r=0.61$; $p=0.021$), Flanker reaction time ($r=-0.63$; $p=0.016$) and DS ($r=0.53$; $p=0.049$). Hydration status was related to ranking ($r=-0.56$; $p=0.045$), BW ($r=0.63$; $p=0.016$), BMI ($r=0.63$; $p=0.016$), FFM ($r=0.68$; $p=0.008$) and MM ($r=0.71$; $p=0.005$). Nutritional status correlated with BW ($r=0.75$; $p=0.002$), BMI ($r=0.84$; $p=0.000$), FFM ($r=0.87$; $p=0.000$), TBW ($r=0.87$; $p=0.000$), MM ($r=0.90$; $p=0.000$) and HG ($r=0.66$; $p=0.010$). In females, hydration correlated with ranking ($r=-0.88$; $p=0.001$), FFM ($r=0.59$; $p=0.033$) and MM ($r=0.71$; $p=0.006$). Nutritional status was correlated with BW ($r=0.59$; $p=0.035$), BMI ($r=0.58$; $p=0.038$), FFM ($r=0.72$; $p=0.005$), TBW ($r=0.70$; $p=0.008$), MM ($r=0.68$; $p=0.010$) and DS reaction time ($r=-0.61$; $p=0.024$). Ranking was correlated with MM ($r=-0.64$; $p=0.045$) and DS reaction time ($r=0.64$; $p=0.047$).

CONCLUSION: Hydration status appears crucial in both male and female élite athletes, correlating with higher national ranking. In males, nutritional status was associated with muscle strength, while MD adherence correlated with EFs. In females, nutritional status and ranking were associated with EFs.

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**THE IMPACT OF BODY MASS REDUCTION AND NUTRIENT INTAKE ON COMPETITIVE SUCCESS IN ELITE JUDO ATHLETES**

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INTRODUCTION: In combat sports such as judo, athletes often engage in rapid weight loss (RWL) processes to achieve the lowest possible weight category[1]. Therefore, managing body mass and optimizing nutrition are key elements for achieving competitive success. Thus, this study aimed to investigate the relationship between body mass reduction, nutrient intake, and medal achievement in elite judo athletes.

METHODS: Forty-five elite judo athletes (age: 22.5 ± 2.7 years; judo grade: 1st dan) competing at national and international levels were monitored over a competition. Body mass was measured at 10, 7, and 3 days before weigh-in, on weigh-in day, and competition day. Body mass reduction was calculated from 10 days before weigh-in to weigh-in day, and body mass recovery from weigh-in to competition day. The official weigh-in took place on the evening prior to the competition. Nutrient intake was assessed using 24-hour dietary recalls at 10 and 3 days before weigh-in, and competition day. Inde-

pendent t-tests compared medallists and non-medallists for total body mass reduction and regain, ANOVA two-way with repeated measurements for group and time point comparisons, while logistic regression analyzed the relationship between body mass reduction and medal success.

RESULTS: There were no significant differences between medallists and non-medallists in terms of body mass reduction (medallists = 3.58 ± 1.81%; non-medallists = 3.04 ± 1.05%; P = 0.297) and body mass regain (medallists = 3.75 ± 1.93%; non-medallists = 3.98 ± 1.61%; P = 0.700). However, logistic regression revealed that a greater body mass reduction from 10 days before weigh-in to weigh-in increased the odds of winning a medal (OR: 1.64; 95%CI: 1.07; 2.51; P = 0.021). Protein intake was significantly higher at 10 days before weigh-in compared to other time points (P < 0.001). Post-weigh-in, both groups showed increased lipid and carbohydrate intake (P < 0.001).

CONCLUSION: Although no significant differences were observed between medallists and non-medallists in body mass reduction or regain, greater body mass reduction prior to weigh-in was associated with an increased likelihood of competitive success, suggesting a potential advantage for athletes who manage their body mass effectively in the lead-up to competition. Additionally, nutritional intake was influenced by RWL strategies. The higher protein ingestion observed 10 days prior to weigh-in could indicate that athletes were prioritizing proper nutrition before staring the RWL. This pattern suggests that closer to the competition athletes were reducing their nutrient intake.

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**DHA INCORPORATION ATTENUATES THE PHYSIOLOGICAL IMPACT OF ECCENTRIC EXERCISE IN PHYSICALLY TRAINED ADULTS: A 12 WEEK DOUBLE-BLIND PLACEBO CONTROLLED TRIAL**

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INTRODUCTION: Recovery from eccentric muscle loading involves a complex integration of perceived muscle soreness and temporary reduction in strength and power. Omega-3 docosahexaenoic acid (DHA) is preferentially incorporated into skeletal muscle (SM) membrane phospholipids and the Omega-3 Index (O3I; %eicosapentaenoic acid+DHA of total erythrocyte fatty acids) serves as an accessible biomarker to reflect SM membrane changes. DHA membrane incorporation promotes the production of pro-resolving molecules, which play a key role in the resolution of inflammation. The aim of this study was to determine if a dietary achievable dose, equivalent to two fatty fish meals per week, of microencapsulated chewable DHA tablets (NuMegaTM Ingredients) consumed for 12 weeks, could improve recovery metrics following eccentric loading, underpinned by an increased O3I.

METHODS: Physically trained adults (18-45y) were matched for peak power output (PPO) and supplemented for 12 weeks in a double-blind manner with either oleic acid (control, n=12, 33% female) or 715mg/d DHA (DHA, n=26, 38% female). At weeks 0 and 12, the O3I was measured and participants performed an eccentric cycling protocol at 30% of PPO to induce muscle damage. Muscle soreness (VAS), countermovement jump height (CMJ-h), peak vertical isometric force (PVIF) and inflammatory cytokines were assessed before, immediately post, 24h and 48h post eccentric cycling. Area under the curve (AUC) was calculated for VAS score, CMJ-h, PVIF and inflammatory cytokines to represent the integrated response over 48 hours. RM-ANOVA was used for O3I and between group effect sizes at week 12 were calculated using Cohen's d. Data presented as mean±SD, or mean difference (MD)±pooled SD.

RESULTS: O3I was equivalent and low in both groups at week 0 (control, 4.75±0.87%; DHA, 4.89±0.88%, P=0.622). At week 12, the ΔO3I was unchanged in the control group, but significantly increased in the DHA group (control, +0.02±0.48%; DHA, +2.47±0.89%; P<0.001). At week 0, eccentric cycling resulted in both groups experiencing a similar reduction in CMJ-h (control; -169±148 cm*48h, DHA; -173±175 cm*48h) and PVIF (control; -6376±5643 N*48h, DHA; -6814±8656 N*48h.). CMJ-h and PVIF were greater within the DHA group at week 12 (CMJ-h, MD= +61±102 cm*48h, d=0.59; PVIF, MD= +2490±7824 N*48h, d=0.32). VAS was not different between groups at week 0 (control, 163±85 cm*48h; DHA, 164±88 cm*48h). VAS was lower in the DHA group and compared to control at week 12 (MD; -76±81 cm*48h; d=0.95). There were significant interaction effects in AUC for TNF-α (P=0.010) and IL-10 (P=0.026), being lower compared to week 0 in the DHA group at week 12.

CONCLUSION: These findings support the hypothesis that a dietary achievable dose of DHA increases the O3I, reflective of muscle membrane incorporation and can attenuate the physiological impact of eccentric exercise, enhancing performance recovery and modulating inflammation in physically trained adults.

Conventional Print Poster Presentations

CP-SH13 Psychology IV - Intervention

**EXECUTIVE FUNCTION RESPONSE TO MODERATE-TO-HIGH-INTENSITY ROPE SKIPPING CONTINUOUS TRAINING IN ADOLESCENTS WITH OVERWEIGHT AND OBESE: A RANDOMIZED TRIAL**

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Background: Previous studies have shown that high body mass index (BMI) is detrimental to executive function (EF) in children and elderly populations but may be improved by physical activity (PA). However, research on adolescents is lacking. This study examined the correlation between BMI and EF in adolescents and investigated the effects of moderate-to-high-intensity rope skipping (RS) training on EF in adolescents with varying BMIs. Methods: 166 adolescents aged 12–14 years were divided into normal weight, overweight three and obese groups according to BMI. 96 adolescents were assigned to the normal weight control and exercise group (NCG, n=23; NEG, n=23), the overweight control and exercise group (OVCG, n=13; OVEG, n=14), and the obese control and exercise group (OBCG, n=12; OBEG, n=11). Exercise program: moderate-to-high-intensity RS training. Control program: sedentary. Data were recorded for BMI and EF tasks. Results: The average reaction time (RT) of EF tasks in OVG, OBG exceeded NG about 14%, 24% respectively ($P<0.05$) in part one. After exercise intervention, the average BMI in OVEG and OBEG decreased about 10% and 11% ($P<0.05$). The average RT of EF tasks in NEG, OVEG and OBEG decreased about 9%, 14%, 13% respectively ($P<0.05$). Exercise groups have a significant difference with the control groups in the RT of EF tasks ($P<0.05$). Conclusions: The EF is weaker in overweight and obese adolescents than in normal weight adolescents. An 8-week moderate-to-high-intensity RS exercise program can improve EF in adolescents with different BMIs, and the improvement is greater in overweight and obese adolescents.

**A 12-WEEK CARDIOVASCULAR EXERCISE PROGRAM ENHANCES BEHAVIORAL AND NEUROELECTRIC MARKERS OF INHIBITORY CONTROL IN SEDENTARY YOUNG ADULTS: A RANDOMIZED CONTROLLED TRIAL**

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Purpose:

Regular physical exercise may enhance cognitive functions, particularly inhibitory control, yet its effects in healthy but sedentary young adults remain understudied. This study examined how a structured 12-week cardiovascular exercise intervention influences behavioral and neuroelectric markers of inhibitory control in this population.

METHODS: Sedentary young adults were randomized into an exercise group (n = 32) or a passive control group (n = 30). The intervention consisted of 6 weeks of moderate-intensity continuous exercise (MCE) followed by 6 weeks of moderate-to high-intensity interval exercise (MHIE) on a cycling ergometer. Inhibitory control was assessed at baseline (pre-test), mid-intervention (mid-test), and post-intervention (post-test) using a modified flanker task with EEG recordings. Key outcomes included response time (RT) and event-related potentials (N2 and P3b components).

RESULTS: The exercise group showed progressive RT reductions in incongruent trials at all time points (pre-to-mid, mid-to-post, pre-to-post) without accuracy loss. The control group exhibited RT reductions only from pre- to post-test but with decreased accuracy. EEG data revealed that the exercise group demonstrated decreased N2 amplitudes and faster P3b latencies from mid- to post-test during incongruent trials, indicating improved neural efficiency. In contrast, the control group showed increased N2 amplitudes during congruent trials at pre-to-mid and pre-to-post assessments.

Conclusions:

A structured cardiovascular exercise program combining MCE and MHIE enhances both behavioral and neuroelectric markers of inhibitory control in sedentary young adults. These findings suggest that tailored exercise programs can serve as an effective, accessible strategy for improving cognitive function in populations at risk of sedentary-related cognitive decline.

**GREATER MOTOR COMPETENCE AND ENHANCED INHIBITORY CONTROL DEVELOPMENT IN CHILDREN WITH ADHD: A NEUROELECTRIC STUDY**

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INTRODUCTION: Neurocognitive deficits, especially inhibitory control processing, are common developmental challenges in children with attention-deficit/hyperactivity disorder (ADHD). Although previous studies have suggested that greater motor competence (MC) is associated with better inhibitory control on both behavioral and neuroelectric levels in children with ADHD, some limitations exist. Therefore, this study aimed to examine whether higher MC is associated with improved neurocognitive development in children with ADHD, as indexed by behavioral and neuroelectric indices of inhibitory control in a well-designed study.

METHODS: Sixty children with ADHD were divided into high MC (n = 30) and low MC (n = 30) groups, based on the median total composite scores from the Bruininks-Oseretsky Test of Motor Proficiency. Forty-four typically developing (TD) children

were recruited as the healthy control. The Stroop task was administered to assess inhibitory control while electroencephalography was recorded to derive P3 component.

RESULTS:

The TD children group demonstrated higher accuracy rate (AR), shorter reaction time (RT), and greater P3 amplitude relative to the Low MC ADHD group. However, the TD children group had higher AR compared to the High MC ADHD group, with no significant differences in RT and P3 amplitude. Further, the High MC ADHD group demonstrated shorter RT and greater P3 amplitude regardless of congruency compared to the Low MC ADHD group while accounting for intelligence quotient and aerobic fitness.

CONCLUSION: Superior MC in children with ADHD is associated with favorable neurocognitive development, as evidenced not only by the association of MC with enhanced inhibitory control performance and increased P3 amplitude but also by that such neurocognitive performance is comparable to those of TD children. These findings suggest that enhanced MC plays a role in mitigating typically developmental neurocognitive deficits associated with ADHD.

**SUPPORTING TEACHERS' WELL-BEING BY [RE]-LEARNING HOW TO BREATH.**

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Faced with increasing tensions, compassion fatigue is a threat to many professionals, particularly teachers. This research studied the stress factors identified in the scientific literature, as in work overload and lack of support, which contribute to the increased risk of burnout in the educational sector. Based on the socio-emotional competencies framework, the integration of emotional regulation strategies, such as conscious breathing, appears to be a key strategy to improving self-awareness and self-regulation. For this purpose, a training program on breathing techniques, entitled Zen Breathing, was offered to primary and secondary school teachers in Quebec, including physical education teachers (PE). The aim of this research was to document the implementation of a training program focusing on these breathing techniques. This exploratory qualitative study was carried out with PE teachers (n = 7) and a trainer responsible for implementing this training program. A thematic analysis was conducted on the corpus combining a survey on PE teachers appreciation of the Zen Breathing training, training artefacts, the trainers logbook and an individual interview with a participant. The initial results shed light on the trainers action model in terms of intentions, planning strategies, and actions or interventions during training. In addition, the results allow to corroborate or compare the trainers impressions to those of PE teachers by analyzing the artifacts and the participants comments. This research project has enabled a better understanding of the facilitators and obstacles involved in implementing a program of this kind.

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**MINDFUL TENNIS: IMPACT OF A 7-WEEK INTERVENTION ON PERFORMANCE AND MENTAL STATE IN COLLEGIATE PLAYERS**

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INTRODUCTION: Maintaining steady psychological state is crucial for achieving and sustaining athletic performance. While mindfulness training has been shown to enhance psychological well-being and performance, its integration into sports training programs remains under-explored with limited research on its impact in collegiate tennis. This study aimed to examine the effect of a 7-week mindfulness-based intervention on psychological state and tennis performance among college-level tennis players.

METHODS: Sixty second-year collegiate tennis players in Yunnan, China, were randomly assigned to an experimental group (n=30) or a control group (n=30). Both groups participated in a 7-week structured tennis training program. The experimental group additionally received Mindfulness Sports Training, which included 30-minute mindfulness-based sessions and two 15-minute integrated tennis skills practices on the training court. Assessments were conducted before, immediately after, and 4 weeks post-intervention. Psychological measures included the Five Facet Mindfulness Questionnaire, Acceptance and Action Questionnaire, Sport Competition Anxiety Test, and Mindfulness Attention Awareness Scale. Standardised tennis skill tests were administered at each assessment. Descriptive statistics, normality tests, independent t-tests, two-way repeated-measures ANOVAs, and Pearson correlations were used for data analysis.

RESULTS: After 7 weeks of training and at the 4-week follow-up, the experimental group exhibited significantly greater improvements than the control group on mindfulness ($p < 0.001$, $\eta^2 = 0.798$), psychological flexibility ($p < 0.001$, $\eta^2 = 0.705$), competition anxiety state ($p < 0.001$, $\eta^2 = 0.766$), and character concentration ($p < 0.001$, $\eta^2 = 0.684$). In terms of tennis performance, the experimental group showed greater improvement in forehand/backhand ($p < 0.001$, $\eta^2 = 0.808$), serving ($p < 0.001$, $\eta^2 = 0.825$), and net volleys ($p < 0.001$, $\eta^2 = 0.805$). Although the control group also improved in tennis skills, they did not demonstrate significant changes in psychological measures. Correlation analyses revealed significant positive relationships between overall mindfulness level and character concentration, as well as between overall mindfulness and psychological flexibility, and between forehand/backhand and net volley performance.

CONCLUSION: The improvements in mindfulness, psychological flexibility, and reduced competition anxiety appear to contribute to better on-court performance, illustrating the interconnected nature of mental and physical training. Future studies could explore the underlying mechanisms in other athletic contexts, investigate longer-term effects on competitive outcomes, and consider how different sports or skill levels might benefit from similar mindfulness interventions.

**SELF-DETERMINATION, HAPPINESS, AND PHYSICAL TRAINING IN STROKE SURVIVORS WITH APHASIA: A HOLISTIC APPROACH TO REHABILITATION**

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Background: Stroke survivors with aphasia face significant challenges in communication, leading to difficulties in social interaction, emotional well-being, and independence. While physical rehabilitation and speech therapy are commonly prioritized in stroke recovery, psychological factors such as self-determination and happiness play a crucial role in improving motivation, emotional resilience, and engagement in therapy. This highlights the need for a holistic rehabilitation approach that integrates both physical and psychological aspects of recovery.

Objective: This study explores the role of self-determination, happiness, and physical training in the rehabilitation process of stroke survivors with aphasia. It aims to assess how combining psychological factors, such as fostering self-determination and promoting happiness, with physical training can enhance both communication skills and overall recovery outcomes.

Methods: Stroke survivors with aphasia will participate in a rehabilitation program that integrates physical exercises with psychological techniques aimed at enhancing self-determination and happiness. The program will include autonomy-supportive strategies, motivational techniques, and physical exercises designed to improve mobility and communication. Interviews are conducted to evaluate improvements in motivation, happiness, communication abilities, and overall rehabilitation outcomes.

Results: Preliminary findings suggest that participants who experience higher levels of self-determination and happiness, in addition to physical training, show significant improvements in communication abilities, increased motivation, and greater engagement in rehabilitation. These factors contribute to better emotional well-being and more sustained participation in therapy, leading to enhanced recovery outcomes.

Conclusion: A holistic rehabilitation approach that combines self-determination, happiness, and physical training is essential for maximizing recovery in stroke survivors with aphasia. By addressing both the emotional and physical aspects of recovery, this approach enhances motivation, communication abilities, and overall quality of life, supporting comprehensive rehabilitation and long-term recovery for stroke survivors.

**THE INFLUENCE OF PSYCHOLOGICAL SKILLS AND STRATEGIES ON COMPETITIVE PERFORMANCE IN SWIMMING**

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INTRODUCTION: A long-term and systematic psychological training program can significantly contribute to the positive development of young athletes. Ideally, this training should commence during the youth and junior stages. The German Swimming Federation has developed a sports psychology training program specifically for the junior sector, aimed at supporting long-term athletic development. This study examines which psychological skills and strategies have a decisive impact on competitive performance.

Method: Between 2021 and 2024, a total of 34 female and 37 male athletes, with an average age of 16.3 years (SD=1.25), participated in sports psychology training and diagnostics as part of four annual training camps for the junior national team. To assess psychological skills and strategies, the Test of Performance Strategies (TOPS-D) was employed [1]. This test evaluates the use of self-talk, emotional control, automaticity, goal-setting, imagery, activation, and relaxation in both training (T) and competition (C). Additionally, negative thinking in competition and attentional control in training were assessed. Competitive performance was measured using the Rudolph Table, which allows for an age-appropriate and discipline-specific performance evaluation in swimming [2].

RESULTS: The findings indicate that young swimmers utilize psychological skills and strategies as frequently as reported in existing literature [1]. However, self-talk (T) (p=.003) and imagery (C) (p=.004) were used significantly more frequently, whereas attentional control (p=.012) was used less frequently than in the comparative sample. Emotional control, goal-setting, imagery, activation, and relaxation were significantly more prevalent during competitions (all: p<.001). With the exception of emotional control (T), imagery (T), and relaxation (C), no gender-specific differences were observed. However, these three psychological skills and strategies were significantly more frequently employed by male swimmers (p=.011–

p=.033). Stepwise regression analysis identified the following factors as influencing competitive performance (Rudolph points – F (1,58)=3.844, p=.004, $R^2$k=.182): Goal-setting (C) (b=.434, p=.002), Self-talk (T) (b=.288, p=.021), Emotional control (C) (b=.239, p=.050), Automaticity (C) (b=-.187, p=.115) and Imagery (C) (b=-.221, p=.125).

CONCLUSION: Psychological skills and strategies are primarily applied by young swimmers during competitions. Athletes who practiced self-talk during training and implemented effective goal-setting and emotional control during competitions demonstrated superior performance outcomes. Conversely, excessive cognitive engagement and imagery during competitions had a negative impact on performance. Based on these findings, the content of the sports psychology training program should be reviewed and adjusted as necessary.

[1] Schmid, Birrer, Kaiser, & Seiler (2010), [2] Rudolph (2024)

**TRAINING PSYCHOLOGICAL SKILLS: EFFICACY AND ASSESSMENT OF A NONCLINICAL PSYCHOLOGICAL SPORTS COACHING E-INTERVENTION FOR YOUNG ELITE ATHLETES**

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*UNIL*

Given the critical role of psychological skills in the development of young athletes and the current emphasis on digital and sustainable innovations, the rise of accessible e-interventions is unsurprising. Indeed, the significance of psychological skills as fundamental attributes of high performance in sports has been well documented (e.g., Birrer & Morgan, 2010; Brown & Fletcher, 2017; Weinberg & Gould, 2023). Solid acquisition of these skills may contribute to more effective learning and optimized development opportunities, aligning with principles of knowledge transfer and long-term sustainability in athlete development.

Recognizing the potential of an e-intervention to impact psychological skills sustainably among talented young athletes, we designed two studies aimed at (1) evaluating the effectiveness of an e-intervention to support athletes in developing these skills and (2) assessing the usability of the intervention, thus providing insights into the user experience. To do so, we employed mixed methods by combining the results of qualitative and quantitative investigations. In Study 1, we conducted quantitative analyses to examine both short- and long-term impacts, offering insights into the interventions effectiveness. Study 2 subsequently focused on quantitative and qualitative data, ensuring the programs design met the practical needs of young athletes while fostering sustainable engagement.

The study sample consisted of 105 athletes (73 males, 32 females), comprising 61 skiers (33 males, 28 females), 29 male footballers, and 15 track and field athletes (11 males, 4 females), recruited from four sports clubs in Switzerland and France. Participants aged 13 to 18 ($M$ = 14.67, $SD$ = 1.13) trained an average of 4.10 times per week ($SD$ = 1.01) and had been practicing their sport for an average of 8.65 years ($SD$ = 2.46). All athletes were enrolled in training centers recognized by their regional committees and were potential candidates for national youth teams. They were randomly assigned to either an Intervention group or a Control group.

The e-intervention, structured as a four-week program, was developed using a psychotherapy process-outcome research framework (Allemand & Flückiger, 2017) and integrated the principle of implementation intention (Achtziger et al., 2008). To measure the impact on psychological skills, the French version of the Psychological Characteristics of Developing Excellence Questionnaire-Short (PCDEQ-S) by Hauw et al. (2023) was administered pre-and post-intervention. The System Usability Scale (SUS) assessed the intervention's usability.

The intervention group demonstrated a significant improvement in self-analysis skills over time [$b$ = 0.49, 95% CI (0.18, 0.80), $SE$ = 0.16, $p < 0.05$]. The e-intervention earned a high usability score, exceeding 80 points on the SUS, placing it in the top 10% of usability rankings. Feedback from participant interviews highlighted areas for potential improvement.

**EVALUATING COGNITIVE ABILITIES AND MENTAL HEALTH IN YOUTH NATIONAL FOOTBALL PLAYERS: A FOUNDATION FOR TARGETED INTERVENTIONS**

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Introduction

Psychological interventions within youth national football teams are markedly constrained due to the restricted duration of time these teams spend in a coordinated manner. The periods for national team selection are governed by the Union of European Football Associations (UEFA). As a result, each football player may be selected for the national team during a maximum of six separate periods annually. Taking into account their commitments to their respective clubs, the impact of injuries, and the tactical decisions made by the coaches, their participation in the youth national team may be further diminished. Nevertheless, in order to identify junior football players who will eventually contribute to the senior national team, it is imperative to consider the psychological development of these athletes. The initial and crucial step in implementing an effective psychological intervention is to conduct a comprehensive psychological assessment.

METHODS: Over three successive UEFA periods (September- December 2024), we evaluated 150 male football players (mean age = 16.20, $SD$ = 1.41) who are members of the national youth team (U15- U19). We assessed three primary components: ten cognitive abilities empirically associated with football performance (e.g., focused attention, visual memory), mental health status (e.g., symptoms of anxiety and depression), and subjective recovery states (e.g., football-related stress and recovery). The comprehensive evaluation for an individual player required 2 to 3 hours.

RESULTS: Individual scores for cognitive abilities, along with team-level scores, were calculated. No overall differences have been identified at the team level; however, distinct cognitive ability profiles have emerged. In the overall sample, visual perception, visual memory, and movement anticipation exhibited lower scores, while mental reaction speed and motor reaction speed demonstrated higher scores.

In terms of mental health status, 70% of the sample indicated the absence of mental health symptoms, which exceeds the incidence reported in existing literature. Sleep disorder symptoms and eating disorder symptoms were most frequently reported among the remaining 30% of players. No problematic scores were identified concerning the subjective recovery states. All athletes indicated moderate to optimal subjective recovery states.

Discussion

Subsequent to the psychological evaluation, a range of interventions aimed at enhancing psychological functioning has been proposed for the upcoming year: (1) a group of coaches tasked with creating training exercises to enhance cognitive abilities that had lower scores, (2) psychological group workshops aimed at individuals exhibiting mental health symptoms, (3) personalised therapy for athletes experiencing significant mental health challenges. Furthermore, we will address different initiatives aimed at enhancing the psychological development of youth football players.

## Conventional Print Poster Presentations

### CP-PN14 Cardiovascular Physiology Training

**EFFECTS OF ACUTE DIFFERENT INTENSITY CYCLING EXERCISES FOR LOWER LIMBS ON SEGMENTAL ARTERIAL STIFFNESS**

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INTRODUCTION: Many previous studies indicate that acute or regular exercises reduce Pulse Wave Velocity (PWV) as an index of arterial stiffness. The increased arterial stiffness is an independent risk factor for future cardiovascular diseases, so preventing an increase in arterial stiffness by exercise is of paramount importance. One-legged physical exercises (aerobic, resistance, and stretching) acutely reduce arterial stiffness in the exercise limb, but not in the none-exercise limb. Blood flow in brachial artery as inactive limbs generally increases in moderate-(MOD) and severe-(SEV) intensity cycling exercises for lower limbs, but not in low-intensity cycling exercise (LOW). These data thus suggest that arterial stiffness responses to exercise are mainly affected by the difference in arterial segment and blood flow associated with exercise intensity. However, the influences of different intensity cycling exercises on segmental arterial stiffness are now well unknown. Therefore, this study aimed to examine the effects of acute different intensity cycling exercises on segmental arterial stiffness.

METHODS: Nineteen young males and females (21 ± 2 years) participated in four separate trials of 40 min in random order and on different days: (1) resting and sitting on a comfortable chair, as a control (CON); (2) LOW; (3) MOD; and (4) SEV. Each exercise intensity was determined by heart rate levels; 100, 125, and 150 beats/min, respectively. Before (Pre) and immediately (Post 1) and 30 min (Post 2) after the exercises, heart-brachial PWV (hbPWV), which reflects arterial stiffness of the upper limbs from the aorta to the brachium; brachial-ankle PWV (baPWV), which reflects arterial stiffness of central (large arteries in the cardiothoracic region) and leg from the femoral to the ankle; and heart-ankle PWV (haPWV), which reflects systemic arterial stiffness, were measured as an index of segmental arterial stiffness.

RESULTS: No significant differences in baseline parameters were observed among trials. After the exercise, the reductions in hbPWV were significantly higher in both MOD (6.1 ± 4.5%) and SEV (14.4 ± 11.6%) trials than in CON (-1.4 ± 6.0%) trials, but not in LOW (2.3 ± 6.0%) trials. On the other hand, interestingly, a significantly higher reduction in baPWV in both MOD (4.1 ± 5.2%) and SEV (4.2 ± 4.6%) trials and a tendency towards higher reduction in LOW (2.6 ± 4.0%) trials as compared to CON (-6.4 ± 18.9%) trials. Finally, the reductions in haPWV were significantly higher in all LOW (2.6 ± 3.6%), MOD (5.3 ± 3.9%), and SEV (9.1 ± 5.5%) trials than in CON (-3.7 ± 9.8%) trials, but not in trials.

CONCLUSION: Our data indicate that cycling exercise of higher intensity induce reductions in relatively systemic arterial stiffness (i.e., blood flow increases in both active and inactive limbs), but lower intensity induce reductions only in the relatively limited and local arterial stiffness (i.e., blood flow increases only in active limbs).

**EFFECTS OF CUSTOM-FIT COMPRESSION GARMENTS ON STROKE VOLUME AND BLOOD FLOW REGULATION**

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INTRODUCTION: Athletes commonly wear compression garments during and after exercise, in the belief that compression garments improve blood flow. However, relatively little is known about how compression garments influence central haemodynamics. This ongoing study investigates differences in resting stroke volume while wearing custom-fit compression garments (which are designed to apply more consistent pressure and gradient) compared with commercial off-the-shelf compression garments.

METHODS: Using thoracic electrical bioimpedance, stroke volume in two body orientations—standing and supine—while wearing custom-fit tights, custom-fit calf sleeves, off-the-shelf tights, off-the-shelf calf sleeves, and no compression gar-

ment was measured. Testing has been completed on eight physically active participants (5F, 3M), with an average height, weight, and age of 166.5cm, 71.6kg, 33.6 years of age for females and 171.8cm, 92.8kg, and 30.3 years of age for males respectively. 13 more participants will be tested. To explore the physiological mechanisms underlying these observations, a secondary analysis of differences in pressure exerted by custom-fit and off-the-shelf compression garments is also being conducted. A pressure sensor is placed under the compression garments at the medial and posterior aspect of the greatest circumference of the lower leg and on the midpoint between the inguinal crease and the superior-posterior border of the patella.

RESULTS: The preliminary findings indicate a notable increase in stroke volume while wearing custom-fit tights in the standing orientation compared with the other conditions. This improvement suggests enhanced cardiac efficiency via the Frank-Starling mechanism, whereby the heart achieves greater output per beat due to an increased venous return. Data also reveals that off-the-shelf calf sleeves exert the highest pressure but yield minimal stroke volume improvements. By contrast, despite covering less than half the surface area of off-the-shelf tights, custom-fit calf sleeves demonstrate a comparable stroke volume increase in the standing position.

CONCLUSION: This work will provide important new insights into how compression garments influence central haemodynamics, and the variability between custom-fit and off-the-shelf compression garments. These data will improve understanding of how compression garments work physiologically and will inform decision-making about the most effective type of compression garment for athletes.

**POSTEXERCISE HYPOTENSION FOLLOWING EXHAUSTIVE AND SUBMAXIMAL EXERCISE AND ITS ASSOCIATION WITH LONG-TERM BLOOD PRESSURE REDUCTION THROUGH EXERCISE TRAINING**

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INTRODUCTION: Hypertension is a major global health concern and a leading risk factor for cardiovascular diseases and premature mortality. While regular physical activity is an effective strategy for managing blood pressure (BP), individual responses to exercise vary, highlighting the need for reliable predictors of long-term BP adaptation. The magnitude of postexercise hypotension (PEH), the acute BP reduction following a workout, has emerged as a potential indicator of chronic BP improvements [1,2,3]. However, most studies have focused on acute BP changes in response to exhaustive exercise, and little is known about the relationship between acute BP responses to guideline-conforming training intensities and long-term benefits [2,3]. Therefore, this study aimed to investigate whether PEH following continuous submaximal exercise and maximal exercise are correlated, and whether they are associated with long-term BP reductions.

METHODS: Thirty-three untrained, healthy adults (18–45 years) participated in an 8-week aerobic training program, completing three 30-minute sessions per week at a vigorous intensity set midway between two lactate thresholds. BP was measured at rest and 10 minutes after a graded exercise test during baseline testing (MAX), following a training bout at the start of the intervention period (SUBMAX), and at rest after the 8-week training period. Changes in BP were analyzed using paired t-tests. The relationships between PEH following SUBMAX and MAX, as well as between acute and long-term BP changes, were assessed using Pearson correlation. To minimize the impact of math coupling on the strength of associations between PEH and long-term BP changes, the average of the two respective resting BP measurements was used.

RESULTS: A significant acute decrease in BP was observed following SUBMAX (systolic: -4.6 [95% CI: -6.9, -2.3] mmHg, $p < .001$; diastolic: -3.1 [-5.4, -0.8] mmHg, $p = .011$) and in systolic BP following MAX (-3.0 [-5.3, -0.7] mmHg, $p = .013$). A significant reduction in resting diastolic BP was observed after the 8-week training intervention (-2.3 [-4.9, -0.6] mmHg, $p = .015$). PEH after SUBMAX and MAX was significantly correlated (systolic: $r = 0.68$ [0.44, 0.83], $p < .001$; diastolic: $r = 0.54$ [0.24, 0.75], $p = .001$). Correlations between PEH and long-term systolic BP reduction were statistically significant for both SUBMAX (systolic: $r = 0.58$ [0.30, 0.77], $p < .001$; diastolic: $r = 0.56$ [0.27, 0.76], $p < .001$) and MAX (systolic: $r = 0.60$ [0.32, 0.78], $p < .001$; diastolic: $r = 0.45$ [0.13, 0.69], $p = .009$).

CONCLUSION: The observed correlations between PEH following SUBMAX and MAX, along with their associations with long-term BP reductions, suggest that acute BP changes may partly reflect an individuals responsiveness of resting BP to exercise.

1. Halliwill (2001) 2. Hecksteden et al. (2013) 3. Wegmann et al. (2018)

**A MODIFIED STRINGER FORMULA ENHANCES POPULATION-LEVEL CARDIAC OUTPUT ESTIMATION BUT LACKS INDIVIDUAL CLINICAL ACCURACY**

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INTRODUCTION: The Stringer method enables non-invasive cardiac output (Q̇) estimation during cardiopulmonary exercise testing. The method is based on the observation that the arteriovenous oxygen difference (avDO2) increases as a linear function of the percentage V̇O2max and was described with the regression equation $avDO2 = 0.1047 * \%\dot{V}O2max + 5.721$. Therefore, applying the Fick principle, Q̇ can be calculated when the actual V̇O2 and %V̇O2max are known as $\dot{Q} = \dot{V}O2 / [0.1047 * \%\dot{V}O2max + 5.721]$.

Since the Stringer method was calculated in 5 men only, we aimed to validate the Stringer formula in a larger population with a wider range of V̇O2max. We also aimed to optimise it by including the magnitude of V̇O2max/kg as a variable potentially influencing the avDO2 regression proposed by Stringer et al. (1997).

METHODS: Sixteen healthy male participants (age 26 ± 4 yr, body mass 78.1 ± 6.8 kg, V̇O2max 56 ± 9.8 mL/min/kg) performed an incremental CPET, during which Q̇ was measured using the Innocor inert gas rebreathing technique (Q̇RB) at seven exercise intensities ranging 40-100% of V̇O2max. At the same time, Q̇ was estimated using the Stringer formula (Q̇ST). To modify the Stringer formula, we then calculated (i) avDO2 from V̇O2 and Q̇RB measured at each intensity, (ii) used these results to calculate individual linear regression equations (avDO2= a*%V̇O2max +b), (iii) then calculated the regressions of these individual results for a and b, respectively, vs. V̇O2max/kg, and (iv) finally used these to calculate Q̇ based on the thereby modified Stringer formula (Q̇STmod). Intermethod agreement was assessed by Bland-Altman analyses.

RESULTS: The measured data were highly plausible with Q̇RB = 4.8*$VO_2$+ 5.6 L/min. For Q̇RB vs. Q̇ST, Bland-Altman analysis indicated a mean difference of -2.9 ± 3.2 L/min with limits of agreement ranging -9.1 to 3.4 L/min.

The modified Stringer formula was calculated as follows:

Q̇STmod = V̇O2 / [(-0.0019 * (V̇O2max/kg) + 0.1966) * %V̇O2max + (0.1387 * (V̇O2max/kg) + 1.068)].

Here, the mean difference to Q̇RB was 0.3 ± 3.0 L/min with limits of agreement ranging -5.5 to 6.2 L/min.

CONCLUSION: When considering the entire intensity range investigated in this study, which included men with varying fitness levels, the original Stringer formula does not provide a consistently accurate estimate of Q̇. Our modified formula considerably improves accuracy at the population level, however, its wide limits of agreement indicate that it lacks the necessary precision for individual clinical application.

Reference: Stringer, W. W., Hansen, J. E., & Wasserman, K. (1997). Cardiac output estimated noninvasively from oxygen uptake during exercise. J Appl Physiol, 82(3), 908-912.

**SEVERELY REDUCED PEAK VO2 IN YOUNG MALE SURVIVORS OF PROLONGED VENO-VENOUS ECMO AFTER BLAST INJURY MAY BE RELATED TO ABNORMAL MUSCLE OXYGEN EXTRACTION**

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INTRODUCTION: Veno-venous (V-V) Extra-Corporeal Membrane Oxygenation (ECMO) is used as rescue therapy for severe respiratory failure. Little is known about exercise physiology of ECMO survivors. This study assesses the physiological response during cardio-pulmonary exercise tests (CPET), including muscle oxygenation pattern, in young previously healthy men who had survived prolonged ECMO treatment following blast injury.

METHODS: Three male patients (age 21-25 years old) with refractory respiratory failure after blast injury were treated with veno-venous (V-V) ECMO for 6-12 weeks; two eventually received bilateral lung transplant. All had normal echocardiograms (Left ventricular ejection fraction = 60%). At 6–10 months post-ECMO they performed lung function tests (spirometry, volumes by plethysmography and diffusion capacity for carbon monoxide (DLCO)) and graded symptom-limited cardiopulmonary exercise tests (CPET) on a cycle ergometer. Near-infrared spectroscopy (NIRS) was used to measure the change in tissue hemoglobin saturation index (TSI) of the vastus lateralis muscle from rest to peak exercise.

RESULTS: Spirometry and lung volumes were within normal limits. DLCO was ranged from normal to mildly reduced (64-103%predicted). Peak Respiratory exchange ratios (1.2-1.5) indicate minimal cardiovascular reserve. Peak oxygen consumption (VO2) was severely reduced (38-52% predicted). VO2 at the gas exchange threshold (GET) was low (25-31% predicted peak VO2), as was peak VO2:heart-rate (HR) (41-60%predicted) and delta(VO2):delta(work) (6.1-6.8 ml/min/W). VO2:HR plateaued above the GET in all patients may suggest impaired muscle oxygen utilization. Exercise gas exchange was normal and there was no evidence of ventilatory limitation at peak exercise. All patients exhibited an attenuated decline of TSI from rest to peak exercise (8-12% decrease) suggesting impaired muscle oxygen extraction during exercise.

CONCLUSION: This case series study of three young male survivors of prolonged ECMO treatment for severe respiratory failure demonstrates a markedly reduced aerobic exercise capacity 6-10 months post-ECMO, potentially due to impaired muscle oxygenation extraction.

**THE INFLUENCE OF AN EXPERIMENTALLY INCREASED ARTERIAL BLOOD PRESSURE ON LEFT VENTRICULAR FUNCTION DURING EXERCISE**

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INTRODUCTION: Dynamic exercise elevates arterial blood pressure, increasing cardiac load and enhancing global left ventricular (LV) function to maintain cardiac output. Previous research shows that inducing hypertension via forearm post-exercise circulatory occlusion (PECO) reduces LV mechanics at rest. However, how the healthy human heart adapts to elevated blood pressure during dynamic exercise remains unknown.

Purpose: To determine the effect of an acute increase in blood pressure on LV function during dynamic exercise.

METHODS: Blood pressure was elevated (without a concomitant increase in heart rate) by inflating a cuff around the forearm after 2-minutes of 30% maximal isometric handgrip (i.e. PECO). Dynamic exercise (DEX) was performed on a semi-recumbent (30°) stepping device at 30% peak power output. Blood pressure and LV function were assessed using a fi-

nometer and transthoracic echocardiography, respectively, at rest and following a randomised exposure to PECO only, DEX only and DEX with PECO (DEX+PECO).

RESULTS: Systolic blood pressure increased from rest during all three conditions (p<0.001), while HR only increased during DEX (p<0.001) and DEX+PECO (p<0.001), but not PECO (p=0.946). Compared with DEX, DEX+PECO resulted in a statistical increase in systolic blood pressure (delta: 15 ± 8 mmHg, p=0.039), with no difference in heart rate (p=0.509).

Cardiac output increased from rest during DEX (p<0.001) and DEX+PECO (p<0.001), with no difference between the two conditions (p=0.776). Increases in cardiac output were primarily due to the aforementioned increases in heart rate, as stroke volume did not differ between conditions (Rest vs. PECO: p=0.812; Rest vs. DEX: p=0.573; Rest vs. DEX+PECO: p=0.930; DEX vs. DEX+PECO: p=0.488). Ejection fraction was also similar across conditions (Rest vs. PECO: p=0.333; Rest vs. DEX: p=0.964; Rest vs. DEX+PECO: p=0.911; DEX vs. DEX+PECO: p=0.894).

Despite no differences in global LV function between conditions, apical rotation was reduced during DEX+PECO compared with DEX (delta: -3.25 ± 3.86 degrees, p=0.032), alongside a reduction in apical systolic rotational velocity (p=0.043). Coinciding with these reductions in LV mechanics at the apex, a significant elevation in basal radial strain rate was observed in DEX+PECO compared with DEX (delta: 0.25 ± 0.39 1/s, p=0.048).

CONCLUSION: Whilst an elevated blood pressure during dynamic exercise does not influence global LV function, decreased rotational mechanics at the apex were observed. The basal region of the LV appears to compensate for these mechanical reductions in the heathy heart, to preserve stroke volume during an elevation in left ventricular afterload.

**THE MECHANISM OF INDIVIDUAL VARIATIONS IN BLOOD PRESSURE RESPONSE TO HANDGRIP EXERCISE**

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INTRODUCTION: Even among healthy individuals, arterial blood pressure (ABP) responses to exercise vary significantly. Notably, normotensive individuals who exhibit exaggerated ABP responses during exercise may have an increased risk of developing hypertension later in life. However, the mechanisms underlying this variability in blood pressure responses among healthy young individuals remain unclear.

METHODS: Even among healthy individuals, arterial blood pressure (ABP) responses to exercise vary significantly. Notably, normotensive individuals who exhibit exaggerated ABP responses during exercise may have an increased risk of developing hypertension later in life. However, the mechanisms underlying this variability in blood pressure responses among healthy young individuals remain unclear.

METHODS: To investigate these mechanisms, 29 participants performed isometric handgrip exercises at 30% of their maximum voluntary contraction, followed by post-exercise muscle ischemia (PEMI) to evaluate metaboreflex activity. ABP responses were assessed, along with peripheral cardiovascular parameters associated with hypertension, including muscle oxidative capacity ($mVO_2$) and arterial stiffness (carotid-femoral pulse-wave velocity, cfPWV).

RESULTS: Variability in systolic blood pressure (SBP) responses to exercise was not significantly associated with cfPWV ($P = 0.745$, $r = -0.063$) or $mVO_2$ ($P = 0.093$, $r = 0.317$).

CONCLUSION: Previous studies have indicated that exaggerated ABP responses during exercise are associated with higher arterial stiffness and lower muscle oxidative capacity in older adults and patients with hypertension. In contrast, the findings of the present study suggest that the mechanisms underlying individual differences in ABP responses to exercise in healthy young individuals differ from those driving exaggerated ABP responses in older adults and patients with cardiovascular diseases, such as hypertension.

**COMPARING MARKERS OF LEFT ATRIAL REMODELLING IN MALE AND FEMALE ELITE ENDURANCE AND SPRINT CYCLISTS**

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INTRODUCTION: The hearts of elite cyclists undergo regular hemodynamic loading which may result in structural, functional and electrical remodelling1. Divergent patterns of remodelling have been proposed to occur in the left ventricle in response to different types of exercise stimulus2, yet the left atrium (LA), a far thinner walled chamber, has received little scientific attention especially in non-male, non-endurance athletes. Accordingly, the purpose of this study was to compare LA structural, functional and electrical parameters in endurance and sprint cyclists and examine potential sex differences. We hypothesized that 1) endurance cyclists would exhibit the greatest degree of LA remodelling 2) endurance females would have greater LA functional remodelling, and 3) male endurance cyclists would have greater LA electrical remodelling.

METHODS: Using a cross-sectional design we compared electrocardiographic (p wave duration) and absolute and scaled echocardiographic measures (LA volumes, strain and electromechanical delay) between elite endurance and sprint cyclists from the Great Britain cycling team. Using independent t-tests (with Bonferroni correction), we first compared female sprint (n=18, mean ±SD: 21±3yrs) and female endurance (n=41, 22±5yrs) cyclists, and then male sprint (n=33, 22±5yrs) with male endurance (n=45, 21±6yrs) cyclists. We then tested for sex-based differences in both sprint and endurance disciplines.

RESULTS: Both male and female endurance cyclists had larger absolute (mean difference: 11.43, P=0.001; 9.73, P=0.008) and indexed (mean difference: 7.47, P<0.001; 6.92, P=0.001) LA size vs. their sex-matched sprint counterparts. Male endurance cyclists also had larger reservoir volumes (mean difference: 6.24, P=0.011), slower LA systolic and late diastolic strain rates (mean difference: -0.24 & 0.33; both P<0.001) than male sprint cyclists. After performing a sex-based comparison, we found that male endurance cyclists had greater absolute LA size (mean difference: 9.99, P=0.002) and lower LA peak strain (mean difference -3.26, P=0.012) than female endurance cyclists. Lastly, male sprinters had longer atrial activation times than female sprinters (mean difference: 16.6, P=0.005).

CONCLUSION: These data suggest greater LA remodelling in endurance vs. sprint cyclists. Male and female endurance cyclists experience similar structural remodelling when indexed to body size with differing functional adaptations. Further work is needed to understand the mechanisms responsible for the differential adaptation observed, and to explore the physiologic and pathologic significance.

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Adaptation to Endurance and Resistance Exercise Training in Humans. J Physiol.

**SEX DIFFERENCES IN THE MAGNITUDE OF THE HEMODYNAMIC RESPONSES DURING MAXIMAL STATIC APNEA WITH FACE IMMERSION IN NON-DIVERS**

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INTRODUCTION: The simple act of breath holding induces vagally-mediated bradycardia and sympathetically-mediated peripheral vasoconstriction (the so-called dive response) which serve as a protective mechanism against asphyxia. Surprisingly, studies investigating sex differences on the dive response have shown inconsistent findings (1). The purpose of the present study was to examine sex differences in the dive response during maximal static apnea with cold-water face immersion.

METHODS: Ten females (aged 24.8±3.2 yrs) and 10 males (aged 25±5.5 yrs) unaccustomed to apnea and matched for breath hold time (P=0.96) participated in this study. After obtaining body measurements the participants performed five repeated maximal apneas (at 80% of vital capacity) with the face immersed in cold water, separated by two minutes of normal breathing. Apnea duration and the hemodynamic (HD) parameters: heart rate (HR), stroke volume (SV), cardiac output (Q), systolic pressure (SP), diastolic pressure (DP), and mean arterial pressure (MAP) were measured throughout the experimental protocol. Mean HD values in the 90-30s period prior to the first apneic bout was considered as baseline. The mean HD values during the longest apneic bout, excluding the first 30s, was considered as the HD response values to apnea. T-tests for independent samples were performed to detect differences in means with α set at 0.05.

RESULTS: Males showed higher baseline values compared to females in SP, MAP, DP, SV and Q (P<0.05), whereas baseline HR did not differ between sexes. During maximal apnea, males exhibited higher SP, MAP and DP values compared to females (P<0.05). However, apneic HR, SV and Q did not differ between sexes. When comparing the magnitude of change (Δ) in the HD parameters between sexes, larger decreases in SV and Q from baseline were observed in males compared to females (P<.05), whereas the magnitude of change in SP, MAP, DP and HR did not differ between sexes.

CONCLUSION: The present study showed that, in an untrained state, males exhibited higher blood pressure and larger decrease in SV and Q than females during maximal apnea of the same duration. These differences could be attributed to the lower vasoconstriction capacity of females (2).

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**FEEDBACK FROM GROUP III AND IV SKELETAL MUSCLE AFFERENTS SLOWS HEART RATE ACCELERATION DURING THE TRANSITION FROM REST TO LOW-INTENSITY EXERCISE**

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INTRODUCTION: The maximal rate of heart rate (HR) increase (rHRI), a marker of HR acceleration during the transition from rest to standardised light exercise is linearly related to changes in exercise performance during differing states of training and fatigue (1,2,3,4). It has been hypothesised that rHRI might be linearly related to changes in exercise performance due to feedback from group III/IV skeletal muscle afferents (1). This study evaluated whether feedback from group III/IV skeletal muscle afferents modulates rHRI.

METHODS: Using a randomised, counter-balanced, cross-over design HR data from eight male recreationally active participants (24 ± 1 years) were collected as R-R intervals during the transition from rest to three minutes of leg cycling at 100

W. Data were collected under control (CON) conditions and following lumbar intrathecal fentanyl (FENT) to impair feedback from group III/IV skeletal muscle afferents of the leg. rHRI was determined as the first-derivative maximum of a logistic curve fit of the HR data.

RESULTS: Pre-exercise HR was not different between CON and FENT (CON 91.7 ± 16.7 bpm, FENT 99.8 ± 15.5 bpm, p=0.25). HR increased more with exercise during CON compared with FENT (B = 12.2, 95%CI 6.5 to 17.9, p<0.001) but rHRI was faster during FENT compared with CON (B = 1.52, 95% CI = 0.24 to 2.80, p=0.02).

CONCLUSION: Feedback from group III/IV skeletal muscle afferents increase HR during standardised light exercise but inhibit rHRI at the onset of exercise.

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## Conventional Print Poster Presentations

### CP-PN15 Omics

**ACE2 EXPRESSION AND RENIN-ANGIOTENSIN SYSTEM ADAPTATIONS IN SKELETAL MUSCLE FOLLOWING SPRINT INTERVAL TRAINING WITH AND WITHOUT POST-SPRINT ISCHAEMIA**

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INTRODUCTION: Angiotensin-converting enzyme 2 (ACE2) regulates the renin-angiotensin system (RAS) by converting angiotensin II into angiotensin (1-7), with vasodilatory, antioxidative, and anti-inflammatory effects. In skeletal muscle, ACE2 is necessary for adaptation to exercise. TMPRSS2 cleaves ACE2, affecting shedding, and viral entry in SARS-CoV-2 infection, being involved in muscle post-viral disorders, oxidative stress (OS), and inflammation. Animal models suggest exercise benefits RAS balance, but human data are lacking. Given the role of OS in ACE2 and TMPRSS2 regulation, we investigated whether Sprint Interval Training (SIT) either alone or combined with post-exercise ischaemia—an intervention transiently elevating OS upon reperfusion—drives molecular adaptations in RAS components in human skeletal muscle. We hypothesised that brief ischaemia during SIT recovery would boost ACE2 and TMPRSS2 expression levels through OS-related mechanisms.

METHODS: Ten volunteers (7M/3W) completed a SIT program (4-6 × 30s sprints, 4min rest) in six sessions over two weeks. After each sprint, occlusion (300mmHg, 30-50s) was applied to one leg, followed by rest. PRE and POST training, participants did an incremental exercise to exhaustion (IE), a 90min rest, and six supramaximal exercise bouts (SPE, 120%$VO_2$max) with 20s bilateral ischaemia applied between bouts. V. lateralis biopsies were taken at baseline (BS), 90min post-IE, and immediately post-SPE unilaterally at PRE and bilaterally at POST (SIT-IS vs. SIT-CT leg) for WB analysis. Stats: ANOVA, t-test, Pearson's correlation.

RESULTS: Basal ACE2 and TMPRSS2 increased by ~145% with SIT-IS but did not change with SIT-CT (p<.05). Basal ACE1 rose by 66% with SIT-IS and dropped 24% with SIT-CT (p<.001). AT2R levels decreased by 19% with SIT-IS (all timepoints). Acute high-intensity exercise increased ACE2 (61%) and TMPRSS2 (88%) after IE, but not further with SPE (p>.05 vs. BS). SIT-IS blunted these effects, unlike SIT-CT (p<.05). ACE1 increased acutely only after SIT-CT (53%) and similarly after IE and SPE (p<.05), with no AT2R changes. ACE2 and TMPRSS2 correlated across conditions (R=.74) and with pS359 p47 NOX2 (R= .59/.72), Nrf2/Keap1 (R=.74/.73), and Catalase (R=.73/.57), all p<.001. ACE1 correlated with ACE2 (R=.39, p<.001) and TMPRSS2 (R=.21, p=.04). AT2R negatively correlated with ACE2 (R=-.28, p=.008).

CONCLUSION: While SIT alone did not upregulate ACE2 or TMPRSS2 in skeletal muscle, SIT combined with post-exercise ischaemia-reperfusion potentiated their expression, likely via an OS-related mechanism, as indicated by Nrf2/Keap1 activation. The blunted post-exercise increases in ACE2 and TMPRSS2 after training with post-exercise ischaemia suggest increased antioxidant capacity after training with ischaemia. The associations between ACE2, TMPRSS2, and OS signalling support this interpretation.

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**INFLUENCE OF ACTN-3 C.1729C>T (RS1815739) POLYMORPHISM ON MATCH-PLAY MAXIMAL RUNNING SPEED IN ELITE FOOTBALL PLAYERS: A PRELIMINARY REPORT.**

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INTRODUCTION: A frequent genetic variant in the alpha actinin-3 gene (ACTN-3, c.1729C>T (rs1815739)) has been linked to the progression of soccer career [2], the prevalence and severity of muscle injuries [3], and elite athletic performance [1]. While the TT genotype appears to have a detrimental impact on football career advancement and the likelihood of developing muscle injuries, the C allele and the CC genotype of the ACTN-3 polymorphism appear to favour the capacity to produce strong and forceful muscle contractions, which are necessary during sprinting performance. A crucial component of contemporary football is high-intensity running, which can distinguish between players at the highest level of competition and those at a lower level [4]. We hypothesized that football players harbouring the C allele would have a higher maximal running speed (MRS) during matches than those footballers with the TT genotype.

METHODS: MRS was collected, using a Global Position System (GPS) at high sampling frequencies (50 Hz), from 45 elite football players of a same professional football team during 26 official matches for a total of 707 matches observations. Genomic DNA was extracted using a buccal swab, and the ACTN-3 genotype was performed using a RFLP PCR method.

RESULTS: The main finding was that CC players showed significantly higher MRS than TT players (CC=33.1±1.3 km•h-1 vs TT=31.5±1.9 km•h-1, p=0.041). Moreover, the players harbouring a copy of the C allele showed a trend toward higher MRS than players carriers of the TT genotype (CC+CT= 32.9±1.5 km•h-1 vs TT=31.5±1.9 km•h-1, p=0.06). The MRS (36.4 km•h-1) was registered for a player carrier of CC genotype, while the lower running speed (29.8 km•h-1) was reordered for a player carrier of TT genotype.

CONCLUSION: For the first time, we discovered an association between elite football players match-play maximal sprinting speed and the ACTN-3 polymorphism. If our findings will be confirmed in more extensive studies, they may be applied in the future to modify training regimens in order to improve football performance.

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**THE AGTR2 RS11091046 (A>C) POLYMORPHISM AND CLIMBING LEVEL IN POLISH SPORT CLIMBERS.**

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INTRODUCTION: The associations between the AGTR2 genotypes and athletic performance have been proven in various sports disciplines. However, there is a lack of studies investigating the AGTR2 rs11091046 polymorphism in sport climbers. This study aimed to examine whether the rs11091046 polymorphism in the AGTR2 gene is associated with athletic climbing status in sport climbers from Poland.

METHODS: AGTR2 genotypes of 142 sport climbers (55 female, 87 male athletes) were compared with 89 sedentary controls. Genotyping was performed using TaqMan SNP genotyping assays on Thermo Fisher Scientific (Waltham, MA, USA). Deviation of genotype frequencies in sport climbers and controls from Hardy-Weinberg equilibrium (HWE) was assessed using a Chi-squared test with Yates's correction. For a 95% confidence interval (CI), we assumed p=0.05 and $\chi 2=3.84$; therefore, if the $\chi 2 \leq 3.84$ and the corresponding $p \geq 0.05$, the population is in HWE. Both male and female athletes were classified into four groups: "Higher elite", "Elite", "Advanced", and "Intermediate" based on the self-reported most difficult route ever climbed converted to the International Rock Climbing Research Association (IRCRA) Reporting Scale (IRS) based on IRCRA standards for the International Rock Climbing Association.

RESULTS: Mean IRCRA scores were 19.48 (SD = 3.92) for individuals with the AA genotype, 19.66 (SD = 3.58) for AC, and 17.07 (SD = 3.41) for CC. The chi-square test showed a significant relationship between the AGTR2 genotype and the IRCRA level in the group of male sport climbers ($X^2 = 14.85$, df = 6, p = 0.02) in comparison to female climbers (p=0.96). Most male climbers with AA and AC genotypes were in the "Advanced" category, while in the CC group, most athletes were in the "Intermediate" category. Notably, no results were recorded among athletes with the CC genotype in the "Elite" and "Higher Elite" categories.

CONCLUSION: The results suggest that the impact of the AGTR2 (rs11091046) polymorphism on IRCRA results may be gender dependent. The male sport climbers with the CC genotype obtain lower IRCRA scores than athletes with the AC genotype, which may indicate the potential impact of this polymorphism on the climbing status. The AGTR2 gene is located on the X chromosome, which may explain the difference in results - in men, the effect of a single allele may be more pronounced than in women, in whom a second copy of the gene may compensate for the possible negative impact of the risk allele. Future studies should include a larger sample size of women to determine further whether the effect of this polymorphism on the IRCRA score is indeed specific to men.

**TRANSCRIPTOMIC ANALYSIS OF RAT SKELETAL MUSCLE AFTER ELECTRICAL STIMULATION WITH DIFFERENT FREQUENCIES**

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INTRODUCTION: Comprehensive RNA expression levels (transcriptome) can be measured using RNA sequencing (RNA-seq). It is reported that skeletal muscle transcriptome using RNA-seq after exercise differed between resistance and endurance exercises. However, the effects of differences in frequency, which determines the muscle tension of electrical stimulation (ES)-induced contraction, on transcriptome have not been elucidated. Therefore, this study aimed to examine transcriptome after different muscle contractions with 1, 10, 20, 60, and 100 Hz ES.

METHODS: Under isoflurane anesthesia, ES-induced muscle contractions as a resistance exercise model (5 sets × 10 times of 3 s of 0, 1, 10, 20, 60, 100 Hz ES) were applied to the right tibialis anterior (TA) muscle of Wistar male rats (n=3) using surface electrodes. At 3 hours after the muscle contractions, TA muscle was harvested and total RNA was extracted for RNA-seq. Differentially expressed genes (DEGs) were identified with a fold-change (FC) >2 or <0.5 to 0Hz-muscle contraction samples and false discovery rate <.05 (one-way analysis of variance). Gene ontology analysis and transcription factor estimation were performed for distinctive gene groups using Metascape and Landscape In Silico deletion Analysis (LISA), respectively.

RESULTS: Maximum muscle tensions (relative to 100Hz) with 1, 10, 20, and 60 Hz ES were 29.7±0.91%, 29.1±1.44%, 68.6±6.91% and 89.3±2.95%, respectively. There were 229 and 43 upregulated DEGs (UP_DEGs) and downregulated DEGs (DOWN_DEGs), respectively. In UP_DEGs, we identified Hz-specific upregulated genes whose expression increased in a low-frequency (1 and 10 Hz) specific manner and Hz-dependent upregulated genes whose expression increased in a Hz-dependent manner. Genes related to "skeletal muscle cell differentiation" and "response to mechanical stimulus" were significantly enriched only for Hz-dependent genes. We calculated peak50, which was the Hz to reach 50% of the peak of FC, as an index of the Hz sensitivity. According to the distribution of Peak50, we classified the Hz-dependent genes into two groups (high-sensitivity group: Peak50 < 35 Hz, low-sensitivity group: Peak50 ≧ 35Hz). For only the low-sensitive genes that need higher Hz ES to increase their expression level, genes related to "skeletal muscle cell differentiation" were enriched. Estimated transcription factors were different between low- and high-sensitive gene groups.

CONCLUSION: Low Hz-specific genes and Hz-dependent genes were identified in UP_DEGs. Also, low- and high-sensitive genes existed in the Hz-dependent gene group. Genes related to resistance training adaptation were especially enriched for low-sensitive genes, which need higher Hz ES to increase their expression levels. Estimated transcription factors were also different between low- and high-sensitive gene groups. These results suggest that different muscle contraction-induced selective muscle adaptation is mediated by genes and transcription factors in response to different frequencies.

**CHARACTERISING MARATHON-INDUCED METABOLIC PERTURBATIONS AND SUBSEQUENT RECOVERY THEREOF USING UNTARGETED 1H-NMR METABOLOMICS**

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INTRODUCTION: Although physical activity is a health-promoting, popular global pastime, regular participation in extreme endurance events results in numerous adverse metabolic, immunologic and physiological perturbations, that may diminish athletic performance and adversely affect the overall health status of an athlete, especially in the absence of sufficient recovery. A comprehensive understanding of the metabolic changes occurring during and following extreme endurance events can inform the development of improved training and recovery strategies.

METHODS: This investigation employed an untargeted proton nuclear magnetic resonance ($^1$H-NMR) metabolomics approach to characterise the changing serum metabolite profiles of 15 athletes at 4 time points (pre-, immediately post-, 24 h post-, and 48 h post-marathon), to better understand the impact of a marathon on the metabolome and the physiology of an athlete.

RESULTS: The results show 26 metabolites to significantly fluctuate, indicating dramatic changes to ATP and glycogen use and synthesis, fat catabolism, aerobic and anaerobic glycolysis, ketogenesis, amino acid catabolism (in particular the BCAAs) and the TCA cycle, in response to the high energy demands of a marathon. Metabolites associated with muscle and kidney damage, changes to the gut microbiota and the impact of energy drink consumption were also observed, in addition to metabolite markers associated with delayed-onset muscle soreness during the recovery period. Although a complete recovery of those metabolites associated with the energy-producing pathways and fuel substrate stores occurred within a 48-hour recovery period, several other metabolites remained perturbed beyond this period (phenylalanine, tyrosine, BCAAs and proline), indicating incomplete recovery of other physiological processes.

CONCLUSION: This study provides a comprehensive description of the marathon-induced metabolic changes and post marathon recovery and additionally suggests pre- and post-marathon nutrition and supplementation strategies (involving fats/ketones, the type of carbohydrate, phenylalanine, tyrosine, BCAAs and proline) for improving the health and performance of athletes who participate in such extreme endurance events. Furthermore, the "late-stage recovery" metabolite markers identified may also later be investigated for personalized monitoring of athletic health/recovery/performance.

**ASSOCIATION OF METABOLOMIC PROFILES AND MIR-126 IN RESPONSE TO ENDURANCE TRAINING IN HYPERTENSIVE POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Endurance training (ET) effectively promotes reductions in blood pressure (BP) levels. However, the factors and molecular mechanisms of reduced BP remain unknown, and investigating them can help design more efficient training strategies. We investigated the association of baseline circulating miRNAs, serum metabolomic profiles, and metabolic pathways with BP changes after 12 weeks of ET.

METHODS: Thirty-six hypertensive postmenopausal women (57.7 ± 6.4 years old) were randomly allocated into the ET (n=16, cycling at moderate intensity 3 times a week) and control - CO (n=6, non-exercise) groups. BP and blood samples were collected at baseline and 12 weeks post-intervention. Samples were analysed: by Proton Nuclear Magnetic Resonance spectroscopy-based metabolomics and, miRNA was analysed by RT-qPCR. We checked the normality and homoscedasticity of the data. T-test was performed on the samples characteristic variables and a Pearson correlation test was carried out between the metabolites, the Mir-126 and the Δ Systolic BP (ΔSBP) and Δ Diastolic BP (ΔDBP). Finally, a pathway enrichment analysis along with the variables correlated with ΔSBP and ΔDBP was realized.

RESULTS: No significant differences were found in the variables characterising the sample. Of the 58 metabolites acquired, 5 were associated with ΔSBP: acetate, glycolate, proline, threonine and xanthine ($0,43 < r < 0,64$; $p < 0,02$). And 8 metabolites were associated with ΔSBP: 2-hydroxyisovalerate, ascorbate, citrate, histidine, inosine, lysine, methanol, myo-inositol ($-0,45 > r > -0,67$; $p < 0,03$). The most enriched pathways for ΔSPB were: glyoxylate and dicarboxylate metabolism, glycolysis and gluconeogenesis and pyruvate metabolism, and for ΔDBP was: methylhistidine and biotin metabolism. The mir-126 was not correlated with ΔSBP and ΔDBP.

CONCLUSION: These results suggest the changes in DBP were associated with pathways and metabolites related to nitric oxide, while the changes in SBP were associated with the regulation of oxidative metabolism. Investigation that targets these metabolic pathways, may improve the specific exercise load control (intensity, duration, and frequency) to reduce blood pressure.

**TRANSCRIPTOMIC RESPONSES TO NINE DAYS OF HEAT ACCLIMATION IN EQUINE SKELETAL MUSCLE**

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INTRODUCTION: Due to their size, horses have a relatively low body surface area to weight ratio and lose heat generated during exercise more slowly than other mammals, resulting in a marked increase in body temperature and a reduction in exercise performance in the heat. Daily heat exposure induces beneficial physiological adaptations, but the effects of heat acclimation on the skeletal muscle transcritome remain unclear. Therefore, the aim of this study was to investigate the time course of transcriptomic responses in equine skeletal muscle following repeated exercise sessions in a hot environment.

METHODS: Three trained Thoroughbred horses were assigned to 9 consecutive days of heat acclimation involving daily interval exercise in hot conditions (Wet Bulb Globe Temperature [WBGT] 29.5°C). The training protocol consisted of alternating high- (100% VO2max) or moderate- (70% VO2max) intensity interval training (3 x 1 min, 2 min recovery) each day. Muscle samples were obtained from the middle gluteal muscle before and 4 hours after the 1st and 9th exercise bout. Differential gene expression was identified using DESeq2 (false discovery rate cutoff: 0.05, minimal fold change: 1.5).

RESULTS: The peak plasma lactate concentration during exercise was lower in the 9th exercise bout compared with the 1st exercise bout. RNA-seq identified 365 and 60 genes that were differentially expressed in response to the exercise in the 1st and 9th bouts, respectively. Of these genes, 49 genes, including well-known exercise responsive genes such as PPARGC1A and NR4A3, were altered in both the 1st and 9th exercise bouts. Gene set enrichment analyses, based on Gene Ontology biological process terms, showed that genes associated with the response to extracellular stimulus and nutrient levels were upregulated after both exercise bouts; genes related to protein folding were upregulated following the 1st exercise bout, whereas genes associated with gluconeogenesis were highly expressed following the 9th exercise bout.

CONCLUSION: Our results suggest that nine days of heat acclimation attenuated exercise-induced transient transcriptomic responses in equine skeletal muscle. This attenuation may be due to the changes of gene expressions at the basal level. These findings uncover the temporal sequence of molecular mechanisms underlying heat acclimation.

**FUNCTIONAL FITNESS, COGNITION, URINARY METABOLOME, AND GUT MICROBIOTA IN COMMUNITY-DWELLING ELDERLY WITH CHRONIC DISEASES IN TAIWAN**

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INTRODUCTION: Taiwan's aging population faces a high socioeconomic burden due to chronic diseases like hypertension and dementia, which impact body composition, cognition, life satisfaction, metabolism, and gut microbiota. This study explores strategies to improve health outcomes for older adults with different chronic conditions.

METHODS: A total of 129 elderly participants were included: 16 with dementia, 27 with early cognitive impairment, 28 with hypertension, and 58 healthy controls. Participants provided medical history, demographics, and anthropometric data and completed fitness, cognitive, depression, and quality-of-life assessments. Cognitive function was evaluated using the 10-item Short Portable Mental Status Questionnaire (SPMSQ), depression with the 15-item Geriatric Depression Scale (GDS-15), and quality of life with a QoL questionnaire. Urinary metabolomics and oxidative stress markers (8-OHdG, 8-isoprostanes, and AD7c-NTP) were analyzed to identify dementia biomarkers. Stool samples were collected for DNA extraction and gut microbiota analysis via next-generation sequencing (NGS).

RESULTS: Dementia patients had significantly lower physical fitness than other groups ($p < .05$), except in aerobic endurance ($p > .05$). Hypertensive individuals had weaker lower extremity strength than healthy controls ($p < .05$). Dementia patients scored lower on SPMSQ and higher on depression scales ($p < .05$). Although QoL scores did not differ significantly ($p > .05$), healthier individuals had higher scores. Dementia patients showed significantly elevated urinary 8-OHdG and AD7c-NTP, while 8-isoprostanes increased in all chronic disease groups. Five urinary metabolites increased, while 14 decreased in dementia patients. Gut microbiota analysis showed distinct differences, with healthy individuals exhibiting higher abundances of Prevotella, Odoribacter, and Muribaculaceae, while early cognitive impairment patients had increased Alistipes, Akkermansia, and Escherichia-Shigella. α- and β-diversity analyses confirmed gut microbiota alterations in early dementia.

CONCLUSION: Dementia patients exhibited the most severe declines in physical fitness and depression. The study identified dementia-related metabolic changes, oxidative stress, and gut microbiota dysbiosis, suggesting these factors as potential biomarkers for early dementia assessment.

## Conventional Print Poster Presentations

### CP-PN16 Muscle and Bone

**TITIN'S ROLE IN RESIDUAL FORCE ENHANCEMENT: STRUCTURAL INSIGHTS FROM SMALL-ANGLE X-RAY DIFFRACTION**

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INTRODUCTION: Titin connects the myofilaments in skeletal muscle and plays a pivotal role in modulating passive and active muscle tension. Residual force enhancement (RFE) describes the phenomenon where force remains elevated following an active stretch compared to a purely isometric contraction at the same final length. Despite its relevance to near-instantaneous muscle force control, the structural underpinnings of RFE remain elusive. This study investigates the contribution of titin to RFE by using 2 genetically modified mouse models: the titin cleavage (TC) and the muscular dystrophy with myositis (mdm) mouse lines,. Small-angle X-ray diffraction was used to elucidate structural changes underlying titins mechanical role during muscle contractions.

METHODS: Fast-twitch, skinned skeletal muscle fibers were isolated from TC (heterozygous) and mdm (wild type and homozygous) mice. In TC mice, a splice site was engineered into the I-band region of titin, enabling rapid and specific cleavage, thereby reducing titin-based force and stiffness. In mdm mice, a small deletion in the I-band of titin nearly ablates RFE. Mechanical properties and sarcomeric structures were assessed during: (1) isometric contractions at short sarcomere lengths (IsoShort), (2) isometric contractions at long sarcomere lengths (IsoLong), and (3) after active lengthen-hold from IsoShort to IsoLong (IsoRFE). X-ray diffraction captured the sarcomeric structural signature in each condition. Stats - full-factorial ANOVA design with individual random effect. Box-Cox transformation ensured normality and variance homogeneity.

RESULTS: Cleaving 50% of I-band titin in TC fibers significantly reduced RFE from 30.69 ± 3.35% to 17.44 ± 2.24% of the reference force (IsoLong; $P < 0.01$). Structural analyses revealed that IsoRFE contractions exhibited increased thick filament strain and reduced lattice spacing compared to IsoLong ($P < 0.01$). Notably, these RFE-specific structural changes were absent in mdm fibers but were prominent in wild-type controls ($P < 0.01$). We estimate that titin-mediated reductions in lattice spacing and thick filament elongation account for approximately 40-70% of RFE. The remaining 30-60% is likely attributable to an activation-dependent, 2-3-fold increase in titin stiffness preceding eccentric stretch, which relatively increases titin-based forces during and after the stretch, compared to a passive stretch-hold.

CONCLUSION: These results underscore titin's integral role in modulating sarcomeric tension and its essential contribution to RFE. The structural signatures associated with RFE—decreased lattice spacing and increased thick filament strain—are directly influenced by titin-based forces. The absence of the mechanical and structural signatures of RFE in mdm mutants highlights the necessity of I-band titin for proper RFE. Our data suggest that RFE involves both structural adjustments and an activation-dependent modulation of titin stiffness, though the precise molecular imechanisms remain to be elucidated.

**MYOFIBRILLAR ATPASE EFFICIENCY OF SKELETAL MUSCLE FIBERS FROM YOUNG AND OLDER ADULTS**

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INTRODUCTION: Age-related declines in skeletal muscle mass and function lead to impairments in mobility and decreased quality of life in older adults. At the single muscle fiber level, many studies show preserved function of slow myosin heavy chain (MyHC) I fibers but decrements in size and contractile function of fast MyHC II fibers(1). Studies of fast fibers from old rats suggest impairments in myofibrillar ATPase efficiency with age(2,3), however it is unknown if these impairments also occur in aging human skeletal muscle.

METHODS: Muscle biopsies were obtained from the vastus lateralis of 6 young (4F; 26.5±4.8 yrs) and 5 older (3F; 71.1±6.1 yrs) adults to assess single fiber myofibrillar ATPase activity via a micro epifluorescence system that measures NADH fluorescence during ATP hydrolysis. Activity was measured in relaxing conditions (basal ATPase) and in saturating Ca2+ activating conditions (pCa 4.5) during isometric contractions of chemically permeabilized single muscle fibers. Simultaneous measures of force and NADH fluorescence were made at 20°C, and the MyHC isoform for each fiber determined by 5% SDS-PAGE.

RESULTS: A total of 63 (33 old) MyHC I and 82 (44 old) MyHC II fibers were tested. Basal ATPase activity in relaxing solution was higher in young compared with older adults in both MyHC I (754±115 vs 583±87nM NADH/s; p=0.004) and MyHC II fibers (733±129 vs 606±131nM NADH/s; p=0.005); however, there were no differences when the basal ATPase activity was normalized to fiber size for either the MyHC I (0.15±0.07 vs 0.12±0.04nM NADH/s/µm2; p=0.638) or MyHC II fibers (0.13±0.08 vs 0.18±0.14nM NADH/s/µm2; p=0.852). Maximal Ca2+ ATPase activity was greater in young compared with older adults in both MyHC I (1,320±410 vs 910±227nM NADH/s; p=0.010) and MyHC II (3,628±1,022 vs 2,408±923nM NADH/s; p=0.031) fibers. When normalized to absolute and size-specific force, ATPase activity of MyHC I fibers was higher in young compared to older adults (2,173±824 vs 1,631±510nM NADH/s/mN; p=0.035 and 11.4±3.9 vs 8.2±2.6nM NADH/s/kN/m2; p=0.044), suggesting a greater myofibrillar ATPase efficiency with aging. In contrast, there were no differences in the MyHC II fibers when normalized to absolute (4,322±2,516 vs 3,919±1,431nM NADH/s/mN; p=0.428) or size-specific force (23.9±7.3 vs 16.8±7.2nM NADH/s/kN/m2; p=0.254).

CONCLUSION: These preliminary results suggest that during isometric contractions, older adults have more efficient MyHC I skeletal muscle fibers but that contractile efficiency of MyHC II fibers is unaltered by aging. The more efficient MyHC I fibers may explain, in part, the fatigue resistance and improved metabolic economy found in older adults during voluntary isometric contractions(4).

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**SPONTANEOUS LOCOMOTIVE ACTIVITY INDUCES SOLEUS MUSCLE HYPERTROPHY AND REDUCES ANXIETY-LIKE BEHAVIOR IN AN ENVIRONMENTAL ENRICHMENT**

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INTRODUCTION: Environmental enrichment (EE) enhances brain function through neuroprotection and neuroplasticity. Our previous study demonstrated that EE induces soleus muscle hypertrophy and increases spontaneous physical activity (Sudo et al., 2023). However, the relationship between soleus muscle hypertrophy, locomotive behavior, and anxiety-like behavior under EE conditions remains unclear. This study aimed to clarify the relationship between soleus muscle hypertrophy and EE exposure under multiple conditions.

METHODS: Wistar rats were divided into four groups: EE (wheel + objects), EE-R (wheel only), EE-O (objects only), and CONT (standard environment) (N=6 per group). Physical activity (PA) was continuously recorded via a three-axis accelerometer. Wheel running duration was measured during the 12-hour dark phase in the final week. After four weeks, spatial memory was assessed using the Morris Water Maze (MWM) test, and anxiety-like behavior was evaluated using the Elevated Plus Maze (EPM) test. Soleus and plantaris muscle cross-sectional area (CSA) was measured from hematoxylin-eosin (HE) stained sections to assess muscle hypertrophy.

RESULTS: Total PA was higher in EE and EE-R than in CONT ($P<0.001$), with no difference between EE and EE-R ($P=0.63$). Wheel running duration was longer in EE (56.3 ± 14.7 min) than in EE-R (37.2 ± 9.4 min, $P=0.03$). The EPM test showed a higher open-to-closed arm time ratio (O/C ratio) in EE (203.5 ± 27.2), EE-R (98.1 ± 25.7), and EE-O (78.8 ± 33.7) than in CONT (11.4 ± 7.6, $P<0.01$). Soleus muscle CSA increased in all EE groups (EE: 2889 ± 162, EE-R: 2575 ± 81, EE-O: 2572 ± 132 µm², $P<0.01$ vs. CONT: 2184 ± 203 µm²). Soleus muscle CSA was also greater in EE than in EE-R ($P=0.01$). In contrast, plantaris muscle CSA did not differ among groups (EE: 2973 ± 297, EE-R: 2898 ± 514, EE-O: 2695 ± 397, CONT: 2590 ± 399 µm²). Furthermore, soleus muscle CSA correlated positively with PA ($r^2=0.38$, $P=0.002$) and the O/C ratio in EPM ($r^2=0.65$, $P<0.001$). In EE and EE-R, soleus muscle CSA also correlated positively with wheel running duration ($r^2=0.48$, $P=0.01$), whereas plantaris muscle CSA showed no correlations.

CONCLUSION: This study revealed that soleus muscle hypertrophy and reduction in anxiety-like behavior are associated with environmental enrichment. Soleus hypertrophy was observed in EE, EE-R, and EE-O groups, with the greatest increase in EE. Since wheel running duration was lower in EE-R than in EE, soleus muscle hypertrophy may be associated with both locomotive activity involving object interaction and spontaneous wheel running in an enriched environment. Furthermore, soleus muscle hypertrophy, in concert with spontaneous intermittent physical activity, may contribute to reductions in anxiety-like behavior.

Reference: Sudo M., Kano Y., Ando S. The effects of environmental enrichment on voluntary physical activity and muscle mass gain in growing rats. Front. Physiol. 14, 2023.

**MONITORING THE MUSCLE OXYGENATION PROFILES DURING A FOREARM CRITICAL FORCE TEST: A TIME-DOMAIN NEAR-INFRARED SPECTROSCOPY PILOT STUDY**

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INTRODUCTION: A key feature of the critical force (CF) concept is its ability to integrate both mechanical and metabolic response profiles (3). However, the determination of whether CF from one all-out test (1) represents a boundary between localized steady and non-steady metabolic conditions remains to be elucidated. It is hypothesised that the muscle O2 delivery-to-O2 utilisation ratio may drive CF, and that critical muscle oxygenation (SmO2 steady-state) may be a relevant physiological measure (2). The present study seeks to explore whether critical oxygenation aligns with CF during a 4-minute all-out forearm handgrip exercise. It is acknowledged that physiological alterations can influence the accuracy of near infrared spectroscopy (NIRS) data (differential pathlength factor, superficial and deep layers) during high-intensity muscle contractions. To mitigate these limitations and provide more accurate assessment of muscle oxygenation, we employed a time-domain (TD) NIRS oximeter, which minimizes confounding signals from superficial tissues and provides absolute oximetry and DPF measurements.

METHODS: A total of 17 young healthy adults (13 males and 4 females, with a mean age of 28.3 ± 9.6 years, a height of 179.0 ± 11.5 cm, and a mass of 72.8 ± 11.1 kg) participated in the study. A 4-min all-out handgrip test in a seated position was conducted at a work:relief ratio of 7:3 s with the dominant hand and upper limbs flexed at 90° elbow flexion (1). During the work phase, participants were instructed to produce as much force as possible. Muscle-O2 dynamics during all tests were assessed using a TD NIRS device (NIRSBOX, PIONIRS SRL, Italy) equipped with two picosecond laser diodes (686 nm and 830 nm), and a single-photon detector to record the distribution of the time-on-flight for the photons re-emitted from the tissue. The sensor was placed over the belly of the flexor digitorum profundus of the dominant hand. NIRS (2 Hz), force (500 Hz) signals, and automated audio instructions were synchronized using a dedicated software platform. CF and critical oxygenation were analysed as proposed (1,2).

RESULTS: Data from 16 participants were usable. CF, determined from the mean force of the last three contractions, was measured to be 73.4 ± 14.0 kg. The results show a significant correlation between CF and HHb ($r = 0.55$, $t(14) = 2.48$, $p = 0.026$, slope of 0.80), but not with SmO2 ($r = 0.34$, $t(14) = -1.35$; $p = 0.200$, slope - 0.12).

CONCLUSION: CF is considered to be the highest metabolic rate that can be achieved by oxidative means. When assessing critical oxygenation, the steady-state level of SmO2 may not be the most appropriate variable to consider. HHb can be a good candidate in tracking CF among the various physiological metrics available from TD NIRS.

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**MINIMAL NUMBER OF MAXIMAL ECCENTRIC CONTRACTIONS TO INCREASE MUSCLE STRENGTH AND THICKNESS IN TWO SESSIONS PER WEEK FOR 4 WEEKS**

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INTRODUCTION: Intensity, volume, frequency and muscle contraction type are important variables in resistance exercise training. We showed that one 3-s maximal eccentric contraction performed 5 days a week (Monday–Friday) for 4 weeks (total exercise time: 60 s) increased maximal voluntary eccentric (MVC-ECC), isometric (MVC-ISO), and concentric contraction (MVC-CON) torque of the elbow flexors by more than 10%, but this was not induced by maximal isometric or concentric contraction in the same format [1]. We also reported that six 3-s maximal eccentric contractions a session performed 5 days a week for 4 weeks increased muscle strength in the same magnitude to that of the one contraction, but no significant increase in the strength was induced when 30 3-s maximal eccentric contractions were performed once a week [2]. Furthermore, when comparing the one 3-s eccentric contraction training between two and three days a week for 4 weeks, no significant increase in muscle strength were evident for the two days per week condition, but small (3%) increases were found for the three days per week condition [3]. The present study investigated whether muscle strength would be increased greater when the number of the eccentric contractions per session was increased to five or 15 than one in the twice-weekly training format.

METHODS: Healthy young adults were placed to two groups (n=12/group) based on the number of 3-s maximal eccentric contractions of the elbow flexors in a session performed two sessions a week for 4 weeks; 5×2 (1 set of 5 contractions, x2 indicates 2 sessions/week) or 15×2 (3 sets of 5 contractions). Changes in MVC-ECC, MVC-ISO and MVC-CON torque of the elbow flexors, and biceps brachii and brachialis muscle thickness (MT) before and after the 4-week training were compared between groups. The changes were also compared to the 1×2 (one contraction/session, 2 sessions/week) and 1×5 (one contraction/session, 5 sessions/week) groups in the previous studies [1, 3].

RESULTS: MVC-ECC (8.6±9.2%, 8.3±5.7%), MVC-ISO (7.5±10.4%, 7.0±5.8%), and MVC-CON (5.0±5.9%, 9.6±6.6%) torque increased ($p \leq 0.05$) similarly for the 5×2 and 15×2 groups. However, these changes were smaller ($p \leq 0.05$) than those of the 1x5 group (>10%). MT also increased ($p \leq 0.05$) similarly for the 5×2 (5.4±4.4%) and 15×2 (8.1±6.2%) groups. No significant changes in MVC torque and MT were evident for the 1×2 group.

CONCLUSION: These results suggest that muscle strength and size increased when the volume was increased to 5 contractions, but increasing the volume to 15 did not further increase them. It appears that the number of maximal eccentric contractions and volume are less important than the frequency for maximal eccentric contraction training, but it becomes effective by increasing the number of contractions from one to 5.

**NEW PERSPECTIVES ON SKELETAL NERVE INFLUENCE IN BONE METABOLISM: INVESTIGATING THE RESTORATIVE EFFECTS OF COMBINED AEROBIC AND RESISTANCE EXERCISE IN OVARIECTOMY-INDUCED OSTEOPOROTIC RATS**

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INTRODUCTION: Postmenopausal osteoporosis is characterized by significant bone loss and an increased risk of fractures. Multimodal exercise training is often recommended to mitigate the effects of menopause-related bone deterioration. While exercise has well-documented benefits on skeletal health, recent research highlights its influence on skeletal nerves, with aerobic training shown to enhance periosteal nerve fiber density. However, the effects of combined exercise on skeletal nerves and subsequent bone volume changes remain unexplored. This study aimed to evaluate whether an eight-week combined exercise regimen could restore trabecular bone metabolism and skeletal nerve density in the tibia following ovariectomy (OVX) in rats.

METHODS: Twenty-eight female Fisher-344 rats were randomly assigned to one of four groups (n=7 per group): (a) Sham non-exercise (SN), (b) Sham combined exercise (SE), (c) Ovariectomy non-exercise (ON), or (d) Ovariectomy combined exercise (OE). The combined exercise protocol included resistance training (tower climbing) and aerobic training (treadmill running) for eight weeks. Micro-computed tomography was used to assess changes in trabecular bone microarchitecture, while immunofluorescent imaging quantified bone-associated skeletal nerve density.

RESULTS: Ovariectomy significantly reduced serum estrogen levels ($P<0.01$) compared to the Sham group. Estrogen deficiency resulted in increased body weight and decreased bone volume. However, combined exercise significantly improved trabecular bone volume (BV, $mm^3$) and fractional bone volume (BV/TV, %) in both sham and OVX groups compared to non-exercise controls ($P<0.05$). Additionally, trabecular number (Tb.N, 1/mm) was significantly increased in SE and showed a tendency to increase in OE ($P<0.10$), while trabecular separation (Tb.Sp, μm) was reduced in SE compared to SN. Interestingly, OVX led to a marked reduction in bone-associated skeletal nerve fibers (SN: 859.4±310.2 in Sham vs. 195.7±43.1 in ON, $P<0.01$). However, combined exercise partially restored nerve fiber density by approximately 135% (ON vs. OE, $P<0.01$). Notably, combined exercise alone had a positive impact on skeletal nerve fibers, as SE exhibited significantly greater nerve density than SN (1407.8±396.9 vs. 859.4±310.2, $P<0.01$). Correlation analysis demonstrated a significant relationship between BV/TV and skeletal nerve fibers in all groups except SE (SN: $R^2=0.81$, $P<0.01$; ON: $R^2=0.45$, $P<0.05$; SE: $R^2=0.31$, $P=0.09$; OE: $R^2=0.78$, $P<0.01$). However, bone mineral density (BMD) remained unchanged between exercise and non-exercise groups.

CONCLUSION: An eight-week combined exercise regimen positively influenced tibial trabecular bone microarchitecture and stimulated bone-associated skeletal nerve fibers. These findings suggest that combined exercise training may serve as a dual mechanism for promoting bone remodeling and skeletal nerve regeneration in response to estrogen deficiency.

**SENESCENCE AS A CELL REGULATORY MECHANISM DURING SKELETAL MUSCLE REGENERATION**

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INTRODUCTION: Senescence is a stress response that is characterized by a permanent cell cycle arrest while remaining metabolically active and is most often considered an age-related phenomenon. Senescent cells secrete a variety of cytokines, chemokines and growth factors known as the senescence associated secretory phenotype (SASP). SASP influences the surrounding microenvironment, which can promote growth in development and contribute to the inflammatory process. Skeletal muscle regeneration is a complex process that requires the coordination of several different cell populations. Therefore, this study examines the impact of senescence on skeletal muscle during regeneration. We hypothesize that senescence serves as a control mechanism throughout the regenerative process in skeletal muscle.

METHODS: Briefly, young mice (n=8/time point) were treated with the senolytic drugs (Dasatinib+Quercetin, D+Q) which selectively eliminate senescent cells. Muscle damage was induced by cardiotoxin (CTx) in one hindlimb. Briefly, mice were exposed to either (a) vehicle (VEH), receiving only a CTx injection or (b) 7 days of senolytic treatment pre-CTx and 3x/week for 4 weeks post-CTx (SEN). Mice underwent grip strength measures throughout the study with CTx injured tibialis anterior

collected for biochemical analysis. Statistical significance was determined by a two-way ANOVA with a Tukey's multiple comparisons post-hoc test.

RESULTS: There were no significant differences in hindlimb grip strength between groups. Cross sectional area decreased at D7 and returned to normal in both groups. Centrally located nuclei significantly increased in both groups following CTx, however eMHC+ remained elevated at D28 in the SEN group ($p<0.005$). Macrophage (F4/80+) infiltration was significantly increased in the SEN group compared to the VEH at D7 ($p<0.001$). Satellite cell number ($p<0.01$) and fibrosis area ($p<0.05$) was significantly increased at D14 in the SEN group compared to the VEH.

CONCLUSION: The removal of senescent cells during muscle regeneration in young mice, significantly alters the kinetics of muscle regeneration. Senescent cells may act as a regulatory mechanism in skeletal muscle, likely through the secretion of SASP, to orchestrate the activity of different cell populations such as the recruitment of immune cells, satellite cells, and fibroblasts or fibro-adipogenic progenitors (FAPs) during muscle regeneration. Therefore, senescent cells may play an important role in skeletal muscle health and repair.

**RESTORATIVE BENEFITS OF EXERCISE ON BONE INTEGRITY AND PERIPHERAL NEUROPATHY IN A HIGH-FAT DIET TYPE II DIABETES MODEL**

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INTRODUCTION: Peripheral neuropathy is one of the most common complications of diabetes. This condition can lead to dysregulation of bone homeostasis, resulting in decreased bone density and increased risk of fractures. A high-fat diets (HFD) has been shown to decrease skeletal nerve fibers, potentially leading to reduced bone mass and quality. Specifically, the periosteum, recognized as a niche for bone progenitor cells sensitive to neural ligands, may experience reduced innervation due to diabetic neuropathy. This loss of innervation could disrupt the periosteal cellular niche, potentially promoting bone loss. This study investigated the impact of obesity-related type II diabetes and associated peripheral neuropathy on bone health.

METHODS: Young (4wks old) C57BL/6 mice were fed normal diet (ND) or HFD containing 60% of calories from fat for 12 wks. DEXA analysis and Thermal Sensation Test were analyzed every other 4 wks. Fasting glucose were measured at 16 wks of age to confirm the development of diabetic condition. The diabetic neuropathy was validated by a thermal withdrawal latency test. Micro-computed tomography (μCT) was used to assess trabecular bone microarchitecture and cortical bone parameters of femur. Immunofluorescence imaging was used to characterize nerve fiber density and localization. Finally, a combination of transcriptomics and in vitro assays was performed to create a communication map between DRGs and periosteum niche bioinformatically.

RESULTS: HFD-fed mice had significantly increased total body and fat mass, along with marked hyperglycemia characteristics indicative of type II diabetes. Additionally, the mice showed sensory polyneuropathy, with significant reductions in intraepidermal nerve fiber density and diminished thermal sensitivity. Bone analysis revealed declines in cortical and trabecular bone indices in long bones, with these structural changes corresponding to a reduction in peptidergic and sympathetic nerve fibers within periosteal regions. Further, single-cell RNA sequencing analysis identified major stromal and immune compartments, as well as 16 dorsal root ganglia clusters within the periosteum niche and HFD suppresses osteoblastogenesis and MAPK signaling pathways, suggesting complex cellular interactions affecting diabetic bone health. In vitro assays demonstrated that HFD reduced osteogenic differentiation and MAPK pathway activation while adding DRG-conditioned media enhanced both in a normal diet and HFD-fed mouse periosteal cells.

CONCLUSION: In HFD-induced type 2 diabetes, we confirmed peripheral nerve reduction and bone loss. In addition, it was confirmed that the nerves in the periosteum were also reduced. We found in in vitro assay that re-exposure to physiological neuronal inputs may restore obesity-related bone health. Future research should explore whether exercise can improve skeletal nerve fiber density and positively influence bone health under HFD conditions, potentially mitigating the damaging effects of diabetic neuropathy on bone.

**EFFECTS OF DAILY JUMP TRAINING DIVIDED INTO MULTIPLE BOUTS ON BONE STRENGTH, CORTICAL MORPHOLOGY, AND TRABECULAR MICRO-ARCHITECTURE**

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INTRODUCTION: Physical exercise is known to increase bone mass and strengthen the bones mainly by mechanical loading. Jump training is an effective exercise model providing high-impact load to the bones. Furthermore, it is observed that jump training enlarges the diaphysis of bones cross-sectionally and not along the long-axis. Jump training also increases the trabecular thickness at the metaphysis of the bones. A previous study reported that mechanical loading was more effective in enhancing bone strength and morphological properties when load was applied for short bouts with recovery periods in between than when applied all at once. However, there is still lack of evidence whether jump training divided into multiple sets can efficiently improve bone mass, strength, morphology, and microarchitecture. Therefore, this study aimed to investigate the effects of the training divided into multiple bouts per day on bone adaptation.

METHODS: Nine-week-old male Wistar rats (n = 32) were randomly assigned to three body weight-matched groups: performing five 10-jumps with 2 h recovery periods (J10 × 5) group (n = 12), a 50-jump (J50 × 1) group (n = 12), and a control group without jump training (n = 8). The jump training consisted of 50 jumps/day, 3 days/week, with a jump height of

40 cm. After 8 weeks of training, both sides of the tibia and femur were removed. The maximum loads at the center of the tibial and femoral diaphyses were measured using a three-point bending test. Micro-computed tomography was used to analyze the three-dimensional cortical bone morphology at the tibial and femoral diaphyses and the trabecular bone microarchitecture at the proximal tibial and distal femoral metaphyses.

RESULTS: The tibial diaphysis in the J10 × 5 and J50 × 1 groups showed significantly improved maximum loading ($p < 0.001$, $p < 0.001$, respectively), cross-sectional area (CSA) ($p < 0.001$, $p < 0.001$, respectively), cortical thickness ($p < 0.01$, $p < 0.001$, respectively), and periosteal perimeter ($p < 0.001$, $p < 0.001$, respectively) compared with the control group. In addition, the J10 × 5 and J50 × 1 groups showed increased trabecular thickness ($p < 0.001$, $p < 0.001$, respectively) and number ($p < 0.01$, $p < 0.05$, respectively) by jump training compared with those in the control group. Although the CSA and cortical thickness of the femoral diaphysis increased in the J10 × 5 and J50 × 1 groups, the maximum loading did not. Only trabecular thickness of the distal femoral metaphysis was increased by jump training. There was no significant difference in the data collected between the J10 × 5 and J50 × 1 groups.

CONCLUSION: Jump training may have provided higher impact loads on bones than the artificial loads used in previous studies. Therefore, dividing training into multiple bouts per day may not have been as effective in increasing bone mass and strength, because the heavy load delayed the recovery of the mechanical sensor.

**PALMITATE EXPOSURE IMPAIRS AUTOPHAGIC FLUX AND ASSOCIATED SIGNALLING PATHWAYS IN IMMORTALISED HUMAN PRIMARY MYOTUBES**

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INTRODUCTION: Lipid infiltration into skeletal muscle in conditions such as obesity and type II diabetes is hypothesized to interfere with proteostatic signalling leading to increased proteolysis and atrophy(1). Evidence from other cell types/tissues suggests lipid infiltration can inhibit autophagy(2), a cellular recycling process essential for the maintenance of skeletal muscle mass and quality(3), although this is yet to be investigated in human skeletal muscle. Therefore, the aim of this study was to investigate the effect of high-fat exposure on autophagic flux and associated cellular signalling in immortalised human primary myotubes.

METHODS: Immortalised human primary myotubes (C25/KM155 cell line) were exposed to palmitate (PAL, 500μM), or control media (CTRL), for 24h. Myotubes were then either immediately collected (BASAL, n=7 per condition) or media changed to EBSS for 5h to deprive cells of nutrients (STARVE, n=5 per condition), a process which typically activates autophagy. A set of experiments was also conducted in the presence of Bafilomycin A1 (100nM) for 2h before collection to assess pre-lysosomal autophagic flux. Immunoblotting was then completed for LC3 (autophagic flux) and a range of associated signalling targets. Two-factor independent measures ANOVAs were used to assess differences between conditions, with significance threshold set at $p<0.05$. Data is presented as Mean ± SD.

RESULTS: Main effects of condition and nutrient deprivation (both $p<0.001$) were observed for pre-lysosomal autophagic flux whereby STARVE elevated flux in both CTRL and PAL (2.2-fold & 3-fold) but overall was lower in PAL. This was not mirrored by more commonly used LC3II/I ratio, where no differences were observed, suggesting this 'static' measure of autophagy does not reflect flux. Further main effects of condition showed AMPK-mediated ULK1 Ser555 phosphorylation and Beclin1 protein content to be greater in CTRL irrespective of nutrient availability ($p\leq0.036$), indicating a potential impairment of autophagy induction in PAL. Markers of mTORC1 activity (p-ULK1 Ser757, p-RPS6 Ser240/244 & Ser235/236) displayed main effects of nutrient deprivation whereby STARVE was lower than BASAL irrespective of condition ($p\leq0.026$). However, when expressed relative to basal mean values, the reduction in p-RPS6 Ser240/244 & 235/236 following STARVE was less pronounced with PAL (72±2% vs. 83±6%, $p=0.009$ & 66±4% vs. 74±3%, $p=0.005$ respectively).

CONCLUSION: We show that palmitate exposure impairs pre-lysosomal autophagic flux but not its responsiveness to nutrient withdrawal. This impairment may be due to reduced autophagy induction displayed by lower Beclin1 content and AMPK-mediated ULK1 Ser555 phosphorylation. These data provide initial evidence of a potential detrimental effect of high-fat/lipid exposure on autophagy in human skeletal muscle which warrants further research in vivo.

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**EFFECTS OF HEAT ACCLIMATIZATION AND HYPOXIA TRAINING ON THE FAT OXIDATION CAPACITY OF COMPETITIVE ATHLETES**

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INTRODUCTION: Heat acclimatization and hypoxic training have improved aerobic capacity and endurance performance, potentially linked to enhanced fat oxidation capacity. Evidence from diseased or obese populations suggests that environmental adaptations can increase fat oxidation as an energy source. However, there is limited research on the metabolic responses of elite athletes. This study aimed to assess the impact of heat acclimatization and hypoxic training on fat oxidation capacity in competitive athletes, exploring potential factors that contribute to improvements in aerobic capacity.

METHODS: Eight elite male modern pentathletes participated in a four-week aerobic endurance training program under three different environmental conditions: control (CON group; 23°C, RH45%, FiO2=20.9%), hot (HOT group; 35°C, RH70%, FiO2=20.9%), and hypoxia (HYP group; 23°C, RH45%, FiO2=15.6%). Incremental exercise tests were performed before and after the training in both the control and respective specialized environments. Gas exchange data were collected to assess aerobic capacity, while indirect calorimetry was used to determine fat oxidation rates, which were plotted as a function of exercise intensity. A SIN model was employed to determine the intensity (Fatmax) causing maximal fat oxidation (MFO), and the models three independent variables, dilation (d), symmetry (s), and translation (t), were used to characterize the dynamics of fat oxidation. A two-way repeated measures ANOVA was used to assess the effects of environmental conditions and training factors, with statistical significance set at $\alpha = 0.05$. Data are presented as mean ± SD.

RESULTS: In the control environment, after the training, the HOT group exhibited a significant increase in absolute VO2 (4322.6 ± 651.64 vs. 4560.75 ± 722.64 ml/min, p=0.003). Both the HOT (626.44 ± 75.58 vs. 722.50 ± 49.79 s, p=0.006) and HYP (573.83 ± 51.77 vs. 683.75 ± 76.15 s, p=0.002) groups showed significant increases in VT2@Time after training. Additionally, both HOT (0.65 ± 0.14 vs. 0.78 ± 0.13 g/min, p=0.015) and HYP (0.63 ± 0.17 vs. 0.79 ± 0.18 g/min, p=0.004) groups demonstrated increased MFO after training. The HOT group also exhibited an increase in Fatmax (30.46 ± 3.61 vs. 35.76 ± 5.12 ml/min·kg, p=0.005). Both HOT (-0.74 ± 0.28 vs. -0.45 ± 0.16, p=0.003) and HYP groups (-0.79 ± 0.27 vs. -0.51 ± 0.12, p=0.003) showed significant increases in d under the control environment, with the HOT group also showing an increase in d under hot environment (-0.74 ± 0.28 vs. -0.45 ± 0.16, p=0.013) after training.

CONCLUSION: Four weeks of hypoxic and heat acclimatization training can enhance aerobic metabolic capacity in competitive athletes under normal conditions, accompanied by improvements in fat oxidation curve dilation and increased fat oxidation capacity. Additionally, heat acclimatization training has similar beneficial effects on fat oxidation capacity during exercise in hot environments.

**OUT WITH THE ICE AND IN WITH THE HEAT: HEAT OUTPERFORMS COLD WATER IMMERSION FOR RECOVERY OF STRENGTH AFTER EXERCISE-INDUCED DOMS IN HEALTHY ADULTS**

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INTRODUCTION: The aim of this study was to investigate the effectiveness of thermal strategies on recovery rate after exercise induced delayed onset of muscle soreness.

METHODS: The study used a randomized, parallel group design (N=40 with 10 in each group) over four consecutive test days. Participants performed a single bout of eccentric knee extensions, with baseline and post maximal voluntary contraction (MVC) measurements on a isokinetic dynamometer (HUMAC NORM), followed by a thermal recovery strategy: hot water immersion (HWI;30 min at 42 °C), cold water immersion (CWI;15 min at 9 °C), hot air immersion (HAI; 30 min at 30°C, 30% RH) or control (CON: 30 min at 18 °C, 30% RH). Recovery rate of strength (via MVC), and pain and muscle soreness (via visual analogue scales) was monitored over 72hr (pre exercise, post exercise, post therapy, 24hrs, 48hrs, and 72hrs after therapy). Venous blood samples were collected each session to analyse Inflammatory marker Interleukin 6 (IL-6), heat shock proteins (HSP72), and Creatine Kinase Muscle-Muscle isoenzyme (CKMM).

RESULTS: HWI returned 85 and 89% of strength back to baseline MVC values at 48hr (284.30±22.04N vs 243.70±25.33; p= 0.356) and 72hrs (284.30±22.04N vs 256.00 ± 26.12; p= 0.801) respectively. CON and HAI returned 88% and 89% of strength back to baseline MVC values at 72hrs (303.70±22.04N vs 268.50±26.12N; p= 0.314, and 299.70±22.04N vs 268.70±26.12N; p= 0.563 respectively). Whereas, CWI MVC values were still 25% higher than baseline at 72hrs (279.10±22.04N vs 218.80±26.12N; p=0.005). There was no significant difference in the recovery of pain or muscle soreness between groups over time (P >0.05). CKMM increased from baseline to post-exercise in all groups ($p < 0.05$). However, HWI caused a significant decrease in CKMM in comparison to other groups over time ($p < 0.05$). HSP72 increased significantly after HWI and HAI (1.36±0.11 vs 1.81±0.14 mg/ml and 1.36±0.11 to 1.6±0.14 mg/ml; $p = 0.001$), while CWI caused a significant decrease (1.36±0.11 vs 0.87±0.10 mg/ml; $p = 0.001$), with no change in CON (1.21±0.01; $p = 0.671$). Quadriceps muscle temperature increased with HWI (36.57±1.2 °C vs 38.83±1.3 °C; p= 0.005) and decreased with HAI

(37.05±0.5 °C vs 34±1.7 °C; p= 0.05) and CON (36.61±0.9 °C vs 34.78±2.2 °C; p= 0.012). There was no significant difference in HAI (36.05±0.9 °C vs 36.27±0.5 °C; p = 0.444). HWI reduced IL6 after 48 hours (0.54±0.02 vs 0.56±0.02 pg/ml; p = 0.096), whereas CWI reduced after 72 hours (0.61±0.04 vs 0.61±0.03 pg/ml; p = 0.953).

CONCLUSION: Hot water immersion was the most effective thermal therapy for returning baseline strength. This was related to the physiological stimulus that hot water immersion caused on the body (elevation in muscle temperature and heat shock protein 70) and associated upregulation of inflammation (IL6) and low circulating markers of muscle damage (CK-MM) compared to other therapies. Therefore, hot water immersion should be favored for recovery of strength.

**THE EFFECTS OF SODIUM CITRATE SUPPLEMENTATION WITH ICE SLURRY ON THERMOREGULATORY MECHANISMS DURING HEAT EXPOSURE IN INDIVIDUALS WEARING MOTORSPORT PERSONAL PROTECTIVE EQUIPMENT**

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INTRODUCTION: Ice slurry ingestion prior to exercise can expand the heat storage window whilst improving tolerance to rising core temperature (Tcore) [1] and blunting the sweating response [2]. Alternatively, sodium citrate (SC) supplementation has been shown to promote water retention and subsequently induce hyperhydration [3]. Both offer potential value as pre-race strategies to mitigate thermal strain experienced by motorsport driver-athletes who race in thermally resistant clothing that renders evaporative heat loss largely ineffective, thus exacerbating thermal strain in high temperature cockpit conditions [4]. The current study aimed to determine the effects of ice slurry ingestion and SC supplementation alone or in combination on thermoregulatory mechanisms during exposure to a hot environment in a motorsport-simulated environment.

METHODS: Four healthy, non-heat acclimated participants (24±2years, 71.8±13.9kg) completed four trials in a double-blind randomised cross-over design. Participants ingested 300mg/kg BM of SC or placebo with 25 mL/kg BM of room temperature water 150 min before a driving simulation, both with and without 10g/kg BM ice slurry consumed in the final 30 min. Simulated driving was conducted in an environmental chamber at 35 °C and 30 % humidity whilst wearing a full-body fire-retardant suit, racing overalls, gloves, boots, balaclava and helmet. Changes in Tcore (ΔTcore) and plasma volume (ΔPV) were assessed pre- and post-30 min ice slurry stage. Whole-body sweat rate (WBSR), back local sweat rate area under the curve (LSR AUC), ΔTcore and ΔPV were measured across 60 min of simulated driving conditions.

RESULTS: There was a significant condition effect for change in Tcore (ΔTcore) during the 30 min slurry ingestion period ($F(3,8) = 9.023, P<0.05$). Ice slurry ingestion significantly reduced Tcore in both conditions compared with the no slurry + placebo condition ($P<0.05$) but not compared to no slurry + SC ($P=0.06$). There were condition effects for ΔTcore during the 60 min simulated driving ($P=0.05$) but no interaction effects were observed ($P>0.05$). There were no condition effects for WBSR ($P=0.90$), back LSR AUC ($P=0.11$) and thermosensitivity derived from LSR AUC relative to ΔTcore ($P=0.09$) during the simulated driving. There was also no significant condition effect for ΔPV between baseline and post-hyperhydration ($P=0.44$), pre- and post-chamber ($P=0.69$) and baseline to post-chamber ($P=0.14$).

CONCLUSION: Ice slurry ingestion reduced Tcore prior to simulated driving in the heat. These preliminary data demonstrate potential uses for motor racing athletes.

[1] Jay & Morris, 2018, Sports Med; [2] Siegel et al, 2010, Med Sci Sports Exerc; [3] Siegler et al, 2021, Int jour sport nutr and exerc metab;[4] Reid & Lightfoot, 2019, Med Sci Sports Exerc

**CONTROLLED HEART RATE STRATEGY TO DETERMINE THE INTENSITY OF A PRACTICAL HEAT ACCLIMATION PROTOCOL UNDER PERSONAL PROTECTIVE EQUIPMENT**

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INTRODUCTION: Heat acclimation (HA) improves heat loss capacity, reduces health risks at work, and enhances performance in hot environments. However, existing HA are impractical for most occupational and sports contexts due to their reliance on specialized infrastructure and expensive measurement tools. Therefore, it is relevant to develop a HA protocol based on accessible and applicable methods for these contexts. A pragmatic approach would be to (1) induce thermal stress through exercise while wearing a personal protective equipment (PPE) in a temperate environment and (2) assess physiological strain using a percentage of maximal heart rate (%HRmax).

Objective: To quantify thermal stress and physiological strain during exercise performed at fixed %HRmax in PPE in a temperate environment, and to determine the intensity that maximizes time within a target core temperature range of 38.5–39.5°C, proposed to result in optimal HA.

METHODS: Eleven participants (5 women, 23 ± 3 years old) had their maximal heart rate measured during a first visit using a VO2peak test (194 ± 5 bpm, 46.4 ± 6.4 ml·kg-1·ml-1), before performing treadmill exercise (60 min at 4.5 km, with an incline modulated as a function of exercise intensity) in a temperate environment (22.7 ± 0.6°C, 27.2 ± 7.9% humidity) at four intensities (70, 75, 80, and 85%HRmax) while wearing a PPE (firefighter jacket, pants, hood and gloves). Thermal stress was assessed through intra-clothing temperature and humidity, while physiological strain was quantified using rectal temperature (Trec), skin temperature, and heart rate.

RESULTS: Thermal stress, assessed via intra-clothing temperature (33.7 ± 0.5°C) and relative humidity (70.7 ± 10.0%), did not differ between conditions (p=0.22). Final Trec values differed between the four intensity conditions (p<0.01), with higher values during 80% and 85%HRmax (p<0.05) compared to 70% and 75%HRmax. Mean Trec values were 38.3 ± 0.3°C, 38.6 ± 0.4°C, 38.9 ± 0.3°C, and 39.0 ± 0.4°C for the 70, 75, 80, and 85%HRmax conditions, respectively. During 85%HRmax, two participants stopped exercising after exceeding the pre-determined safety threshold of 39.5°C, and one additional participant abandoned due to an inability to continue exercising. The time spent in the target hyperthermia range (38.5 < Trec < 39.5°C) differed across conditions (p<0.01), with the longest duration observed during 80%HRmax (27 ± 14 min) compared to 70% (7 ± 12 min, p<0.01) and 75%HRmax (11 ± 15 min, p<0.05), while 85%HRmax was not different (25 ± 12 min, p=0.95).

CONCLUSION: Exercise intensity influences physiological strain during 60 minutes of treadmill walking while wearing a PPE in a temperate environment. An intensity of 80%HRmax optimizes time spent at the target core temperature associated with HA without exceeding safety thresholds and maximizing tolerance. These findings provide a foundation for testing the efficacy of accessible and practical HA protocols for occupational and athletic settings.

**THERMOREGULATORY, CARDIOVASCULAR AND BIOMECHANICAL RESPONSES OF AMATEUR RUNNERS AT A LARGE CITY MARATHON IN TEMPERATE CONDITIONS**

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INTRODUCTION: Exertional heat illnesses (EHI) remain frequent in endurance sports, posing significant risks to amateur and elite athletes. With climate change, the challenge of safely managing sporting events is set to continue. The current approach for many sports is event modification and/or rescheduling based on environmental conditions. However, exercise intensity is the major determinant of EHI risk, rather than environmental heat stress. Therefore, monitoring individual heat strain is more suitable for understanding risk associated with different sporting activities, varied individual characteristics, and when appraising sporting heat stress policies. Addressing this need, we report thermoregulatory, cardiovascular and biomechanical responses of amateur runners completing in 10 km (10KM), half-marathon (HM) and marathon (M) events in Hong Kong in February 2025. The study aims to differentiate heat strain across different event lengths and identify individual characteristics that exacerbate this strain. We hypothesised the greatest heat strain will be experienced in the 10KM.

METHODS: Eighty-five runners (age 38±13 [15–65] years) ran the 10KM (n=22; 8 female, 14 male. Body fat percentage [BF%] 23±12%), HM (n=32; 14 female, 18 male. BF% 19±8%) and M (n=31; 9 female, 22 male. BF% 15±6%). Self-predicted race times were; 10KM 62±10 min, HM 02:00±00:25 hours and M 03:49±00:40 hours. Runners ingested two telemetry pills to monitor core body temperature (TCORE; pill 1 before bed, pill 2 upon waking on race day) and wore a heart rate monitor (HR), with attached skin temperature sensor (TSKIN). Running biomechanics and kinematics were monitored using shoe-worn sensors. Environmental conditions were measured every 5 km using portable meteorological stations. Races began between 05:30-08:30, with course closing at 14:00. Data were integrated by a bespoke app on a smartwatch and streamed in real-time. Upon finishing, participants indicated EHI symptoms experienced during the race and provided a fingertip blood sample to assess markers of gut injury. Runners completed further surveys 12 hours, 24 hours, 48 hours and 72 hours post-race to track recovery status

RESULTS: Environmental conditions from 10 weather stations were; ambient temperature 17.9±3.2°C, relative humidity 42.6±9.6% and Wet Bulb Globe Temperature 12.5±2.9°C. Preliminary results indicate that the highest TCORE recorded was 40.37°C in the 10KM race, while no runners in the half marathon (HM) or marathon (M) exceeded 40°C. Notably, no cases of exertional heat illness (EHI) were reported.

CONCLUSION: We monitored a large cohort of amateur athletes during a large city marathon to understand the thermal strain and EHI risk factors, including individual characteristics and event distance. Ongoing development of multi-sensor approaches, encompassing thermal, cardiovascular, sudomotor, and biomechanical monitoring, combined with multi-location weather data, is needed to understand EHI risk across various sports for amateur and elite athletes.

**THERMONEUTRALITY BLUNTS AEROBIC EXERCISE TRAINING-INDUCED MITOCHONDRIAL ADAPTATIONS IN MOUSE SKELETAL MUSCLE AND ADIPOSE TISSUE**

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INTRODUCTION: Aerobic exercise induces mitochondrial biogenesis and increases oxidative phosphorylation (Holloszy, 1967) in several tissues (e.g., adipose tissue, skeletal muscle, heart). However, aerobic training studies in rodents are often conducted at room temperature (22°C) resulting in thermogenic stress that may impact training adaptations. Specifically, housing mice at thermoneutrality seems to generally dampen the magnitude of training adaptations, however, its effect on mitochondrial adaptations to exercise remains unclear (McKie et al., 2019). Given this knowledge gap, we examined the impact of exercise training on mitochondrial bioenergetics in brown adipose tissue (BAT), inguinal white adipose tissue (iWAT), and permeabilized skeletal muscle fibres in mice housed at thermoneutrality.

METHODS: Male C57BL/6N mice housed at thermoneutrality (28°C: n=22) were randomly assigned to remain sedentary or undergo a 4-week moderate-intensity endurance training protocol, which consisted of forced treadmill running

(3x/week, 60% of maximal baseline speed, increasing weekly) and free access to voluntary running wheels. Whole body energy expenditure and adipose tissue morphology were assessed in addition to mitochondrial respiratory function in permeabilized skeletal muscle fibres, BAT and iWAT. As a measure of in vivo mitochondrial function in BAT, we also assessed whole-body energy expenditure following a single dose of CL-316, 243, a highly specific beta 3-adrenergic agonist that stimulates BAT thermogenesis.

RESULTS: Trained mice had improved exercise performance (run time to exhaustion) but training did not alter resting or CL316, 243-stimulated whole-body energy expenditure. In skeletal muscle, mitochondrial ADP sensitivity and creatine-supported respiration were not altered. In BAT and iWAT, there were no differences in basal (state 2), maximal (state 3) or uncoupled (2,4-dinitrophenol) mitochondrial oxygen consumption following training. This response was not affected by the addition of creatine to optimize ADP transport or by GDP to inhibit uncoupling in BAT.

CONCLUSION: Despite an increase in exercise performance following training at thermoneutrality, in vivo indices of BAT thermogenesis and in vitro assessments of mitochondrial bioenergetics in several tissues were unchanged. This suggests that the sustained performance benefit of training in thermoneutral conditions is likely not due to functional adaptations in skeletal muscle, iWAT or BAT mitochondria.

**EFFECT OF EXERCISE TEMPERATURE ON THE CONTINUOUS MEASUREMENT OF THE NACL CONCENTRATION IN SWEAT IN TRAINED MALE ATHLETES**

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INTRODUCTION: The human body primarily regulates core temperature through evaporation sweat loss, especially during physical activity. Previous studies suggested that an increased sweat rate (SR) leads to higher sweat-related sodium chloride (NaCl) concentration due to reduced NaCl reabsorption in sweat glands. In the heat, a rise in body core temperature and loss of body water via sweating are conse-quences of prolonged exercise. However, current methods for assessing SR and NaCl concentration in sweat do not allow real-time measurement, limiting the ability to make immediate adjustments in hydration or electrolyte management. This study aimed to compare the impact of ambient tempera-ture on the evolution of SR and NaCl concentration in sweat using the BeOne armband, a device that continuously measures sweating throughout exercise in real time.

METHODS: Fifteen well-trained male athletes (age: 19.3 ± 5.1 y ; $VO_2$max: 71.1 ± 5.0 mL.min-1.kg-1) performed a 45-minute cycling exercise at 50% of power output at which $VO_2$max was reached under two environmental conditions: a thermoneutral climate (N: 24 ± 1°C, 30.0 ± 3% RH) and a hot climate (H: 35 ± 1°C, 30 ± 3% RH). During sessions NaCl concentration was continuously monitored using the BeOne armband, while whole-body SR was assessed via body mass changes. Core temperature (Tc), skin temperature (Ts), heart rate (HR), and heat production (indirect calorimetry) were also measured.

RESULTS: Whole-body SR was significantly higher in H than N (969 ± 363 vs. 634 ± 195 mL, $p<0.001$, respectively). NaCl concentration in sweat was significantly greater both at the onset (40.7 ± 16.5 vs. 33.8 ± 8.4 mmol.L-1) and at the end of the cycling exercise (59.3 ± 23.8 vs. 44.8 ± 15.8 mmol.L-1) in H compared to N ($p<0.001$ for both). The rate of increase in NaCl concentration was also significantly higher in H than N (0.56 ± 0.27 vs. 0.34 ± 0.32 mmol.L-1/min, $p<0.001$, respectively). Tc peak (38.34 ± 0.36 vs. 37.94 ± 0.38°C), Ts peak (36.73 ± 0.38 vs. 34.89 ± 0.54°C), HR (163 ± 11 vs. 144 ± 11 bpm) and rating of perceived exertion (14.6 ± 2.1 vs. 12.7 ± 2.4) were significantly higher at the end of exercise in H ($p<0.001$ for all). Finally, heat production was significantly greater throughout the entire session in H compared to N (530 ± 71 vs. 496 ± 60 kcal, $p<0.01$).

CONCLUSION: Whole-body SR was associated with increased NaCl concentration in sweat. The progressive rise in NaCl concentration during exercise suggests an overall increase in SR to regulate body temperature and mitigate thermal and cardiovascular strain. These findings contribute to a better comprehension of the association between SR and sweat composition, therefore improving the monitoring of athlete thermoregulation and electrolyte balance in real time exercise conditions.

**CAN CIRCUMSTANCES OR A RECURRENCE OF EXERTIONAL HEAT STROKE PREDICT HEAT INTOLERANCE?**

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INTRODUCTION: Exertional heat stroke (EHS) is a medical emergency characterized by hyperthermia (>40°C) and central nervous system dysfunction. During return to duty or play after EHS, heat tolerance tests (HTT) assess thermoregulatory function to determine heat tolerance or intolerance status. However, EHS circumstances are rarely considered, despite they could indicate whether or not a thermoregulatory disorder should be suspected. The study aimed to assess the significance of EHS circumstances on thermal responses during an HTT.

METHODS: Fifty-six participants (5 females) were divided into three groups: eighteen healthy military personnel without a history of heat illness constituted the control group (CONT); twenty-one military personnel with a previous EHS episode with risky conditions (high ambient temperature, high humidity, encapsulated clothing, dehydrated state, etc.) constituted the simple EHS group (SIMP-EHS); seventeen military personnel with a previous EHS episode (or a recurrence) without favorable circumstances constituted the complex EHS group (COMP-EHS). After anthropometric assessments, the final rectal temperature (Trec), whole-body sweat loss and oxygen consumption were measured during an HTT (two-hour treadmill

walking at 5 km·h-1, with a 2% slope, at a temperature of 40°C and 40% relative humidity). Heat tolerance status was analyzed both as a dichotomous variable (heat tolerant versus heat intolerant if Trec failed to plateau at or below 38.5°C) and as a continuous variable (final Trec).

RESULTS: No anthropometric characteristics (age, body mass, body mass index, body fat, body surface area, etc.) differed between groups (p>0.05). Heat intolerance was found in 7 out of 18 (39%), 7 out of 21 (33%), and 11 out of 17 (65%) participants in the CONT, SIMP-EHS and COMP-EHS groups, respectively. Final Trec was significantly higher in the COMP-EHS group (38.8 ± 0.63°C) than in the CONT (38.3 ± 0.42°C; p<0.05) and SIMP-EHS (38.3 ± 0.52°C; p<0.01) groups. Similarly, COMP-EHS final Trec (39.2 ± 0.37°C) was higher than in the CONT (38.7 ± 0.24°C; p<0.01) and tended to be higher than in the SIMP-EHS group (38.9 ± 0.33°C; p=0.083). Neither sweat loss nor energy expenditure differed between groups (p>0.05). Regression analyses identified body fat percentage, sweat loss (in mL·kg-1) and energy expenditure (in W·m-2) as significant (p<0.001) predictors of final Trec. Moreover, a history of complex EHS was also a significant (p<0.001) predictor of final Trec when included in the model, unlike a general history of EHS.

CONCLUSION: Final Trec comparison and regressions analyses indicate altered thermoregulatory function in the COMP-EHS group. In contrast, a history of simple EHS does not appear to predispose individuals to heat intolerance compared to those without a history of heat illness. These findings may have implications for clinical guidelines regarding heat tolerance testing.

**HIGH INTENSITY INTERVAL EXERCISE AND HOT WATER IMMERSION FOR OPTIMISING CARDIOVASCULAR HEALTH OUTCOMES**

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INTRODUCTION: Combining exercise and hot water immersion (HWI) may have additive benefits for acute cardiovascular function beyond those demonstrated with HWI alone (1,2). The objective of this study was to assess if a combination of exercise and HWI (ExHWI) augmented cardiovascular responses as compared to time-matched HWI (HWI60).

METHODS: Eleven participants (6 females, 24±5 y, 24±2 kg/m2, 38±6 mL/kg/min) completed two pseudorandomised experimental trials. ExHWI consisted of 30 min high intensity interval exercise (5x1 min intervals at 100% Wmax [277±73 W] interspersed with 4 min active recovery at 35% Wmax) followed by 30 min neck-level HWI (41˚C). HWI60 involved 30 min neck-level followed by 30 min waist-level HWI. Estimated marginal means of group differences in blood pressure (BP), flow mediated dilation (FMD), plasma volume (PV), mood and psychophysical responses were compared at baseline, during (30 and 60 min) and post-intervention (2, 30, 45, 60 min and 24 h) using linear mixed-effects models.

RESULTS: Rectal temperature increased by 1.6±0.3˚C in ExHWI and 1.3±0.7˚C in HWI60 at 60 min and remained elevated until >45 min-post (all P<.01), with no difference between conditions (all P>.99). Heart rate (HR) increased in both conditions and was higher in ExHWI than HWI60 from exercise onset until 2 min-post (all P<.01). Sweat loss was not different (P=.71) between ExHWI (0.9±0.4 kg) and HWI60 (0.8±0.3 kg). Compared to baseline, PV was decreased at 30 min-post in HWI60 (-8±6%, P<.01) but not in ExHWI (-3±3%, P>.99), and no difference was observed at 24 h-post (both P>.99). Compared to baseline, exercise increased SBP at 30 min in ExHWI (114±11 vs. 175±24 mm Hg; P<.01), whereas DBP was decreased at 30 min in HWI60 (63±7 vs. 40±5 mm Hg; P<.01). In both conditions, DBP was decreased at 60 min (ExHWI: 40±4, HWI60: 38±5 mm Hg) and 2 min-post (ExHWI: 41±6, HWI60: 45±8 mm Hg, all P<.01). SBP and DBP were not different from baseline at 45 min-post (ExHWI: 110±10, 63±5 mm Hg, HWI60: 108±10, 64±7 mm Hg) or 24 h-post (ExHWI: 111±10, 64±6 mm Hg, HWI60: 111±11, 62±7 mm Hg; all P>.99). Brachial artery diameter and antegrade shear rate were elevated at 30 min-post in ExHWI, with retrograde shear rate decreasing at 30 min-post in both conditions (all P≤.02). FMD and mood were unaffected across both trials. Perceived temperature increased similarly between conditions while thermal discomfort was slightly higher in ExHWI than in HWI60 at 60 min (P=.02).

CONCLUSION: Both ExHWI and HWI60 elicited similar levels of thermal strain, but ExHWI resulted in a greater cardiovascular load, indicated by a higher HR response and more pronounced blood flow/pressure perturbations. Despite this, ExHWI did not augment BP or FMD responses 24 h-post. Further work is needed to identify if combining exercise with HWI has additional benefits over exercise or HWI alone.

1 Steward et al., Scand J Med Sci Sports, 2024

2 Francisco et al., J Appl Physiol, 2021

Conventional Print Poster Presentations

CP-SH06 Physical Activity Promotion II

**ASSOCIATIONS OF PHYSICAL ACTIVITY, SEDENTARY BEHAVIOUR AND DIFFERENT TYPES OF SMARTPHONE APPS USAGE AMONG CHINESE YOUNG ADULTS**

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Background: Previous studies suggest that smartphone use does not inherently reduce physical activity or increase sedentary behavior among young adults. The impact on health behaviors varies by app type. This study examines the association of physical activity, sedentary behavior and use of different smartphone apps among young adults.

Methods: This study followed 345 university students aged 18-22 for 7 days. Physical activity (PA), and sedentary behavior (SB) were objectively measured using the ActiGraph GT3X-BT accelerometer. Smartphone app usage was tracked via objective daily survey logs. After the 7-day tracking period, semi-structured interviews were conducted to gather detailed information on app usage and physical activity. Data analysis was performed using SPSS 26.0 and R software.

Results: In 248 participants (139 males, 109 females), Males had higher daily energy expenditure and more SB time compared to females, who spent more time in light-intensity physical activity (LPA) but less in vigorous-intensity physical activity (VPA). Males showed a positive correlation between entertainment app usage and SB time ($r = 0.271$, $p = 0.017$) and a negative correlation with sedentary interval (SI) ($r = -0.266$, $p = 0.019$). In females, social app usage correlated with increased LPA ($r = 0.321$, $p < 0.001$) and VPA was positively correlated with screen time (ST) ($r = 0.195$, $p = 0.042$). App usage also influenced SB patterns, particularly in active individuals. After controlling for confounding factors, gaming app usage in males who inactive decreased LPA (0.341 min, $p = 0.036$). In females, social app usage increased LPA (0.112 min, $p = 0.018$) but decreased VPA (0.012 min, $p = 0.011$) in those who inactive. ST was linked to an increase in SB time and to a decrease in SI time in both genders.

Conclusions: Complex associations between the different smartphone apps, sedentary behavior and physical activity in young adults, the type of app used is likewise crucial as screen time.

**THE RELATIONSHIP BETWEEN 24-HOUR BEHAVIOURS AND WORK PRODUCTIVITY ON THE DAY WORKING FROM HOME**

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INTRODUCTION: After the outbreak of COVID-19, working from home (WFH) has become a prevalent working pattern in the UK, introducing both challenges and opportunities for employees' daily movements and work outcomes. This cross-sectional study aimed to investigate the relationship between 24-hour behaviours, including sleep, sedentary behaviour, and physical activity, and work productivity among University of Edinburgh staff working from home.

METHODS: Forty-seven participants (72.3% female, 85.1% white) who worked remotely at least one day per week completed a self-reported questionnaire. The online questionnaire collected demographic information, and data from the Past-day Adults' Sedentary Time Questionnaire, the International Physical Activity Questionnaire, and the Health and Work Questionnaire. Descriptive statistics, independent t-tests, and Pearson correlation analyses were performed to explore associations between 24-hour behaviours and productivity outcomes.

RESULTS: The majority of participants (74.5%) reported sleeping more than 7 hours during WFH days; however, 95% experienced poor sleep quality. Sedentary behaviour levels were high, with 93.6% of participants spending over 8 hours sedentary, whilst most staff (89.4%) met physical activity guidelines of 150 minutes of moderate-to-vigorous physical activity (MVPA) per week. However, no statistically significant correlations were observed between 24-hour behaviours and productivity ($p > 0.05$).

Conclusion

While no significant associations were identified, these findings highlight high levels of sedentary behaviour and poor sleep quality among WFH employees. As hybrid working patterns become increasingly common, further research is needed to explore the nuanced impacts of 24-hour behaviours on productivity and to develop targeted interventions promoting active lifestyles during remote work.

**SOCIODEMOGRAPHIC DIFFERENCES IN TIME USE OF 24-HOUR MOVEMENT BEHAVIOURS: A DESCRIPTIVE STUDY AMONG JAPANESE ADULTS**

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INTRODUCTION: Adults' daily time spent in sedentary behaviour (SB), sleep, light-intensity physical activity (LPA), and moderate-to-vigorous physical activity (MVPA) is collectively termed 24-hour movement behaviours in a compositional nature. Differences in individuals' daily behaviours across their sociodemographic factors are linked to health inequalities. Therefore, understanding these differences using a compositional data analysis approach is critical for addressing health disparities.

METHODS: This cross-sectional study analysed data from 2,718 Japanese adults aged 20–59, collected via an online survey conducted in 2023. Participants' time spent in 24-hour movement behaviours (SB, Sleep, LPA, and MVPA) was expressed as geometric means. Compositional multivariate analysis of covariance (MANCOVA) was used to compare behaviour components across sociodemographic factors (sex, age group, education levels, marital status, living arrangement, annual income, occupational type, and residential area). Back-transformed isometric log-ratio differences with bootstrap 95% confidence intervals were calculated to identify significant differences in movement behaviours between factors' levels. [1]

RESULTS: Participants spent an average of 29.5%, 33.6%, 0.6%, and 36.3% of their day in SB, sleep, MVPA, and LPA, respectively. Significant variations were observed across sex, marital status, living arrangement, and occupation types. Compared with average means, females spent 27.5% less time in MVPA, while unmarried individuals and those living alone exhibited higher SB (+8.9% and +8.9%) and lower LPA (-8.4% and -8.3%). Desk-based workers reported 20.5% more SB, whereas physically demanding jobs were associated with higher MVPA and LPA but reduced sleep time. Although non-significant, trends suggested that individuals with higher education and income levels and those in urban areas were more active.

CONCLUSION: This study first explored the correlates of diverse sociodemographic factors on Japanese adults time use in 24-hour movement behaviours, highlighting the role of sociodemographic factors in shaping time-use behaviours. The present findings underscore the need for targeted public health strategies, such as promoting physical activity in female, socially isolated individuals and reducing SB in desk-based workers, to address health disparities effectively among the Japanese population.

Reference

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**ACTIVITY PURPOSE AND SPORTS BEHAVIORAL CHARACTERISTICS OF BEACHBALL PARTICIPANTS**

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INTRODUCTION: Beachball is a minor sport like volleyball that was invented in Asahi Town, Toyama Prefecture, Japan in 1978. It was originally a sport for agricultural workers to relieve back pain, but it has now spread nationwide and is contributing to regional development in various regions. In a previous study, Ingledew & Markland (2008) revealed that sports behavior such as personal attributes and participation frequency differ depending on the purpose of activity in major sports, but there has been no verification of minor sports. The purpose of this study was to clarify the sports behavior characteristics of Beachball participants as a minor sport from the activity purpose, and to contribute to the future promotion of regional sports.

METHODS: The survey was conducted by questionnaire surveying 407 participants of tournaments held in Japan between August and September 2024, and 314 valid responses (77.1%) were obtained. The questionnaires were distributed and collected directly to participants at the reception desk of the tournament. The survey included personal attributes, activity purpose, and sports behavior (number of tournaments participated per year, number of practice sessions, competitive experience, years on a team, and self-evaluation of skills). Activity purpose were classified into four intentional groups ( 1 . enjoyment, 2. winning, 3. health promotion, 4. purpose of life). The $\chi 2$ test and one-way ANOVA were conducted with these as dependent variables and personal attributes and sports behavior as independent variables.

RESULTS: Overall attributes, 47.5% were male and 52.5% were female. The average age was 48.69 years old. The most common activity purpose was for enjoyment group, accounting for 41.4% of the total, followed by the winning group (28.3%), the health promotion group (20.2%), and the purpose of life group (10.1%). In the analysis of activity purpose, attributes, and sports behavior, the first significant difference in attributes was age ($p<.001$), with the winning group being the youngest at 45.15 years old on average compared to the health promotion and purpose in life groups. In terms of sports behavior, there was a significant difference ($p<.001$) in the number of tournaments participated per year, with the winning group participating 7.80 times, which was more than the health promotion group (4.85 times). There was also a significant difference ($p<.05$) in self-evaluation of skills (5-point scale), with the winning group perceiving themselves as having a higher skill level than the health promotion group. There were no significant differences in other sports behavior factors.

CONCLUSION: The relationship between the activity purpose and sports behavior of participants in Beachball, the inclination toward winning was reflected in their sports behavior in the same way as in major sports.

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**DEVELOPMENT AND EFFECTIVENESS VERIFICATION OF TENNIS PRACTICE SUPPORT SYSTEM USING VR**

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INTRODUCTION: Many people are aware of their lack of exercise, but find it difficult to exercise continuously. In recent years, sports training has been conducted using Virtual Reality (VR) technology. The advantages of VR include the ability to practice in confined spaces, under any weather conditions, and even alone. Based on the benefits above, we decided to develop a tennis practice support system using VR with the aim of enabling enjoyable and continuous physical activity. The effectiveness of the developed system was verified by quantifying the hit rate to the racket and the number of successful ball returns to the opponents court. In addition, we also examined the participants' gaze during the tennis exercise.

METHODS: Sixteen university students participated in the experiment. They wore a head-mounted display, held Meta Quest Touch Pro controllers in both hands, grabbed a VR racket, and practiced volleys and strokes. Balls were launched at three-second intervals from a ball launcher in the VR space, and the participants returned the ball to a target on the opponents court. Training consisted of pre-test, practice, and post-test. In the pre-test and post-test, the players played 50 strokes and 50 volleys, respectively. In the practice session, they played 100 strokes and 100 volleys. Two modes of target movement were conducted: the first was a mode in which the target moved randomly for each ball, and the second was a focused mode in which the target moved every five balls so that the participants could concentrate on one spot at a time. The participants were divided into two groups: a random group and a focused group. The measurement items were eye gaze, electrocardiogram, stroke and volley performance, and responses from post-experience questionnaire.

Results and Discussion: Both groups showed a significant increase in stroke and volley scores in the post-test compared to the pre-test. However, no significant differences were observed between the groups. The increase in scores in the post-test suggests that the developed practice system may have been effective. However, since no significant differences were shown between the target movement modes, it is necessary to study more effective ways of moving the target. The results of the eye movement showed that the players took a closer look at the racket and the ball launcher than the target with significant differences in the eye movement between these objects. Both groups tended to focus more on the target in the post-test than in the pre-test. The heart rate during the exercise showed an increase of about 10 beats per minute compared to that at rest. However, some participants reported that the intensity of the exercise felt low in the post-experience questionnaire, suggesting the need to increase the intensity of the exercise by randomizing the position of the ball.

**GREEN PHYSICAL ACTIVITY FOR A SUSTAINABLE ENGAGEMENT TO TRAINING AND REDUCED HEALTH INEQUALITIES**

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INTRODUCTION: Sustainable commitment to physical activity (PA) for inactive people is a public health challenge. PA is beneficial to health and well-being and conversely, physical inactivity increases risk for noncommunicable diseases and other poor health outcomes. Brisk walking is considered the most popular, accessible form of physical activity potential to reduce disparities in health related to lack of PA (Lee et al., 2008). The positive long-term effects of an outdoor brisk walking program include maintenance of weight loss, as well as improvements in cardiorespiratory fitness and perceived health. These effects were observed after two years, and a large proportion of the women continued to practice PA at least 60 min/week (Garnier et al., 2024). However, do women continue to exercise outdoors or indoors? Does their practice depend more particularly on the education level or age? Does the sustained engagement in PA increase social inequalities in health? The aim of this study is to determine the location (indoor/outdoor) of PA two years after a brisk walking program once the education level and age are considered.

METHODS: Among the 91 sedentary postmenopausal (61±6 yr) women with moderate obesity (BMI = 30±5 kg/m2), 30 % had primary education level, 56 % secondary education level, and 14 % higher education level. Participants were subjected to a 16-week outdoor walking program (green PA) (3 sessions of 45 min/week at 60 % of their heart rate reserve). Two years later, women were asked additional questions about the nature and duration of the physical activity performed. Categorical variables were analyzed using chi-square test.

RESULTS: Results from the additional questions asked about PA engagement two years later showed that among the 91 women, 59 practiced outdoor PA. Among them, 55 continued to walk regularly and 4 combined walking and running; 6 practiced indoor (exercising consisting of warm-up, full body exercise, coordination, balance, stretching (90 min/week)) and outdoor PA (walking (45 min/week)); 5 women practiced indoor PA exercising only (120 min/week) and 21 women no longer practiced. No significant differences were observed once the education level and age were considered.

DISCUSSION: Our data show long term engagement in outdoor PA two years after a brisk walking program, without any increase in social inequalities in health. In conclusion, green PA leads to long-term engagement in PA.

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**EXPLORING TEACHER PRACTICE IN THE ACTIVE SCHOOL PROGRAM, "RUN, JUMP & FUN", IMPLEMENTING EXTRA DAILY MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY IN 3RD-GRADE CLASSES**

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INTRODUCTION: Schools are considered a favorable setting for engaging all children in physical activity (PA). PA can potentially enhance childrens fitness, well-being, and learning. However, to achieve these benefits, it is essential to provide feasible interventions that teachers are capable of implementing. This study aimed to explore how teachers adopted and implemented a school-based intervention for 3rd-grade students, incorporating daily sessions of moderate-to-vigorous physical activity (MVPA).

METHODS: An intervention, "Run, Jump & Fun", consisting of 4 × 30 minutes per week, was implemented in the school day for one school year. The intervention characteristics were MVPA with educational goals underpinning the activities, such as self-determination and cooperation among the students. Teachers received training in the intervention elements throughout the school year, with three courses lasting a total of 15 hours. Five semi-structured interviews were conducted with participating teachers (n=6) at four different schools at the end of the school year. The interviews were transcribed using the AI-driven transcription tool Good Tape (goodtape.io, Denmark) and manually adjusted for errors by the first author. The interviews underwent a thematic analysis across the constructs of implementation outcomes of adoption and implementation and their impact on students in 3rd-grade.

RESULTS: Three overarching themes emerged through the analysis: 1) Teacher practice of implementing MVPA, covering successes and failures, the "golden activities," time constraints, sustainment, and personal drive for the intervention; 2) Adoption of daily activities, covering the use of movement and sports pedagogy and the affordance of tools and materials; and 3) The interventions impact on students, revealing students attitudes, physical and mental progression, and general development.

Discussion: The three themes covered issues concerning positive experiences enabling the new practice and only a small number of negative experiences perceived as barriers. Teachers reported positive outcomes regarding students being more active and robust in physical activities with peers. Teachers enjoyed initiating and developing activities with MVPA and felt that they progressed in their profession. Teachers reported challenges with appropriateness concerning the schools time allocation and curricular demands.

Some teachers expressed an ambition to better integrate the intervention into their academic teaching since the schools key purpose is to educate students academically.

CONCLUSION: Overall, the intervention was perceived as feasible and valuable, particularly concerning childrens general development and physical activity levels. Teachers experienced a lack of time in the schedule to incorporate the effort and desired an intervention focusing more on learning at the expense of MVPA.

**RESEARCH ON THE OPTIMAL PATH OF FUNDING SUPPLY FOR PUBLIC SPORTS SERVICES IN SHANGHAI BASED ON THE LAGRANGE MULTIPLIER METHOD**

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INTRODUCTION: As an important part of the public service system, public sports service is an important means to improve the quality of life and health of residents. In the process of accelerating the construction of a world-famous sports city in Shanghai, public sports services have ushered in the development opportunities, but the existing supply structure is single and overly relies on tangible services and other problems, which are not able to effectively meet the needs of the public. This paper takes Shanghais public sports services as the research object, focusing on how to optimise the proportion of resources allocated to tangible and intangible public sports service provision under the limited financial budget, exploring the path to improve the overall effectiveness of public sports services, and providing scientific basis and policy suggestions for building a higher level of public fitness service system for the whole population.

METHODS: Based on the supply and demand theory and Pareto optimality theory, and combining the Lagrange multiplier method and the multi-dimensional mathematical optimisation model of Cobb-Douglas production function, the study follows the principle of 'problem diagnosis - theoretical assumptions - variable construction - model analysis Following the logical framework of 'problem diagnosis-theoretical assumptions-variable construction-model analysis-application analysis', and combining quantitative methods such as multiple regression analysis and correlation test, we extract the interactions among variables and their effects on the overall utility, and finally construct a functional model with multiple constraints to describe the trade-offs among various elements in the process of optimising the supply of facilities, and put forward a proposal for public sports service supply optimisation based on the Pareto optimisation theory. The optimal solution for the supply of public sports services is proposed based on Pareto optimisation theory.

RESULTS: This study concludes that the optimal allocation of funding for tangible and intangible service provision is approximately 5,182,500 yuan for tangible public sports services and 16,722,100 yuan for intangible services, with a ratio of approximately 1:3.23. This result suggests that with a limited fiscal budget, the government should prioritise increasing funding for intangible public sports services in order to maximise utility.

Discussion: ① The diminishing marginal utility of tangible service supply is significant. ② Intangible service allocation is the key to utility maximisation. ③Multiple driving forces drive the transformation of financial structure: from 'hardware' to

'software'. ④ The government should optimise its budget allocation strategy to give priority to the provision of intangible services.In conclusion, this study provides a theoretical basis and a practical path for the transformation of the public sports service provision model, emphasising the synergistic development of maximising residents utility and social benefits through strategic investment in intangible services.

## Conventional Print Poster Presentations

### CP-SH16 Psychological Well-Being

**THE INFLUENCE OF AESTHETIC-CULTURAL DANCE MEDIATION ON BODY IMAGE AND SELF-ESTEEM IN PEOPLE WITH OBESITY: RESULTS OF AN INTERVENTION STUDY**

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Background: Dance with an aesthetic-cultural approach (Rudi, 2021) enables people to engage directly and creatively with movement and their own body. This non-verbal experience allows for critical-reflective self-awareness and supports people in developing a personal connection to their movement and sensation (Kappert, 1990). In particular, for obese individuals who have difficulties in body perception (Syper et al., 2023), it opens up the possibility of rediscovering vibrant physicality and identity and of distancing themselves from physical discomfort. These experiences are relevant in the context of body image and self-esteem (ibid.), because body image influences affective attitudes and emotional well-being, which in turn affects self-esteem as a stable trait, well-being and self-satisfaction (Frey, 2016).

Method: The intervention study in a mixed-method design aims to use semi-structured guided interviews, body image drawings created by subjects to visually capture their individual feelings, and diary entries for reflection to examine the development of subjective attributions of meaning and to assess the influence on body image and self-esteem.

Results: Initial results show a positive effect of the dance intervention on body perception and emotional experience. Participants reported an improved connection to their own body and increased self-acceptance. The detailed analysis of the data and an insight into the research results of a more extensive study based on this research will be presented in the lecture.

Conclusions: The results show that creative movement classes can promote emotional well-being and contribute to positive self-perception.

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**DID PHYSICAL ACTIVITY, SLEEP, AND MENTAL HEALTH IMPROVE AMONG CHINESE UNIVERSITY STUDENTS IN THE POST-COVID-19 ERA? A LONGITUDINAL COHORT STUDY**

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Background

The COVID-19 pandemic seriously impacted peoples lifestyles, leading to changes in physical activity, sleep and mental health. This study aimed to assess the recovery of these indicators in Chinese university students post-COVID-19 pandemic, and explore the association between lifestyle changes and psychological problems.

METHODS: A two-wave longitudinal study was conducted with 2,748 college students in Hebei, China. Self-report questionnaires measured physical activity, sleep and psychological variables (depression, anxiety symptoms, and perceived stress) in 2022 and 2024. McNemar chi-square test compared differences between the two waves. Additionally, univariate and multivariate logistic regression analyses were performed to examine the independent and joint associations between changes in lifestyle behaviors and psychological problems across this period.

RESULTS: Proportion of physical inactivity decreased from 22.5% to 16.2%, and poor sleep quality reduced from 18.3% to 16.2% after the pandemic ($P < 0.05$). Depression and anxiety also declined ($P < 0.05$), while perceived stress remained high (64.5%). Compared to consistently inactive students, those becoming physically active (depression OR = 40, anxiety OR = 0.34, stress 0.56) and those persistently active (depression OR = 0.43, anxiety OR = 0.38, stress 0.47) had reduced psychological symptoms. However, after adjusting for confounders, the association between improved physical activity and mental health problems was insignificant ($p > 0.05$). Improved sleep (depression OR = 0.42, anxiety OR = 0.24, stress 0.42) and consistently good sleep (depression OR = 0.20, anxiety OR = 0.20, stress 0.37) also demonstrated a protective effect after fully adjusting for demographics and socioeconomic status.

Conclusions

This study found that high perceived stress persisted. Although physical activity improved across this period, its change was not significantly associated with mental health after adjustments. However, improved sleep quality was significantly associated with reductions in depression, anxiety, and perceived stress. These findings highlight the importance of sleep and physical activity in mental health recovery post-pandemic and the need for targeted interventions.

**EMPOWERING/DISEMPOWERING MOTIVATIONAL CLIMATES, PSYCHOLOGY SAFETY, AND THE QUALITY OF ATHLETE ENGAGEMENT IN SPORT**

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INTRODUCTION: Grounded in the theoretically integrated framework of the motivational climate (Duda, Balaguer & Appleton, 2024), research has found athletes to report greater well being and exhibit more adaptive engagement in sport when the coach-created climate is empowering. Disempowering climates have been linked to athlete ill-being and desires to discontinue one's involvement. This study investigated whether differential mental health and participation-related outcomes (enjoyment, commitment, dropout intentions) associated with empowering and disempowering motivational climates are explained (mediated ) by)the degree to which the coach creates an environment marked by 'psychological safety.' In psychologically safe sporting environments (Vella et al., 2022), there is open communication and athletes feel safe and able to take interpersonal risks including talking to and receiving support from the coach about mental health issues.

METHODS: 516 participants (45% women; M age = 21.3 yrs) British athletes who competed in a variety of sports at the local community (25%), regional (44%), national (26%), and international (6%) levels completed an online survey comprising validated scales tapping the targeted variables.

RESULTS: All scale scores had acceptable reliability ($\alpha > .70$). A path analysis was conducted; direct and indirect effects were tested for significance at $p < .01$. An empowering motivational climate significantly predicted a perceived psychologically safe environment (B=.59), which positively predicted enjoyment (B=.93) and commitment to one's sport (B=.59) and negatively predicted intention to dropout (B=-91). The hypothesized indirect relationships to the outcomes via psychological safety were supported. A disempowering motivational climate did not significantly predict psychological safety but, consistent with previous research, was a negative predictor of enjoyment (B=-.66) and commitment (B=-.80) and positively related (B=1.57) to dropout intentions.

Discussion: The findings provide an empirical link between the coach-created motivational climate (particularly its empowering features) and the degree to which athletes perceive their coach to create a 'mentally healthy' environment, based on the recent conceptualisation of 'psychological safety' in sport. Athletes were optimally engaged (they enjoyed and were committed to their sport and expressed lower intentions to dropout) when coaches are empowering and they feel their sport experience is psychologically safe. Disempowering coach behaviours linked to indicators of compromised sport participation.

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**SHOW ME YOUR GAME ! A CREATIVE PROTOCOL ON ATHLETES PERCEPTIONS DURING «LA FINALE DES JEUX DU QUÉBEC»**

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Despite the importance of organized sports among young Quebecers, a number of issues are leading to their decline during adolescence. Youth participation in organized sports is linked to indicators of mental health and well-being, yet competitive sporting events can be the source of increased stress and may also be responsible for an increase in anxiety trait in young athletes. Self-determination theory, achievement goal theory and well-being theory, serve as theoretical underpinnings. The general objective of this project is to document, according to the athletes perception, the quality of their experience during the Finale des Jeux du Québec on four levels : emotional (e.g. well-being, pleasure, pride), social (e.g. quality of relationships), motivational (e.g. satisfaction of needs, climate) and sport related accomplishment (e.g. performance, feeling of sporting competence). This general objective is broken down into three sub-objectives: 1) identify the athletes' level of appreciation at the competitive event ; 2) identify the quality of their experience from an emotional, social, motivational and sporting point of views; and 3) describe the athletes experience during the event. The competitive sporting event is the 59th Finale des Jeux du Québec, where near 3000 athletes, between 12 and 17, will be invited to participate. For the planned methodology, athletes will be invited to participate in six different creative methods for data collection stations (S), four of which will be located in the Athletes Village (S1 - Judge your Games, S2 – Paper pellet, S3 - Press Conference, S4 - Photo Booth) and two in the competition sites (S5 - Vox pop, S6 – Answers for the Mascot). The main results of this research project will 1) highlight the factors contributing to positive experiences for athletes participating in a national competitive event, as well as the negative factors to be considered; 2) establish parameters for leading

sports organizations and associations in order to promote a stimulating, respectful and caring environment that suits the developmental level of young athletes; and 3) provide coaches with guidelines for creating motivating environments that foster the satisfaction of young athletes psychological needs and encourage self-determined motivation, well-being and long-term commitment to sport.

**THE MEDIATING ROLE OF OPTIMISM AND PESSIMISM ON THE EFFECT OF MENTAL WELL-BEING OF PSYCHOLOGICAL PERFORMANCE IN ACTIVE ATHLETES**

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*CANAKKALE ONSEKIZ MART UNIVERSITY*

INTRODUCTION: This study aims to examine the mediating role of optimism and pessimism on the effect of mental well-being of psychological performance in active athletes.

METHODS: A total of 739 licensed athletes actively competing in Çanakkale province participated in the study, including 413 men and 326 women aged between 18 and 35. Among the participants, 406 were engaged in team sports (basketball, football, volleyball, handball), while 333 were involved in individual sports (athletics, tennis, boxing, wrestling, taekwondo, swimming). The data were collected using the Mental Well-Being Scale, Psychological Performance Assessment Scale, Optimism Scale and Pessimism Scale. Descriptive statistics, group comparisons, and correlation analyses were conducted using SPSS, while mediation analyses were performed using AMOS. The bootstrap confidence interval method was applied to test the significance of the observed effect sizes.

RESULTS: The findings revealed that optimism and pessimism had an indirect effect on the relationship between mental well-being and psychological performance. Optimism positively influenced psychological performance, whereas pessimism negatively affected it. The analyses indicated that higher levels of mental well-being significantly and positively influenced psychological performance through optimism ($p< 0.05$; $\beta = 0.06$), while pessimism had a small to moderate negative impact ($p< 0.05$; $\beta = -0.06$).

CONCLUSION: These results suggest that promoting optimism and reducing pessimism can play a crucial role in enhancing athletes psychological performance.

**ATHLETICS: THE ENJOYMENT OF TRAINING AND COMPETITION**

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The study of the psycho-social and emotional circumstances of 12 female athletes between 20 and 73 years old, most of whom participated in a previous study, allowed common concepts to be determined based on the interest expressed in continuing training, even with the weeks of vacation, as an intermediate, at the End of 2024. Their sporting interests vary in different modalities, from short-distance sprints to half-marathon competitions. In comparative function, fatigue or physical discomfort was only a characteristic at the beginning of the process, as it was overcome as the weeks went by.

A fundamental basis was documentary research, supported by authors such as Sandra Rojas, Norbert Stein, Margot Niessen, Budin, López-Cruz, Alvarez-Duque, Galinski & Giraldo-Pérez, and Vallejo & Plested, carried out through tracking and terminological analysis in athletics contexts.

This allowed corroboration of the importance and applicability of emotional intelligence in these sports training processes for athletic competition, that is, intrapersonal and interpersonal elements such as self-regulation of emotions, concentration, self-motivation, and decision-making. These tools are absolutely practical when applied, even in daily life. The specific contexts determined in the preliminary surveys, interviews, videos, photographs, facial and body expressions, and the correlation of the evaluation carried out by the instructor were also studied. These were fundamental in the situated study of the concepts that guided the research, whose methodological development allowed the findings to be ratified.

Some conclusions: The performance comparison between the youngest and the oldest did not show significant progress in terms of reducing running time in training or competitions; it can be said that they continue to be stable in their abilities.

The motivation for athletics for their emotional and physical well-being did make a big difference in the range studied. Throughout the group, there was a noticeable increase in joy, satisfaction, and the desire to continue challenging themselves in their sporting endeavors.

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**UNLOCKING STUDENT POTENTIAL: THE IMPACT OF NUTRITION, SLEEP, AND WELL-BEING ON ACADEMIC SUCCESS**

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*POLITECNICO DI MILANO*

INTRODUCTION: In the context of the LEONARDO project in Politecnico di Milano, we believe that research and education, can be integrated to create productive and virtuous cycles. Expanding this concept, we focus on a third axis: personal well-being. This vision aims to enhance students awareness of their health and abilities, recognizing that personal success is not only defined by technical skills but also by holistic well-being. LEONARDO acknowledges that technical skills are just one component of personal success and integrates well-being into the academic experience. It emphasizes the importance of health, nutrition, and sleep in boosting cognitive performance and overall success. In this context, we conducted a study to explore how an integrated approach can improve cognitive performance and academic success. The goal was to develop a tool that monitors nutrition, sleep, and physical activity, providing a personalized system that supports students well-being. This approach highlights that well-being is not only physical fitness but also cognitive and emotional balance, impacting academic performance and daily functioning

METHODS: LEONARDO emphasizes nutrition and sleep as key to well-being. It organizes sessions with nutritionists to educate students on food's impact on performance. Partnering with a company, it provides pre-prepared lunch boxes, ensuring balanced meals that enhance focus and sleep quality. Proper nutrition stabilizes energy, reducing late-night snacking and improving rest. LEONARDO also researches sleep's impact, equipping students with strategies to optimize rest, boost performance, and well-being.

RESULTS: The study showed a significant improvement in cognitive performance, with notable enhancements in verbal reasoning, memory, and attention. The cognitive tests revealed measurable increases in performance compared to the initial phase, confirming the intervention's effectiveness. Even within the first four weeks, a continuous improvement trend was observed. Data from wearable devices indicated noticeable improvements in sleep quality, including increased sleep duration and reduced nighttime awakenings. These findings highlight the positive impact of the intervention on students overall health. Together, these results underscore the importance of integrating nutrition and sleep as key factors in improving cognitive performance and well-being.

CONCLUSION: This study emphasizes the critical role of nutrition and sleep in supporting cognitive function and overall health. The integrated approach combining personalized nutrition, sleep monitoring, and cognitive assessments proved effective in improving cognitive performance across domains. By enhancing both diet and sleep quality, students experienced better academic performance, improved mental clarity, and better physical and emotional health. These findings suggest that universities should adopt integrated approaches to support students holistic well-being.

**PRE-ACL SURGERY PSYCHOLOGICAL DISTRESS AND THE PSYCHOLOGICAL READINESS TO RETURN TO SPORT: THE MODERATION ROLE OF SOCIAL SUPPORT.**

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*UNIVERSITY OF FORO ITALICO*

Literature reported several empirical evidence among the pivotal role of the psychological factors in the athletes' return to sport process after anterior cruciate ligament reconstruction (ACLR), with particular attention to the psychological readiness [1]. The present study explores the role of pre-surgery psychological distress on the future psychological readiness trying to understand the possible moderation effect of social support, also controlling for other important variables in this process, such as fear of movement, self-efficacy on knees function and knee perceived functionality.

Forty-one patients (mean age = 27.7±12.7 years; 80,5% male) who have undergone ACL reconstruction surgery with the same surgical staff were enrolled in the study.

Participants were asked to respond to a set of questionnaires before the ACL reconstruction surgery (i.e., Pre-Surgery Assessment) and after 30 days of the surgery (Post-Surgery Assessment).

Pre-Surgery assessment included: a) psychological distress, namely anxiety and depression (Hospital Anxiety and Depression Scale – HADS); b) perceived social support (Multidimensional Scale of Perceived Social Support- MSPSS). Post-Surgery assessment included: d) psychological readiness in terms of emotions, confidence in performance, and risk appraisal with respect to return to sport after ACL reconstruction (Return to Sport after Injury Scale-ACL– RSI); e) fear of movement, or (re)injury (Tampa Scale of Kinesiophobia - TSK); f) perceived self-efficacy of knee function after ACL injury (Knee Self-Efficacy Scale- KSES); g) symptoms, function, and sports activity (International Knee Documentation Committee -IKDC).

Separated partial correlations were carried out for the two groups (HIGH Vs. LOW perceived support group) connecting psychological distress (i.e., Anxiety and Depression) with the psychological readiness to return to sport statistically controlling for TSK, KSES and IKDC. The partial correlations showed that for patients perceiving relatively HIGH support the psychological distress is not significantly related to their psychological readiness to return to sport 30 days after the surgery (r=-.271; p=.349). Otherwise, analyzing data of patients perceiving relatively LOW support, clearly emerged that their psychological distress before the ACL surgery is strongly and statistically significantly negatively associated with the readiness to return to sport after the surgery (r=-.728; p=.011).

The study attested the moderation role of perceived social support that seems to buffer the negative impact of psychological distress on return to sport. Results suggested the importance to consider and care the patients' psychological distress as early as in the first stages of the surgical treatment also fostering the social support around the patient.

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**IMPACT OF SOCIAL ISOLATION ON PHYSICAL ACTIVITY ADHERENCE: BIOPSYCHOSOCIAL FACTORS INFLUENCING LIFE-STYLES AMONG BRAZILIANS**

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*SCHOOL OF PHYSICAL EDUCATION AND SPORT OF UNIVERSITY OF SAO PAULO*

INTRODUCTION: Social isolation during the Covid-19 pandemic has required resilience to adhere to healthy habits, including physical activity levels. This study aimed to assess changes in physical activity adherence during this period, focusing on biological, psychological, and social factors.

METHODS: This cross-sectional study included 3,898 adults (n=2,289 physically active; n=1,609 insufficiently active). Participants completed an online survey assessing self-reported data on anthropometric and socioeconomic variables (sex, age, body mass index [BMI], educational attainment, and fear of COVID-19 effects) and exercise-related behaviors before (Transtheoretical Model of Behavioral Change [TTM], and Physical Activity Enjoyment Scale [PACES] for prior exercise experiences) and during social isolation (beliefs regarding attitude, subjective norm, and perceived control), including physical activity levels in both periods. Statistical analyses compared physically active and insufficiently active groups, while a Multilayer Perceptron algorithm identified the most relevant characteristics for significant comparisons in each group.

RESULTS: Overall, the sample showed a significant decrease in physical activity levels from before to during social isolation ($p < 0.001$ for duration, frequency, and intensity). Except for BMI, the insufficiently active group showed worse values in all variables ($p < 0.05$). The Multilayer Perceptron algorithm ranked the most important characteristics as: 1st) Lower perceived control beliefs, a lower percentage of subjects in the maintenance stage of the TTM, and lower scores on process change; 2nd) Lower educational attainment, a higher rate of subjects exhibiting fear of the effects of COVID-19, and a higher proportion of women; 3rd) Lower attitude beliefs, younger age, lower enjoyment from exercise experiences, lower self-efficacy, lower decisional balance, and lower subjective norm beliefs. The insufficiently active group exhibited greater fluctuation in their physical activity behaviors, while the physically active group showed opposite characteristics during the isolation period.

Discussion: Social isolation measures during the COVID-19 pandemic significantly reduced physical activity levels in Brazil. Individuals with lower self-efficacy and inconsistent exercise routines were more likely to experience a decline in activity levels. To improve adherence, interventions should target individuals who struggle to maintain physical activity, focusing on perceived control, self-efficacy, and exercise enjoyment. Exercise professionals should enhance these psychological characteristics and provide ongoing support to help individuals sustain physical activity during challenging periods like social isolation. These characteristics reflect the need for resilience to maintain exercise routines in adverse situations, such as the pandemic.

## Conventional Print Poster Presentations

### CP-SH19 Psychology V - Mental Health

**SANETPERF: A VIRTUAL REALITY AND MENTAL PREPARATION APPROACH TO ENHANCE MENTAL HEALTH AND SPORTS PERFORMANCE**

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*INSERM U1075 COMETE - UNIVERSITÉ DE CAEN NORMANDIE*

SanEtPerf: A virtual reality and mental preparation approach to enhance mental health and sports performance

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Inserm U1075 COMETE - Université de Caen Normandie

INTRODUCTION: Optimizing mental health is essential for elite athletes performance, yet it is often overlooked in favor of physical and technical training.

Studies, such as the Drake Football Study, emphasize the need for long-term psychological monitoring in football players (Gouttebarge et al., 2019). Virtual reality (VR) has shown promising results in cognitive and motor training under stress (Neumann et al., 2018), while mental preparation (MP) enhances emotional resilience and cognitive efficiency (Ross-Stewart et al., 2018). The SanEtPerf project aims to evaluate the effectiveness of a combined VR and MP protocol in regulating stress, improving sleep quality, and optimizing sports performance in professional footballers.

METHODS: A sample of male and female football players from Stade Malherbe de Caen (N = 22) will participate in a crossover experimental design. The study consists of three phases:

Pre-test: Collection of anthropometric data, body composition, biomechanical measures, self-reported stress (STAI), and actigraphy-based sleep monitoring.

Intervention: Athletes undergo five VR-based stress exposure sessions, incorporating decision-making under pressure, coupled with mental preparation strategies such as cognitive reframing and attentional control.

Post-test: Reassessment of the same variables to quantify the impact of the intervention on emotional regulation, sleep efficiency, and motor performance.

Expected RESULTS: This study hypothesizes that:

VR exposure combined with MP will significantly reduce stress and anxiety levels in high-pressure environments.

Improved emotional regulation will enhance sleep quality, leading to better recovery.

Athletes will show improved motor performance under stress, as assessed through biomechanical testing.

Discussion: The interplay between mental resilience, stress regulation, and performance optimization is a crucial aspect of high-level sports. Findings from SanEtPerf will contribute to a deeper understanding of how technological and psychological interventions can synergistically enhance athletes well-being and competitive abilities. If validated, this protocol could be applied broadly across various elite sports to provide scalable, personalized training tools for mental health and performance enhancement.

CONCLUSION: By integrating neuroscience, immersive technology, and sports science, SanEtPerf proposes a novel and interdisciplinary approach to optimize both mental well-being and motor performance. These findings will be presented at ECSS 2025 in Rimini, contributing to discussions on VR-based interventions in elite sports training.

**EFFECTS OF AN EXERCISE INTERVENTION ON DEPRESSIVE SYMPTOMS, CORTISOL AND SCREEN TIME OF YOUNG ADULTS: A RANDOMISED CONTROLLED TRIAL**

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INTRODUCTION: Depression has become a prevalent and debilitating public health condition and the predominant cause of suicide globally, affecting mostly young adults (1). Increased screen time may contribute to depressive symptoms (2). Pharmacological interventions are the first-line treatment, while exercise interventions in adults show promise as an effective alternative treatment option (3). Limited research exists about the effects of a supervised exercise intervention on symptoms of depression, cortisol and screen time in young adults (3). This study aimed to examine the effect of a supervised aerobic exercise intervention on depressive symptoms in young South African adults aged 18-25 years.

METHODS: Seventy-nine (n=79) young adults between 18-25 years (21.8 ± 1.8 years) were randomly assigned to a 12-week supervised aerobic exercise (AE) intervention (n=43) or a control group (n=36). Participants with a Beck's Depression Inventory (BDI)-score of >10 were included in the study. Cortisol, objective habitual physical activity (ActiHeart®) and screen time were measured at baseline and after the 12-week intervention. The intervention consisted of three 60-minute exercise sessions per week. Descriptive statistics and independent T-tests determined statistically significant changes in the outcome variables of the control group compared to the AE group.

RESULTS: The average BDI-score at baseline was 20.95 ± 8.35 points. Cortisol concentrations were 459.7 ± 166.58 nmol/L while engaging in 90.94 ± 86.91 min/week of moderate-to-vigorous physical activity (MVPA) and 3151± 2982 min/week screen time. BDI ($t_{52}$ = -5.45, p=0.027; d=0.7) and screen time ($t_{52}$ = -608.35, p=0.005; d=0.6) decreased significantly from pre- to post-intervention in the exercise group compared to the control group. None of the other variables reported significant changes.

CONCLUSION: Twelve weeks of a supervised aerobic exercise intervention significantly decreased depressive symptoms and screen time in young adults. Exercise as a first-line treatment should be considered to prevent detrimental effects of early pharmacological interventions on health outcomes.

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**NEGATIVE EFFECT OF FMT FROM EXERCISED MICE ON SDS INDUCED DEPRESSION-LIKE BEHAVIOR**

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322 million people worldwide have reported feeling depressed according to the World Health Organization. Recently, we reported that exercise habits may prevent depressive-like behavior via gut microbiota and short chain fatty acids in mice. In this study, we examined whether fecal microbiota transplantation (FMT) from mice with voluntary wheel running could prevent depressive-like behavior in social defeat stress (SDS) mice. Donor mice (C57BL/6, 4week, male) were treated with voluntary wheel running (WR) and sedentary control (C) for 10 weeks. Recipient mice (C57BL/6, 4week, male) were divided into two groups, the CTP and WRTP. The recipient mice were administered an antibiotic solution for 7 days, and then FMT was performed. The CTP group received the transplanted mouse stool from the C donor group and the WRTP group from

the WR donor group once a week for a total of 3 weeks, respectively. After the FMT, the recipient mice were loaded with SDS for 10 days. These SDS treated mice were then subjected to physical interactions with ICR mice for 5 min, and then the mice were housed on the opposite side of a stress cage for 24-h. After that depressive-like behavior in recipient mice was measured using the sucrose preference and the social interaction tests. After these behavioral tests, the mRNA expression of the Bdnf, Tnf-α, 5-ht 1a and Fndc5 in the brains and the fecal microbiota of recipient mice were analyzed. The sucrose preference test, no significant different between the CTP and WRTP groups was found. However, the social interaction test scores of the WRTP group were significantly lower than that of the CTP group. The Bdnf, Tnf-α, 5-ht 1a and Fndc5 expressions in the hippocampus of the recipient mice showed no difference between the CTP and WRTP groups. The FMT altered the β-diversity from the recipient mice. In the WRTP group, several f_Lachnospiraceae were decreased compared to the CTP group. A correlation between the decrease in Lachnospiraceae and the decrease in the social score was shown. Furthermore, a positive correlation between the Ruminococcus and the 5-ht 1a expression in hippocampus was observed. Associations between Lachnospiraceae and depression or mental disorders were reported. Lachnospiraceae and Ruminococcus had lower relative abundance in the WRTP group. We previously reported that an increase in Lachnospiraceae was observed in exercised mice exposed to SDS. Accordingly, the reason that WRTP did not prevent SDS-induced depressive-like behavior might be because the running wheels were not set up in their cages after the mice were exposed to SDS. On the other hand, recent studies reported direct or indirect results showing the preventive depressive-like behavioral effects of exercise. Protective depression may require not only changes in gut microbiota but also regular exercise. Our results suggested that the FMT from donor mice with wheel running exercise habits might not protect SDS-induced depressive-like behavior.

**LOOKING FOR RELIEF WHEN YOU EXERCISE COMPULSIVELY – A STUDY REVIEW**

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INTRODUCTION: Exercise addiction is classified as a behavioral problem that can have negative consequences, affecting daily life and optimal functioning. Despite its significant impact on psychological and physical health, there is limited knowledge about effective treatment methods for this condition. The purpose of this review is to present the current state of research on psychotherapeutic interventions for exercise addiction.

METHODS: Scientific electronic databases were searched, and a total of 11 articles that met the inclusion criteria were selected. Three of these publications (published between 1995 and 2023) reported studies that investigated psychotherapeutic interventions—Rational Emotive Behavior Therapy (REBT), Cognitive Behavioral Therapy (CBT), and Motivational Interviewing (MI)—in small groups of participants. Additionally, eight publications (published between 1990 and 2017) described the use of psychotherapeutic interventions (CBT and MI) and were selected for analysis. This review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The Cochrane Collaboration tool was used to assess the risk of bias and evaluate study quality. Statistical analyses were performed using the R software package.

RESULTS: Rational Emotive Behavior Therapy (REBT), Cognitive Behavioral Therapy (CBT), and Motivational Interviewing (MI) were used to help individuals struggling with primary and secondary exercise addiction reduce their negative symptoms. The findings showed promising results, which may support the long-term maintenance of recovery.

CONCLUSION: More high-quality studies are needed to evaluate the effectiveness of psychotherapeutic interventions in reducing the negative symptoms of exercise addiction. It is essential to support individuals with both primary and secondary exercise dependency and to develop an effective treatment program.

**GENERAL ASPECTS FOCUSED ON PSYCHOLOGICAL AND EATING DISORDERS OF PEOPLE WHO PRACTICE BODYBUILDING; DESCRIPTIVE MONOGRAPHIC REVIEW**

LEDEZMA GUTIERREZ, D.
*UNIVERSIDAD DEL VALLE DE MEXICO Y ESCUELA UNIVERSITARIA REAL MADRID*

Abstract: The objective of this work is to describe the relationship between psychological disorders and eating disorders (ED) in bodybuilders. In order to raise this objective, a descriptive monographic review work was carried out, for which certain bibliography was selected and delimited in search of data in order to provide an answer to the uncertainty of the proposed research. The information search strategy was carried out in 2 databases: PubMed and Google Scholar, searching for information in Spanish and English, taking into account the following inclusion and exclusion criteria. Inclusion criteria: articles related to the practice of bodybuilding, articles related to sports psychology, bodybuilding and psychological disorders, articles related to sports supplementation in bodybuilding and articles related to eating disorders. (TCA). Exclusion criteria: athletes under 18 years of age, articles on psychological and nutritional disorders focused on other sports, people who do not do physical exercise. The study sample is made up of 18 articles by different authors.
Intake of dietary supplements; Sport nutrition, Psisical activity, Nutritional Science and sport, Dietary supplements, eating disorder in bodybuilding (TCA in bodybuilding), Body image, Body image, Bigorexia in bodybuilding, muscle dysmorphia, behavior in bodybuilders, behavior in bodybuildings.
The results achieved, starting with the analysis of the study carried out by Alonso Andrade, García et al. 2012 and Devrim et al. 2018 it is confirmed that bodybuilders carry out practices that are considered high risk for health and in the psychological aspect with the study carried out by Arbinada and caracuel 2008, it is shown that bodybuilders are more realistic, practical, objective, utilitarian, concrete, organized and disciplined and that the majority of these athletes present vigorexia and body image disorder.

## Conventional Print Poster Presentations

### CP-SH22 Psychology and Sociology - Mixed

**GRITTY AND GAME SMART: PSYCHOLOGICAL MECHANISMS TO EXPLAIN THE RELATIVE AGE REVERSAL IN ELITE MALE YOUTH SOCCER**

HENDRY, D., LARKIN, P., OCONNOR, D., WILLIAMS, A.M., VACI, N., BILALIC, M.
*NORTHUMBRIA UNIVERSITY*

Introduction

The relative age effect (RAE) represents a selection bias favouring individuals born earlier in a selection period (e.g., January–March) over those born later (e.g., October–December). Despite being highly prevalent in elite youth sports, research increasingly highlights a relative age reversal at the adult and professional levels. While various theoretical positions have been proposed for this reversal, there is a notable lack of empirically supported psychological explanations for its effects.

Methods

Elite male Australian youth soccer players (n = 388) completed a battery of lab-based, soccer-specific perceptual cognitive tests (e.g., anticipation, pattern recall) and the Short-Grit Scale (Duckworth et al., 2009) at age 14 yrs (M age = 13.8, SD = .8) in October 2013. Players were categorised into 4 quartiles of the selection year; Q1 (Jan – March), Q2 (April – Jun), Q3 (July – Sept) and Q4 (Oct – Dec). All players were then followed up 10 years after (January 2024) initial data collection to establish their current expertise status (professional, semi-professional, drop-out).

Results

A higher percentage of late born players (Q4) reached professional status and fewer dropped out from football than earlier born peers (Q1). Relatively younger player (Q4) scored higher on measures of grit (p = .001) and its sub factors con-

sistency of interest ($p < .001$), and perseverance of effort ($p < .05$) compared to Q1 players. They also scored higher on lab-based tests of perceptual-cognitive skill including knowledge of situational probabilities ($p = .01$), and pattern recognition ($p = .04$), but not anticipation or decision making ($p's > .05$)

Discussion

Although the relative effect appears to persist in adulthood, it is noteworthy that Q4 players are proportionately more likely to advance to professional status and less likely to drop out than earlier born players. Thus, indicating an earlier filtration process for late born players. Findings also provide empirical evidence to support psychological explanations for the relative age reversal effect amongst a sample of highly skilled football players. Late born players were grittier and appeared to have higher game intelligence skills than early born players, suggesting that these psychological factors may act as compensatory mechanisms against their purported chronological disadvantages.

**TITLE: PERSONALITY TRAITS OF MULTI-MARATHONERS: A TIPI PERSPECTIVE**

LUNDY, L., REILLY, R., FLEMING, N., WILCZYNSKA, D.

*TRINITY COLLEGE DUBLIN*

Objectives: Multi-marathoning is a sport for athletes dedicated to completing 100 or more marathons. This study investigates the distinct personality traits of multi-marathoners, compares them to public norms, and identifies specific groupings that highlight potential risks, vulnerabilities, and strengths. The findings also explore the implications of these traits on participation, performance, and overall well-being.

Methods: A cross-sectional survey was conducted targeting the global multi-marathon community, utilising the Ten Item Personality Inventory (TIPI) (1). The study included 593 survey respondents (56% men, 44% women; mean age = 53.87 years, SD = 9.91) with an average marathon completion count of 146.52 from 22 countries, capturing the diverse demographic of the global multi-marathon community. Statistical analyses were performed using Mann-Whitney U tests, ANOVA Aligned Rank Transform (ART) tests, and Spearman's ρ correlations. These correlation analyses were further supplemented with data from a previous study on the demographics and behaviors of multi-marathoners, which included information on motivation, injuries and recoveries, diet, and chronic health conditions such as heart disease and high blood pressure. (2). Latent Class Analysis (LCA) was then used to identify subgroups with shared personality traits.

Results: LCA identified four latent groups, each exhibiting unique combinations of high conscientiousness, low emotional stability, low openness, and varying levels of agreeableness and extraversion. Compared to the general population, multi-marathoners demonstrated significantly higher conscientiousness ($F(1,591) = 2.42$, $p < 0.001$) and lower emotional stability ($F(1,591) = 5.525$, $p < 0.001$). Across all age groups and genders, agreeableness and emotional stability were notably lower ($p < 0.001$). Women showed higher conscientiousness and agreeableness than men. ANOVA ART tests revealed significant age-related differences in extraversion, agreeableness, and emotional stability ($p < 0.05$), with post-hoc analyses confirming that women had significantly higher agreeableness ($W = 50809$, $p < 0.001$).

Conclusion: High conscientiousness reflects the self-discipline of multi-marathoners, while low emotional stability indicates potential challenges in stress management. The identified latent groups reveal vulnerabilities, such as increased risks of stress and injury, highlighting the need for interventions like resilience training. Future research should focus on longitudinal studies and the validation of short-form assessment tools to better support well-being (1, 2).

Key References:

1. Gosling SD, Rentfrow PJ, Swann WB Jr. A very brief measure of the Big-Five personality domains. Journal of Research in Personality. 2003;37(6):504-28.

2. Lundy L, Reilly RB. Demographics, culture and participatory nature of multi-marathoning-An observational study highlighting issues with recommendations. PLoS One. 2024;19(5):e0302602.

**POSTURE AND PERSONALITY. A PILOT STUDY AMONG YOUNG DIGITAL NATIVES**

NART, A., SARTOR, C.

*UNIVERSITY OF PADUA*

Introduction

Posture reflects the way the body positions itself and moves in space. It is a complex expression of our being, influenced by internal (psychological and emotional) and external (cultural and social) factors. The aim of the present empirical study was to investigate the connection between perceived posture in everyday contexts (home, school and technology-related habits) and individual personality by integrating the theoretical perspectives of embodied cognition, emotional expression, and kinesthesia.

METHODS: The online questionnaire Posture and Personality, based on a 1-5 Likert scale, was submitted to a representative sample of 37 students (F 21; M 16) - randomly selected from a group of 150 students from three secondary schools – aged about 18 years old and the data collected were processed using the statistical software RStudio. The Posture and Personality Questionnaire is the combination of two questionnaires already validated in scientific literature (Schwertner et al. 2018 and Morizot, 2014). The self-report was administered online (by WhatsApp, Instagram) via QR Code distribution.

Results

The results indicated significant correlations between perceived posture and specific personality traits, such as: extroversion, agreeableness, conscientiousness, neuroticism, openness to experience. In particular, among many significant data, neuroticism emerged as the most influential variable in determining individuals' total posture (r=.87; p<.0001) and extraversion as the relevant trait in postural control in the classroom (r=.71; p<.001), while conscientiousness acquired greater importance in the transport of objects (r=.79; p<.001). The use of technology related with posture showed that the neuroticism variable is associated with a contracted posture when using digital devices (r=77; p<.001), while conscientiousness favours a more ergonomic attitude (r=73; p<.001).

Conclusions

The statistical analysis revealed interesting dynamics between personality trait variables and the different postural contexts under examination. The neuroticism variable stands out as the most influential in determining participants' total posture, suggesting consistence in its cross-sectional effects on various aspects of daily posture. The analysis conducted showed that the types distinguishing individual's personality can help us predict the outcome of their posture in daily contexts. The results suggest the importance of considering the body, particularly the sensorimotor system, as an integral part of the mental system, in line with embodied cognition approaches. Movement education would improve not only young people's awareness of their posture, but it could also promote active lifestyles, healthy habits and increasingly widespread emotional well-being among students.

**PHYSICAL ACTIVITY IS AN IMPORTANT RESOURCE FOR IMPROVING WORK PERFORMANCE AND SERVES AS A MEANS FOR RESILIENCE AND RECOVERY AMONG MARKETING EMPLOYEES IN STRESSFUL BUSINESS CAREERS.**

SOLLERHED, A.

*KRISTIANSTAD UNIVERSITY*

INTRODUCTION: Appearance and body language are key components of non-verbal communication and play a crucial role in the marketing and business sector, where individual employees represent the company brand. Despite their importance, organizational support from companies appears to be minimal or non-existent, leaving stress-coping and recovery strategies largely to the individual.

Aim

The aim of this study was to explore experiences and perceptions of work stress and resources for work resilience and recovery among employees in the marketing and business sector, where appearance and body language are key components of non-verbal communication.

Methods

Interviews were conducted with 15 marketing and communication employees (five males, ten females) at multinational companies. The employees were either marketing managers or marketing officers with 4-39 years of work experience. The interviews varied in length and depth, generally lasting between 40 and 120 minutes. They were digitally recorded and transcribed verbatim before analysis. The transcripts were analyzed using a combination of thematic and qualitative content analysis.

Results

The analyses revealed two main themes with subthemes:

1. Perceived stressful work demands (Adaptation to situation and culture; Gender roles).

2. Perceived resources for work and recovery (Experience and age benefits; Physical activity resources).

Discussion: Marketing employees perceive their work as stressful due to various dilemmas related to representing the company. Their engagement in maintaining a good appearance and representing the company's brand effectively, along with self-protection to achieve a sense of ability and control in different situations, led them to create their own job resources. They associated success in their careers with being in good shape, fit, and feeling strong. Physical activity was a conscious strategy related to their work life. Fitness provided them with a sense of capability and control in their work. They invested time, commitment, money, and effort to be representative and to look good and appropriate for work. They perceived their appearance as part of the company brand, where both their competence and appearance were in focus.

CONCLUSION: Physical activity and fitness were seen as prerequisites for better work performance, good appearance, and self-confidence at work. A well-trained and fit body was important for status and authority in business and for coping with stressful situations. Physical activity was also viewed as the most important resource for resilience, recovery, and recharging energy for work. Therefore, organizational support from business-driven companies needs to be more comprehensive in supporting employees opportunities for physical activity.

**LATENT PROFILES OF INTERPERSONAL EMOTION REGULATION IN ADOLESCENT ATHLETES: EXPLORING DENSITY, CENTRALITY, AND FRAGMENTATION IN TEAM DYNAMICS**

ROMERO, V., GERVILLA, Y., RAMIS, Y., LÓPEZ DE SUBIJANA, C., TORREGROSSA, M., LLABRÉS, J., MOLINA, J., PORTILLO, J., PONS, J.

*UNIVERSITAT DE LES ILLES BALEARS*

INTRODUCTION: Efforts have been made to identify factors that protect adolescent's mental health, with the beneficial role of sports being emphasized (Simpson et al., 2024). Emotional regulation has been observed to play a key role in adoles-

cents' well-being and mental health (Bird et al., 2021). Given that adolescence is the stage when peers exert the greatest influence, it is important to explore profiles of interpersonal emotional regulation within sports teams (Tamminen et al., 2016).

Method: A total of 2043 adolescent athletes (56.9% men, Mdage=15.9) from 225 Spanish teams responded to the Emotion Regulation of Others and Self-Questionnaire (EROS). Social Network Analysis was used to analyze interpersonal emotion regulation, including density (connections in the team vs. total possible connections), centrality (connections of a player with teammates), and fragmentation (how divided the team is into disconnected components). Latent profile analysis (LPA) identified profiles of interpersonal regulation using centrality. ANOVA was used to examine differences between profiles in continuous variables (density and fragmentation), and chi-square tested differences in the categorical variable (gender).

RESULTS: The best-fitting model identified four patterns of emotional regulation (ER) among the players. Profile 1 includes athletes whose ER is generally low, 'Low regulators', Profile 2 includes those with generally average ER, 'Average regulators', Profile 3 includes athletes who stand out for their high worsening ER, 'Negative regulators' and Profile 4 includes athletes distinguished by their high improving ER, 'Positive regulators'. The profiles did not differ in terms of the density of ER of improvement (e.g. helping and listening to teammates), but differences were observed in the density scores of ER of worsening (e.g. complaining about the teammates). Players in the Negative regulators profile tend to belong to teams with higher ER of worsening. Additionally, players in the Low regulators and Negative regulators profiles tend to belong to teams with greater fragmentation in improvement efforts (i.e., lower connection between teammates), whereas regarding worsening efforts, Negative regulators tend to belong to teams with higher connection between teammates (i.e., lower fragmentation). Gender differences were observed across the profiles [$\chi 2$ (3) = 31.4, $p < .001$], with the greatest disparity found in 'Negative regulators', where women represent only 18.5%.

Discussion: These results highlight the variance in interpersonal emotional regulation behaviors among athletes and their relationship with their team's emotion regulation dynamics. The findings suggest a connection between athletes tendency to regulate their teammates' emotions and the overall emotional climate of the team. Future studies should explore how these different profiles relate to the mental health of young athletes.

**SPORT AND LEISURE SOCIAL PROJECTS IN BRAZIL: SOCIAL REPRESENTATIONS OF PARTICIPANTS**

MARINHO, A., CUNHA, B.F., LUIZ, M.E.T., MARTINS, S.M.

*STATE UNIVERSITY OF SANTA CATARINA*

Introduction: Social projects are public interventions that aim to continue the process of comprehensive development of young people outside of the school environment. Among the different types of social projects are those related to sports and leisure. In Brazil, sports and leisure are social rights provided for in the Brazilian Federal Constitution of 1988. When understood as distinct, complex, and plural phenomena, leisure and sports can act as facilitators of pedagogical and educational actions, promoting social and moral values, in addition to physical and cognitive capacities. In the Brazilian reality, social sports and leisure projects are suitable opportunities for this practice, as they serve children and adolescents in situations of social vulnerability, with the perspective of providing them with alternative educational possibilities. The success of these projects is based on the dialogue established between the institutional proposals and the expectations of their participants, considering their experiences, needs and meanings, which can be identified through ongoing conversations and observations. Given these considerations, this study aimed to investigate the social representations that students of social sports and leisure projects have about these projects.

Methodology: This descriptive-exploratory field study employs a qualitative approach to data, grounded in the Theory of Social Representations (Jodelet, 2001). Data collection was conducted through focus groups with 84 students participating in nine government-funded social sports and leisure projects, which are offered free of charge to the population in the city of São José (SC), southern Brazil. The data were organized using NVivo software, version 14, and analyzed through the content analysis technique (Bardin, 2016).

Results: As a result, the responses were grouped into two main categories, considered core representations: "spaces for self-realization" and "interpersonal relationships." These findings indicate that the social projects investigated serve as learning environments where participants primarily develop motor skills to enhance their sports performance during leisure activities. Additionally, they function as spaces for social interaction, fostering peer engagement, enjoyment, and moments of relaxation.

Conclusion: We emphasize the importance of social projects that establish ongoing dialogue with their participants. This continuous engagement allows for a better understanding of the diverse contexts in which they operate, enabling the systematization of interventions based on significant elements that contribute to the projects' longevity.

References:

Bardin, L. (2016). Análise de Conteúdo. Edições 70.

Jodelet, D. (2001). Representações sociais: um domínio em expansão. As representações sociais, 17(44), 1-21.

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**REVIEW OF THE HISTORY, OPPORTUNITIES, CHALLENGES, AND DEVELOPMENT STRATEGIES OF WOMENS PARTICIPATION IN WINTER SPORTS AROUND THE WORLD**

LIU, Y.
*UNIVERSIDADE DA CORUÑA*

research objective

This article summarizes the development process of womens participation in winter sports around the world, analyzes the opportunities and challenges of womens participation in winter sports at the current stage, and studies the development strategies for womens participation in winter sports around the world.

Research object : Female athletes participating in world winter sports ; research method ; Literature review method, data induction and statistical analysis method, expert discussion Method: Research results ; Early participation (late 19th century to early 20th century): In the early stages of winter ice and snow sports, womens participation was relatively low. However, with the gradual change of social concepts and the rise of womens rights movements, women have gradually begun to participate in winter ice and snow sports.

Enhancement of athletic level (mid-20th century): With the popularization of winter ice and snow sports and advances in technology, womens athletic level in these sports gradually improved. For example, in events such as skiing and figure skating, female athletes begin to demonstrate skills and abilities comparable to male athletes.

Breakthrough on the international stage (late 20th century early 21st century): Womens performance in winter ice and snow sports began to gain recognition on the international stage. For example, in the Winter Olympics and other international events, female athletes began to win medals and honors, breaking the male monopoly in these fields.

Popularization and professionalization (21st century present): With the further popularization of winter ice and snow sports and social support for womens participation in sports, the participation and professionalization of women in these sports continue to increase. At the same time, the image of women in winter ice and snow sports has gradually shifted from traditional "softness" to a combination of "strength and skill".

Overall, the development path of womens participation in winter ice and snow sports worldwide is a gradual process from initial participation, improvement of competitive level, breakthroughs on the international

**OXYTOCIN AS A POTENTIAL MEDIATOR BETWEEN AEROBIC FITNESS AND SOCIAL FUNCTIONING IN SCHIZOPHRENIA**

CHENG, M., GOH, K., CHEN, C., WANG, C., YANG, C.
*NATIONAL CHENG KUNG UNIVERSITY*

INTRODUCTION: Although the positive effects of aerobic fitness on social functioning in individuals with schizophrenia have been extensively studied, the underlying biological mechanisms remain unclear. Specifically, it is unclear whether oxytocin plays a critical role in this relationship. To address this research gap, we investigated whether plasma oxytocin levels mediate the relationship between aerobic fitness and social functioning.

METHODS: The study recruited a cohort of 72 individuals with schizophrenia. Aerobic fitness was assessed using the six-minute walk test, and social functioning was evaluated with the Social Functioning Scale. To determine whether oxytocin mediates the relationship between aerobic fitness and social functioning, a mediation analysis was conducted using the bootstrapping method of Process SPSS macro.

RESULTS: In patients with schizophrenia, aerobic fitness was positively correlated with the oxytocin levels ($r = .25$, $p = .04$) and SFS scores ($r = .30$, $p = .01$). A mediation model was constructed to explore these association. Results showed significant regression coefficient between aerobic fitness and plasma oxytocin levels ($p = .04$) and between plasma oxytocin levels and social functioning ($p = .007$). The bootstrapped unstandardized indirect effect was also significant ($\beta = .21$, SE = .28, 95% CI [.0022, .47]) after controlled gender. These results indicated that plasma oxytocin levels partially mediate the effect of aerobic fitness on social functioning.

CONCLUSION: Our findings suggest that plasma oxytocin partially mediates the relationship between aerobic fitness and social functioning, suggesting that individuals with higher physical fitness may experience elevated oxytocin levels, which would, in turn, enhance social functioning in schizophrenia. These results provide novel insights into the interplay between physical fitness and neurophysiological processes, highlighting oxytocin as a key biological mechanism linking physical health to social behavior. Such insights provide important significant potential for interventions aimed at improving social functioning in schizophrenia.

# Friday, 4 July 2025

## 08:00 - 09:15

Invited Symposium

IS-AP04 Advancing Performance: The Applied Use of Wearable Technologies in Sports Science

**ACCURACY AND PRACTICAL APPLICATIONS OF WEARABLE SMART WATCH TECHNOLOGY IN SPORTS SCIENCE**

LEPLEY, A.
*UNIVERSITY OF MICHIGAN*

Wearable technology is widely used by athletes and physically active individuals to monitor their health and fitness, record and document workouts, and enhance the overall exercise experience. Smart watch wearable technology has become increasingly popular in both recreational and professional sports settings due to its accessibility, ease of use, and ability to continuously track a variety of physiological parameters. However, questions remain regarding the accuracy and reliability of the physiological and performance metrics these devices provide. This session will explore the capabilities and limitations of smart watches in the context of sports science, with a focus on evaluating their accuracy in measuring key parameters such as heart rate, energy expenditure, sleep patterns, and physical activity levels. Dr. Lepley will present research comparing the data accuracy of smartwatches with that of gold-standard laboratory equipment, including electrocardiograms (ECGs), metabolic carts, and motion capture systems. Emphasis will be placed on identifying the conditions under which smart watch accuracy excels or falters, such as environment, participant skin tone, task completed, etc. and how these devices can be best utilized by researchers, coaches, and athletes to gather actionable data. Practical case studies will illustrate how smartwatches are currently being used to monitor athletes' health and performance during training and competition. Additionally, the session will discuss user compliance and other practical considerations for implementing smartwatch technology in long-term monitoring protocols. Dr. Lepley aims to provide attendees with insights into the practical application of smart watch data for personalizing training programs, assessing workload, and evaluating recovery, while also addressing the key accuracy concerns that can influence decision-making in both research and practice. Dr. Lepley will also discuss emerging trends and future directions, such as the potential for non-invasive biomarkers, real-time injury prediction algorithms, and the use of wearables to enhance the mental as well as physical performance of athletes.

**PLAYER TRACKING TECHNOLOGY FOR TEAM TACTICAL ANALYSIS**

OLTHOF, S.
*LIVERPOOL JOHN MOORES UNIVERSITY*

The implementation of sports technology has transformed how teams and individual athletes approach performance optimization. From real-time tracking devices to advanced video analytics, modern sports technologies offer a wealth of data-driven insights that enable coaches and sports scientists to make informed decisions aimed at maximizing performance outcomes. This session will focus on the practical integration of player tracking technology into team environments and training programs, highlighting their impact on improving both player and team performance from a tactical perspective. Player tracking technology has traditionally been employed to evaluate the physical exertion and workload of athletes during both training and competition. However, its utility extends far beyond physical metrics. By examining spatial and temporal data, team tactical analysis can provide insights to coaches in collective behavior during competition and game formats during training sessions. This enables a holistic approach to integrating player tracking technology in the coaching process, where tactical analysis can support the decision-making in training program design. Dr. Olthof will explore how wearable technologies such as Global or Local Positioning Systems (GPS and LPS, respectively), are being used for tactical analysis. She will demonstrate how GPS and LPS data can be used to analyze team dynamics and player movements during competition and training sessions, providing a comprehensive view of team tactics. This can provide feedback to coaches and players on tactical performance during match-play and training sessions, facilitating adjustments during training sessions and competition. The presentation will illustrate how the integration of these technologies has led to improved training strategies for elite team sport athletes. Topics covered in this presentation will include technology and analytics for team tactical performance, the use of game formats for match preparation, and optimizing training strategies for talent development. In addition, this session will address practical aspects of using wearable technology for tactical analysis, such as ensuring data synchronisation, analyzing offensive and defensive phases of the competition, and making the insights accessible and actionable for coaches and players. Ultimately, the presentation aims to provide an insight in the variety of applications of player tracking technology in a team sport environment and the applications of tactical analysis for training program optimization in team sports.

**USING WEARABLE DEVICES FOR HOLISTIC ATHLETE MONITORING: STRATEGIES FOR INTEGRATION**

COUTTS, A.
*UNIVERSITY OF TECHNOLOGY, SYDNEY*

Wearable technologies are commonly utilized tools for monitoring and assessing athletes during training and competition. These are often employed to assess athletes' readiness to perform and reduce injury risk. Over the past two decades, these devices have significantly impacted the role of the sport scientist, transforming how coaches, sports scientists, and medical professionals monitor athletes. This presentation will explore how wearable devices can be integrated into a comprehensive athlete monitoring system. Initially, we will provide a framework for designing such systems before outlining best practice approaches for selecting, applying, and integrating measures into athlete monitoring systems. Wearables are central to athlete monitoring as they provide real-time, objective data on training loads as well as measuring athletes responses to training. However, the ease of use and availability of these tools often lead to challenges due to the sheer volume of data, the integration of blackbox algorithms and continual creation of new metrics. Without appropriate selection and application, this data can create unnecessary noise that can interfere with decision-making processes. Furthermore, with the rise in artificial intelligence and promise of injury prediction models highlights the need for quality data systems. Without these best practice approaches, the false promises will ultimately result in loss of trust in monitoring from both athletes and coaches. To address this risk, this presentation will emphasize an athlete-centered, holistic approach to monitoring, advocating for the judicious selection of essential data. We will also examine athletes' perspectives on the effectiveness of monitoring that can be used to improve current methodologies. This session is designed for sports scientists, coaches, and medical professionals seeking to optimize the potential of wearable technologies within a holistic, evidence-based approach to athlete monitoring. We will highlight the importance of interdisciplinary collaboration between sport scientists, data scientists, coaches, and medical professionals, to ensure that ethical, safe, and effective methods are applied. Real-world examples of successful implementation of wearables in athlete monitoring will be discussed to provide attendees with practical insights.

## Invited Symposium

### IS-BM08 Brain & Body Bootcamp: Revolutionizing Fitness with Exergames!

**MOVING BEYOND SCREENS: UNLEASHING THE POWER OF EXERGAMES FOR HEALTH AND WELLNESS**

DE BRUIN, E.
*INSTITUTE OF HUMAN MOVEMENT SCIENCES AND SPORT, ETH*

Technological innovations (e.g. exergames) provide new options to engage older adults in motor-cognitive training [1]. Simultaneous motor-cognitive training is considered promising to prevent both the decline in physical and cognitive functioning in older adults and can be highly motivating when applied in form of exergaming. A systematic review found exergames appearing to be more effective on global cognitive performance than conventional physical training. Furthermore, neurophysiological benefits were mainly seen following exergaming [2,3]. These benefits are believed to be caused by the unique opportunity for trainees to interact in an enriched environment that, in turn, provides structured, scalable training opportunities augmented by multi-sensory feedback to enhance skill learning and neuroplasticity through repeated practice [4]. Here we explore several mechanisms why video game-based exergame training necessitating subject's ability to lift the toes and to place the feet on different target zones can lead to improved brain and physical function. The physical exercise involved promotes cardiovascular health, enhances coordination, and increases strength and endurance, which contributes to overall physical fitness. Simultaneously, the cognitive aspects of gaming—such as problem-solving, strategy formation, and rapid decision-making—stimulate brain activity and can improve neuroplasticity, attention, and memory. Positive effects in the nervous system are due to stimulating neural pathways through concurrent movement, thinking and coordination. [1] Dove et al. JMIR, 19: p. e3, 2017 [2] Soares et al. Arch Gerontol Geriatr 97: 10485, 2021; [3] Davis et al. J of ACH 72:1-9, 2022; [3]; [4] Aminov et al. JNER 15: p. 29, 2018.

**GAIT-RELATED ELECTROPHYSIOLOGICAL ADAPTATIONS FOLLOWING EXERGAME TRAINING**

GENNARO, F.
*UNIVERSITY OF PADUA*

Electrophysiological assessments, such as Electroencephalography (EEG) and Electromyography (EMG), can be employed in movement-related tasks such as walking, thanks to recent advances in hardware design and signal processing, which helped to overcome previous existing data collection and analysis limitations. That is, acquiring cerebral activity during movement represented a challenging condition for decades. due to the inherently present physiological and not physiological artifactual activity [1]. Gait is a locomotor task driven by neural inputs directed to skeletal muscles, and exergames can be designed for gait training purposes [2] as well as targeting central nervous system (CNS) potential adaptations [3]. Here we explore results from an exergame training intervention, where the employed videogame required the older adult's subject ability to lift the toes and to place the feet on different target zones as a requirement to successfully play the game [4]. We illustrate gait-related electrophysiological adaptations following exergame training, and we introduce prospects of using a combination of several electrophysiological measurement devices as well. In our study CNS adaptations

are assessed by means of a paired set of two bipolar EMG sensors. This configuration is required to run intramuscular coherence analysis (IMC), which represents a useful (but proxy) method to assess neural drive to specific muscles during gait tasks. We show that IMC significantly changes following exergame training, during dual-task but not during single task gait. These findings are important, since the former is greatly impaired in older adults, involving more cognitive resources compared to normal gait, but gait-related IMC can adapt following exergame training. That is, consistently playing exergame over several weeks can lead to changes in the central drive to ankle dorsiflexors during dual-task gait. This shows that exergame-based training in upright standing position, which includes movement pattern resembling "gait initiation", can improve neural drive to the lower extremities in older adults. Whether combining EMG and EEG assessments (i.e. Corticomuscular Coherence) can yield similar results remains to be still elucidated, promising results of this approach have been already shown in other contexts (e.g. sarcopenia). Interestingly, mounting evidence hints towards the feasibility of using EEG playing exergame as well, showing interesting potential cognitive and motor adaptations. [1] Gennaro F., & de Bruin ED. Front. in public health, 6 (39), 2018 [2] Pichierri et al. BMC Geriatr 12: 74, 2012 [3] Schättin et al. Front. Aging Neurosci. 8: 278, 2016 [4] de Bruin ED et al. Front. Aging Neurosci. 11:263, 2019 [5] Gennaro F. et al. J. Clin. Med., 9(3):720, 2020

**EXAMINING COGNITIVE AND MOTOR ENGAGEMENT IN EXERGAMING**

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Exergaming has gained traction as a dual-purpose activity for enhancing both physical and cognitive health, especially among older adults [1]. Characteristics of different games and game settings affect physical and cognitive activity [2]. Here we explore how different exergame types, such as balance and stepping games, influence brain and physical activity through real-time EEG analysis. EEG provides a dynamic and non-invasive method to capture the neural responses of players, focusing on cognitive engagement markers like theta and alpha rhythms. Frontal theta and central/parietal alpha frequencies are key indicators of cognitive processing in working memory tasks for both young and older adults [3,4]. While frontal theta power increases with cognitive demands and task difficulty, alpha oscillations decrease with increased information processing [3,5]. Our studies shows that exergaming can significantly increase frontal theta power, indicating heightened cognitive demand and attentional processes during gameplay. These neural responses suggest that exergaming, by requiring attention and motor coordination, promotes active cognitive engagement beyond the physical movements alone. Our findings also highlight the varying impact of game difficulty and type on neural activation, underscoring the importance of tailoring exergames to individual abilities and rehabilitation goals. This research supports the potential of exergaming as a structured, interactive intervention to foster cognitive and motor health, while underscoring the importance of tailoring exergame interventions to optimize both cognitive and physical outcomes in older adults. [1] Stojan & Voelcker-Rehage J. Clin. Med, 8:734, 2019 [2] Müller et al. Front. Aging Neurosci. 15:1143859, 2023 [3] Sauseng et al. Int. J. Psychophysiol. 57, 97–103, 2005; [4] McEvoy et al Cogn. Brain Res. 11, 363–376, 2001; [5]; Pfurtscheller et al. Clin. Neurophysiol. 110, 1842–1857, 1999.

## Oral Presentations

### OP-AP33 Cycling III

**FORCE EXPRESSION APPLICATIONS IN CYCLING**

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INTRODUCTION: Research in Sports has explored a few frameworks for understanding the force domains, primarily focusing on strength qualities1 (e.g., isometric mid-thigh pull). In contrast, Bosco2 proposed a physiological categorization of force expressions based on concentric propulsive time, applicable to various sports movements (e.g., running, jumping). However, this framework has not been applied to cycling, where research has focused on the relationship between rate of torque production (RTD) and strength measurements3, rather than concentric muscle action. This study investigates the relationship between torque application and different pedaling cadences (RPM) in skilled cyclists, employing a multivariate approach to analyze force expression across varying pedal loads

METHODS: Nineteen highly trained4 cyclists completed the trials using an ergometer capable of independent 1000 Hz frequency sampling for each pedal and precise RPM manipulation to impose varying pedal loads. Following familiarization, cyclists performed six trials (three per leg, alternating) of a single maximal-effort downstroke at 30, 60, 90, and 100 RPM in a counterbalanced order. Only propulsive phase (torque > 0 N*m) of the targeted leg was analyzed. Outcome measures included kinetic torque-time variables: peak torque (PT), average rate of torque development (avgRTD; Δtorque/Δtime), impulse (Im; Δtorque*Δtime), and propulsive time (t). Data analysis was conducted using a custom MATLAB script, with statistical testing performed via RM-MANOVA in SPSS.

RESULTS: RM-MANOVA revealed a significant multivariate effect of RPM on the combined dependent variables (Pillai's Trace = .997, $p < .001$), with strong effect sizes (Partial Eta Squared = .997). Univariate tests confirmed significant differences across RPM conditions for PT ($p < .001$), Im ($p < .001$), t ($p < .001$), and avgRTD ($p = .035$). Propulsive time values

increased with decreasing RPM: t30RPM (.926 ± .188 s), t60RPM (.617 ± .080 s), t90RPM (.483 ± .046 s), and t100RPM (.431 ± .020 s). Notably, PT and Im increased with higher RPM, while avgRTD peaked at 60 RPM (658 N/s). Post-hoc contrasts revealed significant differences between all RPM levels for PT and Im ($p < .001$), while avgRTD showed significant differences only between extreme RPM conditions ($p < .001$).

CONCLUSION: This study demonstrates that RPM significantly influences force expression during single-leg maximal-effort pedal strokes in highly trained cyclists. Lower RPMs were associated with greater PT and Im, indicating maximal strength expression. The highest RTD occurred at 90 RPM, suggesting an optimal cadence for explosive strength expression. These findings highlight the importance of RPM-specific adaptations in cycling performance. Future research should compare cyclists across expertise levels, competition disciplines, and age groups, providing deeper insights into force expression during cycling.

References

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**LEG MUSCLE ACTIVATION ACROSS CYCLING POSTURES AND PEDALING STRATEGIES IN RECREATIONAL MALE AND FEMALE CYCLISTS**

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INTRODUCTION: Cyclists adjust body posture and pedaling strategy to counter air resistance and adapt to varying terrains, which influences performance and injury risk. Changes in cycling posture appears to affect muscle activation in novice but not elite cyclists, who exhibit superior neuromuscular control to maintain performance [1]. Sex may play a role in the effects of posture and pedaling on muscular activation as females exhibit greater pelvic motion in dropped postures and at higher intensities than males [2]. Examining the influence of posture and pedaling strategy on muscle activation in males and females may guide the development of targeted training programs. This study aimed to investigate the effects of different cycling postures, cadences, and resistances on muscle activation in male and female recreational cyclists.

METHODS: Eighteen recreational cyclists (nine males, nine females) completed 18 cycling bouts on a training stand in three postures (neutral, comfort, dropped) and six pedaling strategies [combinations of three cadences (self-selected, slow, fast) and two resistance levels (heavy, light)] in randomized order. Surface electromyography (1000 Hz) obtained mean muscle activation of the biceps femoris (BF), vastus lateralis (VL), rectus femoris (RF), tibialis anterior (TA), and gastrocnemius (GAS) during 15 stable pedaling cycles. Data were normalized to maximal muscle activation during 10-second maximum-effort sprints. A three-way repeated-measures ANOVA examined the effects of posture, pedaling, and sex on muscle activation at $\alpha=.05$.

RESULTS: Postures did not affect muscle activation ($p=.05–.91$, $\eta^2p=.01–.17$) except for right leg RF ($p<.05$, $\eta^2p=.19$), with no significant Bonferroni-corrected post-hoc comparison ($p=.06–.10$, $\eta^2p=.02$). Pedaling strategies affected both legs' BF ($p<.001$, $\eta^2p=.62–.70$), RF ($p<.001$, $\eta^2p=.71–.71$), TA ($p<.001$, $\eta^2p=.59–.67$), GAS ($p<.001$; $\eta^2p=.51–.66$), and VL ($p<.001$; $\eta^2p=.13–.86$) activation. Sex interacted with the effects of pedaling strategy on RF activation in both legs ($p<.05$; $\eta^2p=.18–.29$). Females demonstrated greater left leg RF activation during heavy resistance at all cadences and greater right leg RF activation during all pedaling strategies than males ($p<.05$, $\eta^2p=.27–.28$).

CONCLUSION: The effects of posture have been marginal, whereas pedaling strategy greatly influenced muscle activation. Females exhibited higher RF activation than males, particularly at heavy resistance (significant in both legs), emphasizing the importance of RF functionality in females and suggesting special consideration of RF in training regimes for females. As pedaling strategies affected RF activation differently between sexes, cadence and resistance should be adjusted considering sex-specific adaptation for trainings that target RF.

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**EFFECTS OF DIFFERENT SADDLE HEIGHT DETERMINATION METHODS ON LOWER LIMB MECHANICS AND PHYSIOLOGICAL PERFORMANCE IN CYCLING**

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INTRODUCTION: An adequate saddle height is crucial for cycling performance, comfort, and injury prevention [2]. Despite its importance, most methods for determining saddle height have been developed through practical experience rather than scientific evidence [3]. This study examined the impact of four different saddle height determination methods (LeMond LM; Trochanteric TM; Heel HM; Minimal knee angle ($\alpha = 30°$) AM) on cycling biomechanics and physiological responses.

METHODS: In an acute randomized crossover design, 23 physically active individuals (f =11; m =12; age: 22 ± 1.9 years; body mass 71.3 ± 9.6 kg; height 174 ± 8.7 cm) cycled on an adjustable trainer at the four different saddle heights and two

resistance levels (low: 100% of body mass in Watts; high: 200% of body mass in Watts). Heart rate, oxygen uptake, perceived exertion, and discomfort for each saddle height were analyzed using an ANOVA, while differences in electromyography (EMG) data of the lower extremity muscles (Vastus Lateralis and Medialis Obliquus, Gastrocnemius Medialis, Rectus Femoris, Semitendinosus, Tibialis Anterior), knee and ankle angles, and torque were analyzed continuously over the revolution using statistical parametric mapping (SPM).

RESULTS: The largest differences in saddle height were found between AM and TM (98.4 ± 4.6 vs.102.9 ± 4.2 cm; 4.5%, SMD = 1.02, $p < .01$). Oxygen uptake showed significant differences at low load between AM and TM (1.45 ± 0.21 vs.1.55 ± 0.25 l/min, SMD = 0.43, $p < .02$), but no significant differences at high load. Discomfort (1-10; very comfortable - uncomfortable) was rated significantly higher for LM (5.52 ± 2.50) and TM (6.13 ± 2.44) compared to HM (3.70 ± 1.82) and AM (4.01 ± 2.39) (SMD = .83 -1.13; $p < .05$). No significant differences in RPE were found. At low load for torque, the one-way repeated measures ANOVA using SPM1D revealed a significant main effect of saddle height (SPM{F}; df = 3, 66; FWHM = 23.89; 7.49 resels) with a critical threshold (SPM.z* = 5.24 at $\alpha = 0.05$) (set-level $p = 0.001$; cluster-level $p < 0.001$ and 0.036) between 123° and 173°. Subsequent paired t-tests showed significant differences between AM and TM (t* = 3.84, df = 1, 43.545, $p = 0.004$).

CONCLUSION: Methods resulting in higher saddle heights were associated with increased discomfort. The results indicated superior cycling efficiency and comfort in favor of AM and HM. Therefore, practitioners should consider saddle height adjustments based on knee flexion angle (~30°) to optimize cycling efficiency, comfort, and injury prevention.

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**ENHANCING TRAINING OUTCOMES WITH SUPERIMPOSED ADAPTIVE FUNCTIONAL ELECTRICAL STIMULATION DURING CYCLING: A COMPARISON TO CYCLING ALONE**

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INTRODUCTION: Percutaneous Neuromuscular electrical stimulation (NMES) is used in sports medicine both for strength training and rehabilitation (1). The effects of NMES during cycling showed a higher metabolic and cardiorespiratory response compared to a control condition. However, training studies failed to show a higher effectiveness of this method compared to normal cycling (2). This might be due to the time asynchrony between NMES and voluntary contraction. The aim of the present training study (6 weeks/2-3 sessions per week) was to investigate the effects of a novel Adaptive Functional Electrical Stimulation Kinesitherapy (AFESK™) that can trigger the electrical stimulus in synchrony with the voluntary contraction of the stimulated muscles.

METHODS: Sixteen males (age 39±10 years, VO2peak 48.0±4.8 ml·min·Kg-1) were randomly allocated to either a control (CON) group performing 4x5 min intervals at 60% aerobic peak power output (3 min recovery, 40% PPO) or an experimental (EXP) group performing the same training protocol with superimposed AFESK™ on leg muscles. Before and after the training period, aerobic and anaerobic lactate thresholds, 6 seconds sprint, 5km time trial performance were assessed during cycling. Similarly, the neuromuscular function of the knee extensors muscles (NMF) including maximal voluntary contraction (MVC), activation level (VA) and electrically evoked twitch responses (1, 10, 100 Hz), was investigated in isometric conditions. Change scores between post and pre assessments were determined in each group and for each dependent variable, then compared using Mann-Whitney U test. Data are presented as mean ± standard deviation.

RESULTS: Power outputs at aerobic (CON +4±19 W vs EXP +27±22 W, p=0.031) and anaerobic (CON +1±14 W vs EXP +28±23 W, p=0.021) lactate thresholds statistically increased only in EXP. Mean maximal 6 seconds cycling power output statistically (p=0.028) increased in EXP (+26±29 W) but not in CON (-3±23 W). The 5km time trial did not statistically change (CON +1±15 s vs EXP -8±8 s, p=0.226). The training period did not impacted on maximal voluntary contraction (CON -1±45 Nm vs EXP -8±30 Nm, p = 1.000) and maximal voluntary activation levels (CON -1±4% vs EXP +3±6%, p=0.161) in both groups but reduced evoked twitch responses at 1 Hz (CON +3±6 Nm vs EXP -2±4 Nm, p=0.038) and at 100 Hz (CON +4±9 Nm vs EXP -7±7 Nm, p=0.038) in EXP.

CONCLUSION: This is the first study suggesting a beneficial impact of electrical stimulation used during cycling training. The enhanced training effects encountered in EXP at the Aerobic and Anaerobic thresholds might be partly ascribed to a slightly higher level of muscle strain, and consequent fatigue, caused by the administration of AFESK™. This could represent a stronger stimulus promoting muscle adaptations. Further studies showing similar results are necessary to confirm the use of AFESK™ as a tool to potentiate the training effects in cycling.

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**CONCENTRIC VERSUS ECCENTRIC CYCLING: A COMPARATIVE ANALYSIS OF CARDIOPULMONARY RESPONSES AT MAXIMAL INTENSITY**

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INTRODUCTION: Several studies (1,2) have shown that eccentric cycling requires a lower metabolic demand compared to concentric exercise when performed at equivalent power outputs. However, cardiovascular and pulmonary responses differ between these two exercise modalities under maximal-intensity protocols to exhaustion have been much less studies. Therefore, the present study was aimed to investigate the metabolic responses elicited during incremental tests conducted in both concentric and eccentric modes.

METHODS: 15 participants (F=4; M=11; 23±3 years; 1.77±0.09 m; 71.3±14.5 kg) performed in two separate weeks, both concentric (CONC) and eccentric (ECC) cycling tests until reaching task failure (Monark COSMED for the concentric and Cyclus 2 for the eccentric modalities), starting by a 75W and incrementing the workload by 25W every minute. Throughout the tests, gas exchange, heart rate (HR) and power output were continuously monitored by a CPET cart (QuarkB2; COSMED, Rome, Italy). The normality of the data was evaluated using the Kolmogorov-Smirnov test, and significant differences among the variables were determined via ANOVA.

RESULTS: Peak power output (PPO) in the ECC condition ($p=0.25$, $\eta p2 = 0.11$) was 7% lower (329 ± 60 W) than in the CONC (353 ± 76 W) condition, although this difference was not statistically significant. In contrast, there were significant differences between the ECC and CONC cycling tests in other parameters. For instance, peak oxygen consumption (V'O2peak) was 37% lower for ECC (2385 ± 403 mL/min) compared to CONC condition (3804 ± 797 mL/min). Additionally, maximal ventilation (VEmax) in ECC (60 ± 10 L/min) was 60% lower than in CONC (150 ± 29 L/min), and maximal heart rate (HRmax) was 18% lower in ECC (149 ± 20 bpm) compared to CONC (183 ± 15 bpm).

CONCLUSION: During a maximal incremental test, metabolic responses exhibit distinct differences between eccentric and concentric exercise modalities. Contrary to the limited evidence available (3), our results indicate a comparable PPO between the two conditions. However, we demonstrated that V'O2peak, VEmax, and HRmax values are lower. Our results confirmed that the ventilatory thresholds (VT1 and VT2) are clearly identifiable during concentric modality but remain undetectable when the same test is performed in eccentric modality.

These findings suggest further investigations are necessary, both in maximal and submaximal contexts in order to better understand the cardiometabolic responses to these two exercise modalities to optimize training program effects while minimizing risks, especially in pathological populations.

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## Oral Presentations

### OP-AP36 Recovery and Performance Enhancement

**OPTIMAL RECOVERY INTERVALS FOR POST-ACTIVATION PERFORMANCE ENHANCEMENT VARY GREATLY AMONG INDIVIDUALS: ANALYSIS OF A LARGE SAMPLE**

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INTRODUCTION: Responsiveness to post-activation performance enhancement is mediated by moderators such as training experience, conditioning activity (CA) volume and intensity, and post-CA recovery interval. In a recent metanalysis, Xu et al. [1] provided an evidence-based framework for designing effective PAPE protocols for both clinical and research purposes. Their finding indicated that, regardless of CA type, the optimal post-CA recovery interval (OPT) ranges between 2.5 and 11 minutes, peaking at 5.5 minutes. Given the high inter-individual variability in PAPE responsiveness and the relatively wide range of OPT observed by Xu et al. [1], our aim was to analyze the distribution of the OPT in a large sample. We hypothesized that OPT would not follow a normal distribution.

METHODS: Following familiarization and 1-RM determination sessions, forty-six trained males (23.8±4.0 years, 79.0±12.8 kg, 175±3 cm) who were PAPE responders attended the laboratory on two separate days to complete an experimental and a control session in randomized order. The control session involved assessing countermovement jump (CMJ) performance at baseline, followed by a standardized warm-up comprising five minutes of light cycling and three sets of three unloaded squats. CMJ performance was subsequently assessed at 2, 4, 6, 8, and 10 minutes post-warm-up. In the experimental session, instead of the standardized warm-up, participants performed a CA consisting of three sets of three barbell squats at 87% 1-RM. CMJ performance was assessed at the same time points as in the control session. The recovery interval at which each participant achieved their best CMJ performance was recorded as their OPT. A two-way ANOVA

was conducted to compare CMJ performance between sessions and across recovery intervals. OPT distribution was tested using the Smirnov-Kolmogorov test.

RESULTS: CMJ performance declined two minutes after seated rest (34.7±6.2 vs 33.6±6.6 cm) but returned to baseline levels for the remainder of the control session, indicating that the assessment protocol did not induce significant potentiation. In the experimental session, CMJ performance was significantly higher than baseline (33.3±7.0 cm) at all time points post-CA (2 min: 35.6±6.9 cm; 4 min: 36.1±7.0 cm; 6 min: 35.9±6.7 cm; 8 min: 35.5±6.5 cm; 10 min: 35.1±6.3 cm). The mean, median and mode OPT were 4.8, 4.0, and 4.0, respectively. OPT distribution was non-gaussian ($D[46] = 0.236$, $p < 0.01$,).

CONCLUSION: Our findings support the data reported by Xu et al. [1] demonstrating that the mean OPT is approximately 5.5 minutes post-CA. Our hypothesis that OPT distribution would not be normal was confirmed by the obtained data, suggesting that individualized post-CA recovery intervals should be adopted when designing protocols aimed at inducing PAPE.

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**DOES ACUTE SLEEP RESTRICTION NEGATIVELY AFFECT MAXIMAL STRENGTH, MUSCLE POWER, STRENGTH ENDURANCE, AND PSYCHOLOGICAL READINESS IN RESISTANCE-TRAINED WOMEN? PRELIMINARY RESULTS OF RANDOMIZED CONTROLL**

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INTRODUCTION: Sleep is essential for optimal physical and cognitive performance, yet its effects on resistance exercise performance remain unclear in women. This study aimed to investigate the effects of acute sleep restriction on maximal strength, muscle power, and strength endurance in resistance-trained women.

METHODS: Eight resistance-trained women (age:25±4 years; BMI:23.0±2.8 kg/m2 ) participated in a randomized, counterbalanced, crossover study, completing two identical experimental sessions under different sleep conditions: a) night of habitual sleep (HS) and b) acute sleep restriction (SR) at the beginning of the night (i.e. 3 hours less than habitual sleep with a delayed bedtime). Sleep was monitored using wristwatch actigraphy (MotionWatch8, CamNtech, Neurotechnology Ltd., Cambridge, UK) to ensure compliance. Each session took place at the same time (~09:00am) and included: a) one repetition maximum test (1RM) in bench press exercise; b) three sets of three repetitions of explosive bench press exercise at 50%1RM; c) countermovement jump (CMJ) and d) strength endurance test in the bench press exercise at 50% 1RM. Before testing, participants completed: a) the Readiness-to-Train Questionnaire (RTT-Q) and b) the Self-Assessment Manikin questionnaire (SAM) to assess arousal and valence. Immediately after testing, ratings of perceived exertion (RPE; 6-20) and pain levels on visual analogue scale (VAS; 0-10) were obtained. Difference between conditions was determined by paired T-tests or Wilcoxons tests according to data distribution, except explosive bench press exercise, where a two-way ANOVA was applied. Effect sizes (ES) were calculated using Hedge's.

RESULTS: No significant differences between HS and SR conditions were observed in: a) 1RM (45.9±5.1 kg vs 44.4±5.6 kg; p=0.14; ES=0.26; Δ=-3.3%); b) peak (1.52±0.15 m/s vs. 1.42±0.23 m/s; p=0.13; ES=0.49; Δ=-6.6%), and mean (1.12±0.11 m/s vs. 1.00±0.15 m/s; p=0.05; ES=0.86; Δ=-10.7%) bar velocity during explosive bench press exercise; c) CMJ (28.6±4.8 cm vs 29.0±6.3 cm; p=0.22; ES=-0.07; Δ=1.4%) and d) number of repetitions during strength endurance test (37±9 vs 34±6; p=0.22; ES=0.37; Δ=-8.1%). Significant differences between HS and SR conditions were noted on SAM scores for arousal (62±19 arbitrary unit a.u.) vs 36±12 a.u. ; p=0.01; ES=1.55), dominance (71±21 a.u. vs 43±19 a.u.; p=0.02; ES=1.32) and valence (77±22 a.u. vs 45±27 a.u. ; p=0.01; ES=1.23), without changes in RTT-Q, RPE and VAS.

CONCLUSION: Acute sleep restriction (3-hour reduction) does not significantly impair maximal strength, muscle power, or strength endurance in resistance-trained women. However, reduced emotional state scores indicate a negative impact on mood and psychological readiness. While short-term sleep loss may not immediately affect physical performance, it could influence motivation and long-term outcomes. Further research is needed to explore the relationship between emotional state and resistance training performance after sleep restriction.

**ACUTE EFFECTS OF DIFFERENT STRETCHING TECHNIQUES ON REGIONAL MUSCLE STIFFNESS OF THE GASTROCNEMIUS MEDIALIS ASSESSED WITH SHEAR-WAVE ELASTOGRAPHY**

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INTRODUCTION: Stretching can acutely increase the maximum range of motion (ROMmax). However, its effects on muscle mechanical properties vary depending on the type, intensity, and duration of the stretching maneuver. Shear-wave elastography (SWE) was used to assess muscle stiffness by measuring ultrasound wave speed through the tissue. This speed can be converted into modulus (μ, kPa), providing an estimate of tissue elasticity. Recently, SWE has been applied to investigate stretch-induced changes in muscle stiffness. Since different muscle regions may exhibit different μ values, we examined whether three stretching protocols affected μ differently in two muscle regions.

METHODS: Twelve participants (8 men, 4 women; mean±SD: age = 23.9±2.4 years, body mass = 69.8±10.6 kg, height = 172.0±8.5 cm) completed three stretching sessions on separate days. ROMmax was assessed. GM stiffness (μ) was measured using SWE (V8, Samsung Healthcare, Seoul, Korea) at both a neutral ankle angle (90°) and at 80%ROMmax in the middle muscle portion (GMmid) and the muscular region of the GM myotendinous junction (MTJ). Measurements were taken PRE and immediately POST 5×30-s passive static stretching (PS30, 30-s inter-set rest), 5×45-s PS (PS45, 15-s inter-set rest), and 5×30-rep dynamic stretching (DS, 30-s inter-set rest). The order was randomized. The same absolute angle at 80%ROMmax was used in POST evaluations. Within-day reliability was assessed before stretching using intraclass correlation coefficient (ICC) analysis. Data were analysed with repeated-measures ANOVA (within-factors: stretching type, region, ankle angle, time) at $p<0.05$, with Bonferroni correction for pairwise comparisons.

RESULTS: ICCs were >0.80 for all parameters. No significant differences were found at PRE across the three days ($p>0.05$). No main interactions were observed ($p>0.05$). PS30 increased ROMmax (8.4%, $p<0.01$) and decreased GMmid μ at 80%ROMmax (–17.6%, $p<0.01$). PS45 increased ROMmax (7.8%, $p<0.01$) and decreased GMmid μ at 80%ROMmax (–14.2%, $p<0.01$), as well as MTJ μ at both 90° (–13.4%, $p<0.01$) and 80%ROMmax (–8.6%, $p<0.01$). DS increased ROMmax (11.1%, $p<0.01$) and reduced GMmid μ at 80%ROMmax (–12.5%, $p<0.01$) and MTJ μ at 90° (–12.7%, $p<0.01$), while the decrease at 80%ROMmax was not significant (–8.3%, $p>0.05$).

CONCLUSION: This study highlights that stretching-induced changes in muscle stiffness can be region-specific and depend on the protocol used. Longer-duration static stretching was more effective in reducing stiffness across GM regions. Dynamic stretching improved ROMmax but had a more limited impact on muscle stiffness, particularly at the MTJ. However, the small sample size and variability in μ may have influenced these findings.

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**TRAINING LOAD AND RECOVERY IN ELITE VOLLEYBALL PLAYERS: NEUROMUSCULAR, PSYCHOLOGICAL, AND SOCIAL PERSPECTIVES**

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INTRODUCTION: Optimizing recovery is important for sustaining performance and minimizing injury risk in elite team sports. Training load is commonly divided into internal (ITL) and external (ETL) components, both of which influence various aspects of recovery. However, the extent to which ITL and ETL impact neuromuscular, psychological, and social recovery in elite volleyball remains unclear. This study investigated the associations between training load metrics and recovery dimensions over a 105-day competitive period.

METHODS: Fourteen elite male volleyball players participated in 95 training sessions and 18 matches. ITL was assessed using session rating of perceived exertion, while ETL was quantified via inertial measurement units. Neuromuscular recovery was evaluated using countermovement jump (CMJ) metrics, while psychological and social recovery were assessed via the Recovery-Stress Questionnaire for Athletes (RESTQ-Sport). Linear mixed-effects models were used to analyse repeated measures across players and time points. Significance was set at $p < 0.05$.

RESULTS: Chronic ETL negatively affected neuromuscular recovery, with increased ETL associated with longer time to takeoff ($\beta = -0.008$, $p = 0.03$) and reduced reactive strength index modified ($\beta = -0.008$, $p = 0.047$). ITL significantly influenced social and psychological recovery, with acute ITL increasing social stress ($\beta = -3.512$, $p = 0.034$) and chronic ITL contributing to higher emotional exhaustion ($\beta = -0.013$, $p = 0.029$). Additionally, an elevated acute:chronic ITL ratio was linked to greater psychological strain ($\beta = 0.021$, $p < 0.001$).

CONCLUSION: These findings highlight the multidimensional impact of training load on recovery. Neuromuscular recovery was primarily influenced by ETL, while ITL played a more significant role in psychological and social stress responses. Coaches and practitioners should integrate objective neuromuscular assessments with subjective monitoring tools to detect fatigue, optimize recovery strategies, and enhance athlete well-being throughout the competitive season.

**IMPACT OF MENTAL FATIGUE ON TRAINING VOLUME AND INTENSITY IN RESISTANCE TRAINING: A SEX-BASED ANALYSIS**

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INTRODUCTION: Mental fatigue (MF) is a psychobiological state that arises following prolonged and demanding cognitive activity (1). Although the effects of MF on endurance performance are well recognized (1), there is a lack of research on its effects on resistance training (RT) sessions. Velocity of the first repetition (V1Rep) and training volume (TV) have been shown to be affected by MF but only when sets are performed to failure (2). However, athletes rarely train to failure while they use the V1Rep to set training intensity and the percentage of velocity loss (VL) from the V1Rep to define TV, a practice known as velocity-based training (VBT). Its main benefit is real-time monitoring of daily readiness and fatigue. Therefore, the aim of the present study was to investigate the effect of MF on TV and V1Rep during back squat in males and females, using VL to determine TV. The hypothesis is that MF will decrease TV and V1Rep in both sexes with no difference between sexes.

METHODS: Nineteen experienced resistance-trained athletes (10M, 9F) completed six sessions. The first four familiarized subjects with VBT and VL. In the last two sessions (randomized order), subjects underwent either a MF protocol (45 min AX-CPT) or a control session (CS; 45 min documentary). In both, they performed a standardized warm-up followed by four sets of back squats. The squat sets included two VL conditions (20%VL and 40%VL) and two loads (60% 1RM and 80% 1RM). Repeated measures ANOVA (pre- vs. post-condition) with sex as a between-group factor analyzed MF's impact on V1Rep and TV. MF was measured via VAS and TV is the total number of repetitions completed across the four squat sets.

RESULTS: MF significantly increased ($p<0.05$) after the AX-CPT session but not after the CS. In the MF condition, TV significantly decreased for both sexes (M: PRE 29.6±8.3, POST 25.1±7.3; F: PRE 34.7±9.6, POST 25.6±7.9; $p<0.05$) with no significant interaction condition*sex. V1Rep significantly decreased in males at 60%RM (m/s: M PRE 0.70±0.10, POST 0.63±0.07) but not in females (m/s : F PRE 0.61±0.07, POST 0.59±0.08); at 80%RM, V1Rep significantly decreased in both sexes (m/s :M PRE 0.49±0.05, POST 0.43±0.05; F PRE 0.44±0.08, POST 0.41±0.07), with a significant sex interaction at 60%RM but not at 80%RM. In the CS, no differences were observed ($p>0.05$).

CONCLUSION: MF decreased the total number of repetitions across the four sets in both sexes. V1RP decreased at both 60%1RM and 80%1RM in males, but only at 80%1RM in females. MF may affect sexes differently, notably at V1Rep at 60%1RM, where males decline more than females. Evidence on sex differences in MF is scarce and sometimes contradictory, warranting further research. Regardless, MF negatively impacts RT sessions, making it essential to avoid cognitively demanding tasks before RT or adopt strategies to counteract MF.

1. Van Cutsem, et al., (2017)

2. Alix-Fages C, et al., (2023)

## Oral Presentations

### OP-AP32 Power and Strength III - Load Velocity Approaches

**EFFECT OF LOAD-VELOCITY PROFILING METHODS ON BENCH PRESS 1-RM ASSESSMENT**

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INTRODUCTION: Individual load-velocity profiles (LVP), which is measured during multiple sets with incremental load repetitions performed at maximal velocity, have been proposed as an accurate method to assess muscular fitness and one-repetition maximum (1-RM). LVP can be assessed using several protocols consisting of different load increments patterns and reps to be performed. The commonly used strategies to assess the LVPs are to adjust the load increments using either the a) repetition mean propulsive velocity (MPV) performed at the different loads (standardized LVP [LVPSTND]) [1] or b) individuals' %1-RM using multiple (LVPMULT) [2] or two (LVP2-POINT) [3] loads. Despite variations in sets and repetitions, no study has examined whether testing protocols affect 1-RM load and velocity (V1-RM). This study investigates the impact of different LVP methods on these measures.

METHODS: Fifteen healthy males (25.9±3.9 yrs) visited the lab 4 times, separated by at least 48 h of rest. On day 1, participants 1-RMs (89.5±15.9 kg) were assessed and they familiarized with the Smith machine bench press exercise and trained to push the barbell as explosively as possible during the concentric phase. On days 2 to 4 (random order), participants' LVPs were assessed using: LVPSTND (load increments: 10 kg for MPV>0.5 m/s, 1-5 kg for MPV<0.5 m/s; reps: 3 for MPV>1.0 m/s, 2 for MVP between 0.65-1.0 m/s, 1 for MPV<0.65 m/s), LVPMULT (20, 40, 60, 80, 90% of 1-RM), and LVP2-POINT (50 and 80% of 1-RM) methods, and 1-RM load and V1-RM were assessed. The execution velocity was measured using a linear position transducer (Vitruve, Madrid, Spain) attached to the barbell of a Smith machine. After assessing the normality of the distribution of the variables, 1-RM loads across methods were compared using a repeated-measure ANOVA followed by Bonferroni corrected pairwise post-hoc comparisons, while V1-RM were compared across methods using the Friedman test.

RESULTS: The LVP testing method affected ($F(2,28)=3.476$, $\eta^2=0.199$, $p=0.045$) 1-RM load. Bonferroni comparisons showed that solely the LVP2-POINT 1-RM (93.3±16.8 kg) was significantly higher ($p=0.044$) than the LVPSTND 1-RM (90.6±16.2 kg), whereas there were no differences between LVPMULT (92.3±16.2 kg) and LVP2-POINT ($p=1.000$) or LVPSTND ($p=0.331$). Conversely, V1-RM measured using LVPSTND (0.15±0.03 m/s), LVPMULT (0.14±0.04 m/s), and LVP2-POINT (0.16±0.04 m/s) were not different ($\chi^2(2)=0.792$, $p=0.673$).

CONCLUSION: This study indicates that while the testing protocol used to assess LVP does not influence V1-RM it affects 1-RM load. In particular, the LVP2-POINT seems to allow an accurate estimation of 1-RM while minimizing fatigue. Therefore, LVP2-POINT could offer not only a higher, hence more accurate, 1-RM estimation, but also a more feasible and time-saving strategy to assess 1-RM due to the fewer sets needed.

REFERNCES:

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[2] Banyard et al., J Strength Cond Res, 2017

[3] Garcia-Ramos et al., Strength Cond J, 2018

**THE PREDICTIVE VALIDITY OF BACK SQUAT ONE-REPETITION MAXIMUM ESTIMATION USING OPTIMAL MINIMUM VELOCITY THRESHOLD: IS IT OPTIMAL OR COMPLEX AND NONBENEFICIAL?**

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INTRODUCTION: The load-velocity relationship (LVR) is used to predict one-repetition maximum (1RM); however, it often yields inaccurate estimations. The minimum velocity threshold (i.e., the velocity at 1RM [MVT]) has been used to make predictions, whereby poor MVT reliability may contribute to erroneous predictions and limit application. To enhance predictions, optimal MVT-the velocity where the difference between actual and predicted 1RM from the same 1RM test is zero-has been proposed. Unlike some other prediction methods, optimal MVT needs to be established in a preliminary 1RM test and requires multiple loads to be performed within subsequent sessions. Currently, the predictive validity of optimal MVT across multiple testing sessions is unknown. Thus, the utility of various 1RM prediction models using optimal MVT in both the free-weight (FW) and Smith-machine (SM) back squat was investigated.

METHODS: In this counterbalanced, randomised, crossover design, 14 trained males (FW 1RM=132.5±28.5kg; SM 1RM=163.9±30.4kg) performed a familiarisation session followed by three sessions each of FW and SM back squat 1RM testing separated by 72 hours and alternating between the exercises. Loads of 20, 40, 60, 80, 90, and 100% of 1RM were performed each visit with the load and concentric mean velocity recorded. The reliability of MVT was determined via intraclass correlation coefficient (ICC) and coefficient of variation (CV) with ICC>0.9 and CV<10% deemed reliable. Optimal MVT for both exercises was determined from the day one LVR and subsequently used to predict day two and three 1RMs from the submaximal loads in these sessions. Optimal MVT from linear regression was used in the linear multiple-point and two-point models, while polynomial multiple-point models used the polynomial regression-derived optimal MVT. Additionally, both individual and group mean optimal MVT was used for all models. The percentage difference between the actual and estimated 1RM on each day was used to determine model error (ε) for each participant with ε<2.5% considered excellent, 2.5-5% acceptable, and >5% unacceptable.

RESULTS: Both FW (ICC=0.92, CV=6.62%) and SM (ICC=0.91, CV=5.38%) MVT were deemed reliable. From all prediction models, only the FW individual 40-90% multiple-point linear and SM individual 20&90% two-point models had all participants within the acceptable threshold across both days. None of the polynomial models for either exercise had all participants in the acceptable threshold and generally displayed greater ε than the linear and two-point models.

CONCLUSION: The predictive validity of all but two of the 1RM prediction models using optimal MVT from day one was unacceptable, despite the high MVT reliability within our trained population. Our findings indicate that using optimal MVT to estimate FW and SM 1RM may not be suitable, as it adds complexity without eliminating the need for a submaximal load near 1RM (i.e., 90% 1RM) to ensure acceptable predictive validity.

**TRAINING-INDUCED CHANGES IN THE FORCE-VELOCITY PROFILE OF THE LOWER-LIMB LEAD THE STEP-SPECIFIC ADAPTATIONS OF SPRINT ACCELERATION KINETICS**

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INTRODUCTION: Greater sprint acceleration is achieved by producing large horizontal ground reaction forces (GRFs). Recently, our group found that higher maximal strength and power of the lower-limb, assessed by the force-velocity (F-V) profile in vertical jumps, are associated with greater horizontal GRF during the earlier and later steps of sprint acceleration, respectively. This study examined the effects of maximal strength training and power training on the F-V profile of the lower-limb and sprint acceleration kinetics.

METHODS: Twenty-three healthy adults (7 females and 16 males, 23 ± 3 years) were assigned into the following three groups: jump squat group (JSQG, n = 7); back squat group (BSQG, n = 8); control group (CG, n = 8). JSQG and BSQG trained three times per week for 11 weeks, performing jump squats (0% and 20% 1RM, 3–5 sets × 4–6 reps at each load) and back squats (85% 1RM, 4 sets × 3–4 reps), respectively. CG was instructed to maintain their daily routines. Before and after the intervention, participants performed 15-m sprint accelerations to evaluate mean horizontal and resultant GRFs and mean angles of the GRF vector during the propulsive phase for the first and ninth steps. Jump squats were performed to evaluate the F-V profile of the lower-limb. Theoretical maximum force (F0), velocity (V0), and power (Pmax) were derived from the F-V profile. Generalized linear mixed-effects models were used to examine main and interaction effects (F-V profile: group × time; 15-m sprint acceleration: group × time × step). Between-group differences in percentage changes were compared using one-way analysis of variance or Kruskal-Wallis test. Cohen's d effect sizes were calculated to interpret the magnitude of the between-group differences in percentage changes.

RESULTS: Significant main effects of time were observed for F0, horizontal and resultant GRFs, and the angle of the GRF vector (p = 0.002–0.048), with no significant interaction effects. Between-group differences in percentage changes were not found for any variable of the F-V profile and sprint acceleration. For the F-V profile, JSQG and BSQG showed moderate changes in F0 compared to CG (d = 0.62 and 0.67). JSQG also showed small changes in Pmax compared to BSQG and CG (d = 0.43 and 0.30). For sprint acceleration, JSQG and BSQG showed small to moderate changes in the horizontal and resultant GRFs for the first step compared to CG (d = 0.38–0.99). JSQG also showed small to moderate changes in the horizontal and resultant GRFs (d = 0.25–0.66) and the angle of the GRF vector (d = –0.30 and –0.46) for the ninth step compared to BSQG and CG.

CONCLUSION: The present results imply that in healthy adults, maximal strength training enhances F0, leading to an increased GRF in the earlier step, whereas power training enhances both F0 and Pmax, leading to increased GRFs in both the earlier and later steps during sprint acceleration.

**ASSESSING THE GYMAWARE RS LINEAR POSITION TRANSDUCER RELIABILITY AND VALIDITY IN MEASURING COUNTER-MOVEMENT JUMP HEIGHT**

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INTRODUCTION: Linear position transducers (LPTs) are portable and practical instruments that measure the displacement and velocity of an object using optical encoding technology. LPTs are widely used in training and athletes physical rehabilitation due to the widespread adoption of velocity-based training. LPTs also measure the distance traveled by the bar, and this function of the LPT can be used to assess vertical jump height before a training session to measure the athletes preparation and recovery. This study aimed to assess the concurrent validity and intra-device reliability of a linear position transducer (LPT) for counter-movement jump (CMJ) height. The Gymaware RS model was analyzed for intra-unit reliability by obtaining data from two devices simultaneously.

METHODS: Twenty-six subjects (22.21 ± 5.3 years) performed five CMJs using a force plate (Forcedecks) concurrently with the LPT to test validity. Data were taken from two units simultaneously to examine their values for inter-unit reliability. RESULTS: A paired t-test showed a significant difference between the two devices (Forcedecks and Gymaware RS ) for CMJ ($p < 0.001$). Bland-Altman analysis for validity revealed that LPT overestimated jump height for CMJ in both units, Gymaware RS unit 1 (MD = 6.18 cm) and Gymaware RS unit 2 (MD = 6.38 cm). Gymaware RS unit 1 (CV%: 1.41) and Gymaware RS unit 2 (CV%: 1.14) units appear below 5% CV, as does the forcedecsk force platform (CV%: 1.41). Reliability of the Gymaware RS unit 1 and Gymaware RS unit 2, intraclass correlation (ICC) for CMJ (ICC = 0.97) was high.

CONCLUSION: The Gymaware RS overestimates jump height but is a reliable tool for tracking changes in jump height to measure performance improvement and monitor fatigue.

**RELATIONSHIP BETWEEN LOWER LIMBS DRY-LAND FORCE-VELOCITY PROFILING AND SWIMMING LOAD-VELOCITY PROFILING**

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INTRODUCTION: Characterizing the maximal mechanical capabilities of the neuromuscular system provides valuable insights into sprint swimming. These insights are commonly obtained through dryland and in-water evaluations, considering the relationship between force/load and velocity. To achieve this, load-velocity profiling based on semi-tethered swimming has been successfully employed [1,2]. To date, previous studies have investigated whole-body load-velocity profiles without distinguishing the specific contributions of the legs. However, the lower limbs play a substantial role, contributing 43.8% to the theoretical maximal speed and 37.3% to the theoretical maximal load in front crawl load-velocity profiles of highly trained swimmers [3]. Given the crucial role of the lower limbs in propulsion, this study aims to establish a link between force-velocity (F-V) parameters in dryland conditions and load-velocity (L-V) parameters in swimming, with a specific focus on the lower limbs.

METHODS: Eight participants (16.2±2.1 years; 63.7±6.3 kg; 177.3±5.4 cm) participated in the study. In-water L-V profiles were obtained from maximal sprint exercises in flutter kicks, butterfly kicks, and breaststroke kicks against four loads (0.1, 1, 2, and 3 kg) using the 1080 Motion device (1080 Motion AB, Lidingö, Sweden). For each stroke, maximal velocity ($V_0$), maximal load normalized to body mass ($rL_0$), and the L-V slope were calculated using L-V linear regressions. Additionally, dryland F-V profiles were assessed through countermovement jumps (CMJ) and squat jumps (SJ) with three loads (0, 20, 50 kg) to estimate maximal force normalized to body mass (rFmax) and maximal velocity (Vmax). Correlation analyses were conducted to examine relationships between dryland F-V and in-water L-V parameters. Statistical analyses included Spearman's rank correlation and Kruskal-Wallis tests, with significance set at $p < 0.05$.

RESULTS: Dry-land parameters, Vmax and rFmax exhibited strong correlations with $V_0$ and $rL_0$ obtained for flutter kick ($r > 0.7$, $p < 0.05$) while weaker correlations were observed for breaststroke and dolphin kick. Significant differences in L-V variables were measured across the three strokes. The dolphin kick exhibited the highest $V_0$, but lowest $rL_0$ values. The breaststroke kick demonstrated the strongest $rL_0$ but the lowest $V_0$. The flutter kick showed moderate $V_0$ but was the most affected by the load.

CONCLUSION: Dryland F-V capabilities exhibited the strongest correlation with flutter kick performance. Regardless of whether SJ or CMJ was used, a higher Vmax was associated with a greater $V_0$ in the flutter kick. Additionally, a higher rFmax in dryland corresponded to a higher $rL_0$ in water.

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1. Raineteau et al., 2024; 2. Gonjo et al., 2021; 3. Keller et al., 2024

Oral Presentations

OP-AP34 Coaching II - Team Sports

**A FIVE-WEEK TRAINING INTERVENTION IMPROVED SCANNING BEHAVIOR IN U19 FEMALE FOOTBALL PLAYERS**

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INTRODUCTION: Visual exploration, or scanning, plays a crucial role in football, enabling players to assess their surroundings, anticipate, and make better decisions [1-3]. Despite its recognized importance, systematic research on effective training methods for developing this skill remains limited. This study employed a quasi-experimental design to examine changes in scanning behavior before and after a five-week training intervention.

METHODS: A total of 36 U19 female football players (mean +/- SD age: 16.7 +/- 1.2 years) were recruited from two elite national league teams and two grassroots teams. Teams from each level were assigned to either a control or intervention group, with the latter completing 1-2 scanning-focused training sessions per week. These sessions contained exercise and game formats designed to implicitly promote scanning. To assess scanning behavior, 4v4 small-sided games were video recorded pre- and post-intervention. A scan was defined as an active head movement in which a players face was temporarily directed away from the ball [2]. Two-way analysis of variance (ANOVA) with a Tukey post-hoc test was conducted to assess time x group effects.

RESULTS: The intervention group showed a significant increase in the mean number of scans from pre- to post-test, regardless of level (pre: 0.88 +/- 0.36, 95% CI [0.70; 1.07]; post: 1.44 +/- 0.52, 95% CI [1.17; 1.70]; $p = 0.002$). The control group also exhibited a slight increase, but the change was not statistically significant (pre: 0.61 +/- 0.27, 95% CI [0.49; 0.72]; post: 0.92 +/- 0.43, 95% CI [0.73; 1.10]; $p = 0.068$).

Further analysis integrating level as an additional factor in the ANOVA revealed a significant time (pre-, post-) x level interaction ($p = 0.038$), indicating that elite and grassroots players responded differently to the intervention. Among elite players, those in the intervention group performed significantly more scans in the post-test compared to the control group (intervention: 1.72 +/- 0.39, 95% CI [1.48; 1.96]; control: 1.17 +/- 0.43, 95% CI [0.89, 1.45], $p = 0.005$). Additionally, elite players in the intervention group exhibited a significant increase in scanning behavior from pre- to post-test ($p < 0.001$), whereas no significant improvements were observed in grassroots intervention players.

CONCLUSION: A five-week scanning-focused training intervention can significantly improve scanning behavior in young female football players. This intervention can serve as a practical coaching tool for integrating perceptual-cognitive training into on-field training programs. However, the effectiveness of the intervention appears to be more pronounced in elite players, suggesting that level may moderate its impact. Given the small sample size and dropouts during the study, results should be interpreted with caution, and further research is needed to explore the long-term effects and applicability across different levels of competition.

REF:

[1] Aksum et al., 2021

[2] Jordet et al., 2020

[3] Hintermann et al., 2024

**DETERMINING THRESHOLDS FOR MATCH SEQUENCES DURING CONGESTED FIXTURES TO MINIMIZE DECREMENTS IN FOOTBALL PLAYERS LOCOMOTOR PERFORMANCE**

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INTRODUCTION: The relentless scheduling of football matches has become a growing concern for professionals, as it can drain players physical performance (1) and heighten their risk of injury (2, 3). Recognizing this, the Fédération Internationale des Associations de Footballeurs Professionnels (FIFPRO) has increasingly urged sporting organizations to heed players concerns and take meaningful action (4). This work delves into the impact of fixture congestion, examining how recovery time between matches and travel demands influence physical performance, while also identifying potential threshold limits to mitigate these negative effects.

METHODS: Sixty-six elite football players were monitored over two competitive seasons using global navigation satellite systems (WIMU Pro, 10 Hz). Matches were classified based on recovery time (<72h, 72-120h, 121-168h, >168h) and accumulated travel distances in the previous 3, 5, and 7 days (0 km [home matches], 1-250 km, 251-1000 km, >1000 km). Playing positions and match sequences during congested periods were also considered. Locomotor metrics included total distance, distance covered at various speed ranges (14-20 km/h, 20-25 km/h, 25-30 km/h, >30 km/h), maximal velocity, maximal accelerations and decelerations, and the number of accelerations and decelerations between 2-3 $m/s^2$. A linear mixed model was applied to each physical variable to assess differences based on recovery intervals, travel distances, playing positions, and match sequences during congested fixtures. Statistical significance was set at $p<0.05$.

RESULTS: Players performed more decelerations (2-3 m/s²) in matches with 121-168 hours of recovery compared to those with less than 72 hours (p=0.027). Matches with 72-120 hours of recovery and 251-1000 km of accumulated travel saw higher maximum velocities and greater distances covered at speeds above 30 km/h compared to matches with over 168 hours of recovery across various travel distances (0 km, 251-1000 km, >1000 km) (p<0.05). Central defenders and central midfielders exhibited the most significant variations in locomotor activity compared to other positions, though no consistent advantage was found between congested and non-congested fixtures. Crucially, locomotor performance declined noticeably after 3 (<72h) or 4 (<120h) consecutive matches.

CONCLUSION: This work underscores the significant physical strain placed on players during congested fixtures, with notable declines in locomotor performance after 3 (<72h) or 4 (<120h) consecutive matches. The findings highlight the critical need for managing recovery periods to prevent fatigue accumulation and reduce injury risk. To minimize these risks, limiting players to no more than 3 matches with less than 72 hours of recovery, or 4 matches with less than 120 hours of recovery, is recommended as a potential threshold.

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**COACHING STRATEGIES AND PERFORMANCE IN ELITE ITALIAN FOOTBALL: AN OBSERVATIONAL COMPARATIVE ANALYSIS OF POSSESSION-ORIENTED AND DIRECT-PLAY APPROACHES**

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INTRODUCTION: This study examines the influence of coaching styles on performance patterns in elite Italian mens football by comparing a possession-based "building-from-the-back" approach with a direct style. By analyzing tactical indicators such as ball possession, goal-scoring opportunities, and match outcomes, it underscores the pivotal role of coaches in shaping these styles [1]. Particular attention is paid to the evolving role of goalkeepers in developing offensive phases, as well as to the broader impact of playing style on team success in Italy's Serie A.

METHODS: Observational data were gathered from all 380 games of the 2022-2023 "Serie A" season through publicly available data sources. Teams were sorted based on their preferred style of play by examining the distribution patterns of goalkeepers. Those who preferred short passes were grouped under the build-up play approach (Group 1), and those who used long clearances were grouped under the direct style (Group 2) [2]. Statistical tests applied included Welchs t-test to compare group means, Logistic regression was also applied to estimate the impact of playing style on qualification to major European competitions.

RESULTS: Teams using the "building-from-the-back" strategy achieved superior results across multiple metrics: higher average points (63.8±14.4 vs. 40.2±14.1, $p < 0.002$), more goals scored (57.3±10.5 vs. 40.1±12.5), and fewer goals conceded (42.4±10.4 vs. 55.0±10.9). Offensive efficiency was also greater, with increased total shots, shot-creating actions, and goal-scoring actions. Ball possession was significantly higher in Group 1 (53.05±4.35% vs. 46.95±5.00%), demonstrating enhanced control over match tempo [3]. Logistic regression analysis indicated that possession-based teams were 13.5 times more likely to qualify for European competitions, although confidence intervals suggest further validation is needed.

CONCLUSION: While results indicate that possession-based strategies correlate with better performance, the observational nature of this study prevents causal inferences. Tactical decisions made by coaches, particularly in adapting styles to match situations and player capabilities, are crucial in determining success. These findings reinforce the importance of structured coaching methodologies that enhance technical and decision-making abilities within specific tactical frameworks. This study contributes to the discourse on coaching effectiveness, offering empirical evidence for strategic development in elite football. Future research should incorporate longitudinal analyses or experimental interventions to establish causality between playing style and performance outcomes.

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**GENDER DIFFERENCES IN DIVERGENT THINKING AND MOTOR CREATIVITY AMONG YOUNG BASKETBALL PLAYERS**

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INTRODUCTION: Creativity plays a pivotal role in basketball performance, enabling players to effectively respond to novel situations and challenges during gameplay. Creative acts originate in the mind through divergent and convergent cognitive processes before manifesting as motor behaviors1. Divergent thinking (DT), which involves the generation of multiple alternative ideas, encompasses dimensions such as fluency (the ability to generate several responses), flexibility (the ability to generate different categories of responses), and originality (the ability to generate unusual responses)2. Motor creativity (MC) refers to the production of new motor patterns to solve pre-established problems3. Despite extensive research, gender-specific findings remain inconclusive, especially among athletes4. This study aimed to explore gender differences in DT and MC among young basketball players.

METHODS: A total of 162 youth basketball players (86 males, aged 14-18) were divided into National Team (NT; n=82) and League Players (LP; n=80). DT was assessed using the Runco Creative Assessment Battery (rCAB; 2011, www.creativitytestingservices.com), which scored both figural and verbal responses. MC was evaluated through an agility ladder task that measured movement fluency, flexibility, and originality.

RESULTS: Significant gender differences in DT were found, with male NT players outperforming both male LP (7.46 vs. 3.89, 4.44 vs. 2.61, 3.53 vs. 1.31, for figural DT fluency, flexibility and originality respectively, $p<0.05$; 4.74 vs. 2.55, 3.32 vs. 2.06 and 1.92 vs. 0.94 for verbal DT fluency, flexibility and originality respectively, $p<0.05$); and female NT players (4.62, 2.71, 1.53 for figural DT fluency, flexibility and originality respectively; 2.97, 2.20 and 0.83 for verbal DT fluency, flexibility and originality respectively). Notably, female NT and LP players demonstrated similar DT scores. In contrast, no gender differences were observed in MC dimensions. However, LP players exhibited higher MC fluency but lower flexibility than NT players.

CONCLUSION: The results suggest potential gender-specific developmental trajectories in DT at elite levels. However, the absence of gender differences in MC suggest that physical creative expression may develop independently of cognitive creative abilities. These results highlight the complex relationship between gender, competitive level, and different forms of creativity in basketball, suggesting the need for tailored development approaches that consider both cognitive and motor creative abilities across genders and competitive levels.

**WHERE IN A HANDBALL MULTI-PHASE ATTACKING SEQUENCE IS THE SPEED-ACCURACY TRADE-OFF?**

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INTRODUCTION: Previous research on throwing in handball has focused on the technique and the speed-accuracy trade-off of the throw in isolation from a typical attacking sequence [1,2]. In such constrained conditions a traditional speed-accuracy trade-off has not been found [1,2]. A typical attacking sequence includes collection of the ball, with up to three steps to evade defenders and perform a shot. The present study aimed to determine whether a speed-accuracy trade-off existed when the player was placed within a game context, and to determine where in the sequence the trade-off occured.

METHODS: Twenty-seven experienced university handball players, on presentation of a visual stimulus, were required to grasp the ball, step around a virtual defender, then jump shoot between two virtual defenders towards a target within a handball goal, again with a defending virtual goalkeeper. The task was repeated under two conditions, with instructions to prioritize speed or accuracy. High speed video and digitizing was used to record the reaction, approach, throwing, and ball flight time along with the accuracy of the. Additional maximal velocity throws, with no concern for accuracy, were recorded. Two-way repeated measures ANOVAs were used to determine differences in group (male vs. female) and condition (speed vs. accuracy). Significant interactions and main effects were followed-up by Bonferroni post-hoc procedures. Significance was set at $p<0.05$.

RESULTS: A traditional speed-accuracy trade-off was found for the sequence, with both groups (main effect for condition $F1,25=11.40$; $p=0.002$) being quicker (males: 1.85 ± 0.11 s vs. 1.91 ± 0.15 s, females: 1.95 ± 0.06 s vs. 1.97 ± 0.08 s) and less accurate (main effect for condition $F1,25=5.09$; $p=0.033$; males: 0.50 ± 0.13 m vs. 0.45 ± 0.13 m, females: 0.52 ± 0.11 m vs. 0.44 ± 0.15 m) in the speed condition. The reduction in time came from the approach and throw time, with reaction and ball speed remaining consistent across trials (males: 19.45 ± 1.24 m/s vs. 19.47 ± 1.24 m/s, females: 18.39 ± 1.13 m/s vs. 17.08 ± 0.91 m/s).

CONCLUSION: The novel finding of this work is that when placed in a sport specific context, including a typical attacking sequence, and without specific instructions regarding throwing speed (ball speed) players displayed a speed-accuracy trade-off, which has previously not been demonstrated in the literature [1,2]. The handball players, however, maintained their sub-maximal preferred ball speed (approximately 94% of maximum) in the flight phase of the throw, with gains in performance made in the earlier phases of the sequence. The study demonstrates that tasks must be investigated using as close to a real-world situation as possible in order to understand the underlying strategy. In addition, the work provides insights for coaches as to where athletes can make performance improvements.

## Oral Presentations

### OP-AP35 Running IV - Trail

**ANALYSIS OF THE FORCE-VELOCITY PROFILE IN TRAIL RUNNERS: A PERFORMANCE STUDY**

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INTRODUCTION: Trail running (TR) has grown exponentially in recent years, increasing interest in its performance factors (Babí-Lladós et al., 2021). Strength is crucial for these athletes, especially on uneven terrain (Ehrström et al., 2018), and the Force-Velocity Profile (FVP) is a useful tool to assess neuromuscular balance and its impact on performance (Pastor et al.,

2022). This study analyzed the FVP in trail runners, as well as their body composition and vertical jump ability, identifying common patterns and optimization strategies.

METHODS: A total of 17 trail runners (6 female and 11 male) with at least two years of experience were evaluated. Body composition was assessed using bioelectrical impedance (InBody 770), jump ability with the Bosco Test, and FVP through countermovement jumps (CMJ) with progressive loads (0, 10, 20, and 30% of body weight) on a force platform (Hawkin Dynamics). Theoretical maximum force (F0), theoretical maximum velocity (V0), maximum power (Pmáx), and the imbalance between force and velocity (FVimb) were calculated.

RESULTS: Results showed differences in body composition, with a body fat percentage of 10.17 ± 2.92% in male and 17.25 ± 3.95% in female. In the Bosco Test, male achieved greater jump heights in SJ (28.64 ± 4.90 cm), CMJ (32.58 ± 5.24 cm), and DJ (32.91 ± 6.19 cm) compared to female (23.48 ± 5.81 cm, 26.28 ± 6.53 cm, and 27.02 ± 5.00 cm, respectively). In PFV, all runners showed an imbalance with a force deficit (FVimb <100%), with mean F0 values of 28.35 ± 3.79 N/kg in male and 24.73 ± 4.37 N/kg in female, while V0 was slightly higher in female (5.25 ± 2.22 m/s) compared to male (4.90 ± 1.61 m/s). The mean Pmáx was 35.16 ± 11.93 W/kg in male and 30.79 ± 8.62 W/kg in female.

CONCLUSION: The most relevant finding was the generalized imbalance in FVP, with a tendency towards a force deficit. This suggests the need to incorporate specific strength training to optimize TR performance. Evaluating FVP may be key to individualizing training programs and improving physical preparation in this sport. Future research should focus on the application of strength interventions and their impact on performance improvement.

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**INTENSITY AND LOAD CHARACTERISTICS OF MOUNTAIN RUNNING RACES: DIFFERENCES BETWEEN MENS AND WOMENS RACES**

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INTRODUCTION: Mountain running races take place on predefined routes in mountainous terrain, requiring athletes to navigate steep elevations, varied surfaces, and changing weather conditions while optimizing speed and endurance [1]. Heart rate (HR) has traditionally been used to monitor race intensity, though running power has recently emerged as a valuable metric [2]. While previous research has primarily focused on male athletes, competition demands for female runners remain unclear. This study aims to examine sex-based differences in external and internal load during mountain running competitions, considering physiological, performance, and biomechanical variables in races ranging from 20 to 45 km.

METHODS: Twenty-four trained mountain runners (12 men and 12 women) with over four years of experience participated in the study. They trained approximately five days per week, accumulating 5 to 12 hours of training. Body fat percentage was assessed via bioelectrical impedance, and a graded treadmill test was conducted to determine maximal HR and VO2max. Runners competed in two 20-45 km races while wearing GPS and Stryd devices to record HR and running power data. Post-race, rate of perceived exertion (RPE) was collected. Data were analyzed using GoldenCheetah to determine exercise intensity distribution and external/internal load.

RESULTS: Men exhibited significantly higher VO2max, maximal workload, and speeds at ventilatory thresholds ($P<0.01$), as well as a lower body fat percentage ($P<0.01$). Women completed races in significantly longer times (31%, $P<0.01$) and placed lower overall ($P<0.001$), though no significant differences were observed in relative rankings within each sex. At the same relative intensity, men produced greater running power, resulting in lower RPE/power and %HRmax/power ratios ($P<0.01$). Men also displayed higher maximal mean power and spent more time at higher power intensities($P<0.01$), while women accumulated more time in the 1-3 W/kg power range($P<0.01$). External load was higher in men($P<0.01$), whereas internal load (assessed via RPE and HR) was similar or lower($P<0.05$). Biomechanically, men demonstrated higher cadence, form power, and stiffness ($P<0.05$), whereas women exhibited longer ground contact times and greater form power relative to running power ($P<0.05$).

CONCLUSION: This study highlights key physiological, performance, and biomechanical differences between male and female mountain runners. Men exhibit higher maximal power output and external load, while women show distinct intensity distribution and biomechanical patterns. These findings underscore the importance of running power and biomechanics in understanding sex-based performance differences in mountain running.

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**DEFICIT OF STRENGTH AND RUNNING PERFORMANCE IN HIGHLY TRAINED TRAIL RUNNERS**

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INTRODUCTION: Trail runners develop biomechanical and neuromuscular adaptations to improve performance and reduce muscle damage due to the sport's demands. Key factors include speed, ground contact time (GCT), cadence, and leg stiffness. Shorter GCT and increased leg stiffness enhance elastic energy return, with both reflecting the stretch-shortening cycle (SSC), crucial for running efficiency. Strength, particularly knee extensor strength and Achilles tendon adaptations, is essential for trail running performance. However, the impact of different resistance training loads on performance remains unclear, especially regarding how varying loads affect elastic energy utilization and force production in prolonged versus short efforts. This study aimed to assess the relationship between biomechanical and strength variables at various 1RM percentages in highly trained male trail runners.

METHODS: Fifteen internationally competitive, injury-free trail runners participated in this study. To estimate their one-repetition maximum (1RM) in the half-squat, participants performed the exercise on a Smith Machine. Mean propulsive velocity and peak force were continuously measured at 1,000 Hz using a linear position transducer attached to the barbell. Participants then completed a running session consisting of a 9-minute and a 3-minute run, separated by a 30-minute rest. They refrained from vigorous activity for 24 hours before each test. Spatiotemporal variables and leg stiffness were recorded with a Stryd power meter.

RESULTS: Pearson's correlation analysis identified significant associations between relative load (%1RM) and leg stiffness across different running efforts. Specifically, leg stiffness correlated with loads of 30% (r=0.533) and 40% 1RM (r=0.33) during the 9-min run and with 40% 1RM (r=0.547) during the 3-min run. Regarding SDef, significant correlations were found between SDef at 50%, 60%, and 70% 1RM and leg stiffness during the 9-minute run (r = 0.539, r = 0.560, and r = 0.535, respectively). During the 3-minute run, SDef at 40%, 50%, 60%, and 70% 1RM correlated significantly with GCT (r=-0.559, r=-0.570, r=-0.565, and r=-0.527, respectively). Additionally, leg stiffness was significantly associated with SDef at 60% (r=0.544) and 70% (r=0.525) 1RM.

CONCLUSION: Significant correlations between relative training loads (%1RM), leg stiffness, and GCT emphasized the role of the stretch-shortening cycle (SSC) in performance. Moderate loads (30–40% 1RM) influenced leg stiffness during prolonged running, while higher loads (50–70% 1RM) affected both stiffness and GCT in shorter efforts. These findings suggest that resistance training modulates SSC efficiency, impacting elastic energy utilization and force production. Tailoring resistance training loads to enhance stiffness and SSC function may optimize performance in trail running, providing valuable insights for coaches.

**INTERACTION BETWEEN MUSCLE ACTIVITY AND RUNNING ECONOMY DURING DOWNHILL RUNNING**

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INTRODUCTION: Running Economy (RE) is a major determinant of performance. A positive relationship between RE and electromyographic (EMG) activity of the knee extensor and plantar flexor muscles has been reported in flat running [1]. To what extent EMG activity explains RE in downhill running, and whether EMG activity can explain the existence of an optimal negative slope (i.e. between -10% to -20%) that minimizes RE [2,3], remain unknown. This study therefore aimed to examine the evolution of RE and EMG activity of knee and plantar flexor muscles, and their correlation, during downhill running at various slopes and speeds.

METHODS: Fourteen healthy participants performed 10 treadmill running trials (5 slopes: 0%, -5%, -10%, -15%, and -20% × 2 speeds: 10 and 12 km/h) in a randomized order. Each bout lasted 4 minutes and was followed by 5 minutes of rest. $VO_2$, EMG activity of the vastus lateralis (VL) and gastrocnemius lateralis (GL), and ground reaction forces were recorded. $VO_2$ and EMG data were collected and synchronized (Delsys Trigno Link), and ground reaction forces were measured via an instrumented treadmill.

RESULTS: The optimal slopes for RE were identified at -13.5% ± 2.8% and -15% ± 2.3% at 10 km/h and 12 km/h, respectively. Across slopes, RE was strongly and positively correlated with GL EMG (Rm = 0.70, $p < 0.001$). The slopes for minimizing GL EMG were found at -14.8% ± 6.1% and -17.3% ± 7.4% at 10 and 12 km/h, respectively. There was conversely only a weak correlation between RE and VL EMG (Rm = -0.19, p = 0.035), with the slopes minimizing VL EMG being irrelevant (-1.3% ± 6.1% and -3.5% ± 9.6% at 10 km/h and 12 km/h, respectively). Moreover, GL EMG showed a strong positive correlation with propulsive impulse (Rm = 0.63, $p < 0.001$), while VL EMG was strongly correlated with braking impulse (Rm = 0.55, $p < 0.001$).

CONCLUSION: These findings highlight the complex interplay between muscle activity and RE during downhill running. RE was strongly correlated with GL EMG, suggesting that the decrease in GL EMG with increasing negative slope (i.e. due to less propulsive requirements, as evidenced by the strong positive correlation between GL EMG and propulsive impulse, which gradually decreases as slopes become steeper) likely plays a major role in minimizing RE. Conversely, optimal slopes identified through VL EMG did not correspond with those minimizing RE and whereas VL EMG was only weakly correlated with RE, it showed a strong positive correlation with braking impulse. This emphasizes the quadriceps crucial role in braking forces that gradually increased with steeper negative slopes, yet without any major influence on RE likely because eccentric contractions during the braking phase require minimal metabolic energy.

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**COMPARISON OF NEUROMUSCULAR FATIGUE AND BIOLOGICAL MARKERS OF MUSCLE DAMAGE BETWEEN MARATHON AND TRAIL RUNNING OF EQUIVALENT EFFORT**

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INTRODUCTION: Trail running has gained in popularity since the 2000', becoming progressively as practiced as road running. Sabater et al. (1) showed that elite trail runners exhibit higher maximal power and force, and spend less time training but more time competing annually than elite road runners. While neuromuscular fatigue has been studied in marathon running (2,3) and trail running (4-7), no direct comparison has been done. The study aimed to compare neuromuscular fatigue and biological markers induced by marathon and trail running races of equivalent km-effort (distance in km + positive elevation in m / 100).

METHODS: Well-trained male and female runners, specialized in road or trail running, participated in a 42.7-km treadmill marathon simulation (MAR, n=5), or in a 29-km simulated trail on a treadmill (TS, n=11) or in a 29-km outdoor trail running bout (TN, n=11) with ± 1400 m elevation. The following assessments of neuromuscular function were conducted before (PRE) and immediately after (POST) the run: maximal isometric voluntary contraction (MVC) of the knee extensors (KE) and plantar flexors (PF), and maximal theoretical force (F0), velocity (v0) and power (Pmax) derived from maximal 8-s cycle ergometer sprints. Blood samples were collected to determine Creatine Phosphoskinase (CPK) concentration. Kruskal-Wallis tests were performed for groups comparison, followed by Dunn's post hoc tests with Holm correction, when p-values were <0.05.

RESULTS: The percentage decrease in MVC for KE (MAR: -36.3 ± 18.5%; TS: -17.6 ± 10.6%; TN: -19.5 ± 8.6%) and PF (MAR: -26.1 ± 14.4%; TS: -19.5 ± 15.2%; TN: -21.3 ± 18.2%) were not statistically different between groups. There was also no significant difference in percentage change in F0 (MAR: -12.6 ± 14.3%; TS: -5.1 ± 6.0%; TN: -5.0 ± 4.4%), V0 (MAR: +9.9 ± 11.0%; TS: +6.2 ± 7.3%; TN: +6.3 ± 2.4%) and Pmax (MAR: -5.2 ± 7.7%; TS: +0.4 ± 3.6%; TN: +0.9 ± 3.7%). MAR showed a greater increase in CPK compared to TS (p=0.0139) and TN (p=0.0136), with no difference between TS and TN (p=0.4149).

CONCLUSION: Neuromuscular fatigue and changes in force-velocity profile parameters were similar following marathon and trail running. However, marathon running induced greater muscle damage, potentially explaining the lower number of marathon races than trail running races per year. These preliminary results must be confirmed as type II errors are possible at this stage.

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## Oral Presentations

### OP-BM08 Ageing II

**AGING EFFECTS ON MUSCLE SIZE AND STRENGTH: A COMPARISON OF MASTICATORY AND LOCOMOTOR MUSCLES**

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INTRODUCTION: Aging is associated with decreased physical activity, leading to muscle mass and strength loss, particularly in the lower extremities. However, the masseter, continuously engaged in mastication, may be less affected, making it a potential model for studying age-related muscle changes with minimal bias from activity. This cross-sectional study examines agings impact on masseter size and strength compared to the quadriceps femoris, a muscle more influenced by activity levels.

METHODS: Thirty women were recruited and categorized into three age groups: young (26 ± 1.8 years), middle-aged (44.1 ± 3.4 years), and older (69.5 ± 3.1 years). Quadriceps and masseter cross-sectional area (CSA) were assessed via ultrasound, lower limb maximal isometric strength (MVIC) via an isokinetic dynamometer, and masseter strength via a bite force sensor. Muscle size and strength were expressed relative to the young group's mean. Data were analyzed using two-way mixed-factorial ANOVAs (3 groups × 2 muscles or 3 groups × 2 strength tests) in SPSS ($\alpha = 0.05$). Sidak's post hoc

tests were used for pairwise comparisons. Cohen's d effect sizes were calculated to quantify the magnitude of differences between age groups.

RESULTS: Both muscles exhibited a progressive reduction in size across age groups. Quadriceps CSA in the middle-aged and older participants was found to be 75 ± 14% and 56 ± 13% of that in the young participants (all $p < 0.05$). Similarly, masseter CSA in the middle-aged and older participants corresponded to 94 ± 15% and 79 ± 14% of that in the young individuals (all $p < 0.05$). Although the group × muscle interaction was not significant ($p = 0.110$), effect sizes were larger for the quadriceps (young vs. middle-aged: 1.56, young vs. old: 2.95, middle-aged vs. old: 1.47) than for the masseter (young vs. middle-aged: 0.29, young vs. old: 1.08, middle-aged vs. old: 1.09). For strength measures, no significant group × strength test interaction was observed ($p = 0.541$), but a significant main effect of group was found ($p < 0.001$). Strength was significantly lower in middle-aged and older participants compared to young adults (MVIC: 81 ± 14% and 62 ± 16%; bite force: 75 ± 15% and 68 ± 31%; all $p < 0.05$), with no significant differences between middle-aged and older participants ($p = 0.186$). Effect sizes were comparable between MVIC and bite force for the young vs. middle-aged comparison (MVIC = 1.20, bite force = 1.33), whereas a larger effect was observed for MVIC (1.25) than for bite force (0.27) when comparing middle-aged to older adults.

CONCLUSION: This study demonstrates a progressive age-related decline in muscle size and strength. Although the lack of significant group × muscle interactions suggests limited statistical power, larger effect sizes in the quadriceps indicate a more pronounced reduction as compared to the masseter muscle. Further research is needed to determine whether aging affects these muscles differently and to explore the underlying mechanisms driving these differences.

**HD-SEMG: A POTENTIAL TOOL TO CONFIRM THE FUNCTIONAL IMPAIRMENT THAT LEADS TO MUSCLE DYSFUNCTION IN ELDERLY**

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INTRODUCTION: The age-related decline in muscle mass and function known as sarcopenia contributes greatly to the loss of quality of life within the older population(1). The pathogenesis of these alterations is related to several known factors contributing to varying degrees. Typical tests used to diagnose sarcopenia are based on muscle mass indexes (e.g. appendicular skeletal mass, ASM) and functional abilities (e.g. handgrip, HG). Nevertheless, these parameters cannot discriminate muscle alterations that lead to functional disability. Recent evidence suggests changes in neurophysiological processes to be major contributors (2). Therefore, the aim of this study is to explore possible correlations between motor units (MUs) properties and typical sarcopenic indexes in a non-sarcopenic group of elderly.

METHODS: Fifty-two non-sarcopenic elder subjects (43F/9M, age=72.1±5.0 years, BMI=25.24±2.69 kg/m2) performed isometric knee extension maximal voluntary contractions (MVC) and trapezoidal contractions at 25% of the MVC. During the MVCs, maximum torque (MT) and rate of force development at 200ms (RFD200) were determined. MUs properties (i.e. recruitment and de-recruitment threshold, discharge rate during steady state, mean discharge rate) of the vastus lateralis (VL) were obtained during the submaximal contractions using high-density EMG. Moreover, participants underwent a dual-energy X-ray absorptiometry (DXA) scan to determine the ASM and performed HG and chair stand tests. Muscle architecture of VL was also assessed at rest at 50% of the femur length. Pearson's correlation coefficient was used to determine the association between MUs properties and DXA and functional and muscle architecture parameters

RESULTS: Recruitment and de-recruitment thresholds are related to ASM (r=-0.30,P=0.048; r=-0.33,P=0.030), HG (r=-0.32,P=0.036; r=-0.35,P=0.020), MT (r=-0.67,P<0.001; r=-0.63,P<0.001) and RFD200 (r=-0.31,P=0.040; r=-0.32,P=0.035). Moreover, the recruitment threshold is associated with VL thickness (r=-0.31,P=0.044) and the de-recruitment threshold correlates with the chair stand score (r=-0.32,P=0.031). The discharge rates (i.e. mean and during the steady state) correlate with the fascicle length (r=-0.30,P=0.049; r=-0.31,P=0.044). All the relationships are classified as weak correlations, except those that include the MT, which are strong correlations.

CONCLUSION: In the elderly, MUs properties of VL could represent significant parameters related to functional abilities and skeletal muscle mass. Our results suggest that among the MUs properties, recruitment and de-recruitment thresholds of MUs can relate better to functional scores and anthropometric characteristics than other. Nevertheless, further studies are necessary to improve the knowledge about muscle alterations related to functional disability in the elderly including a population of sarcopenic individuals.

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**DOES OLDER AGE AFFECT HIGH-DENSITY EMG-FORCE COHERENCE OF THE LUMBAR ERECTOR SPINAE DURING FATIGUE?**

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INTRODUCTION: Proper control of the trunk muscles is essential for maintaining stability and performing daily activities, particularly in the presence of muscle fatigue1. However, the effects of ageing on trunk muscle force control remain largely

unexplored. Force control primarily depends on the common synaptic input received by motoneurons2 and therefore high-density surface electromyography (HDsEMG)-force relationships provide insights into the association between muscle activity and the generated force. This study investigates the relationship between oscillations in lumbar erector spinae (LES) HDsEMG activity and force in young and older participants during a fatiguing task.

METHODS: Twelve older (O, age: 69±4) and twelve young (Y, age: 26±2) participants performed an isometric trunk extension at 30% of their maximal voluntary isometric force until failure. HDsEMG signals were recorded using a 13x5 grid of electrodes placed over the LES. Muscle fibre conduction velocity (MFCV) values were measured. Force steadiness was quantified using the coefficient of variation of force (CoV). Coherence analysis was applied to examine the relationship between HDsEMG and force signals in the delta (0-5 Hz) frequency bandwidth. A mixed-model ANOVA was used to analyse differences in MFCV, CoV and coherence values (Coh) over time (3 epochs of equal duration) and between groups. The Wilcoxon test was used to compare endurance time between groups. Regression analysis examined the association between the percent variation in Coh and CoV values from the beginning to the end of the task.

RESULTS: Endurance time did not differ between groups (O: 90.56 ± 34.75 s; Y: 100.71 ± 49.20 s; p=0.41). MFCV significantly decreased throughout the fatiguing task in both groups ($p<0.01$), indicating LES fatigue. CoV increased significantly at the end of the task in both groups ($p<0.01$) with O showing greater values than Y ($p<0.01$). Coh values decreased significantly at the end of the task in both groups ($p<0.01$), with a significant Time*Group interaction ($p<0.05$) revealing lower Coh values in O in the middle phase of the contraction. Lastly, a greater decline in Coh was associated with a larger increase in CoV values in both O ($R2=0.86$; $p<0.01$) and Y ($R2=0.75$; $p<0.01$).

CONCLUSION: Despite similar endurance between groups, older participants showed greater force variability. In both groups, coherence values declined with fatigue, likely reflecting the recruitment of synergistic muscles to prolong endurance. However, this decline occurred earlier in older participants, suggesting earlier disruptions in common synaptic input to the LES. This may contribute to the age-related increase in force variability, as the decline in coherence is associated to greater force fluctuations.

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**MOTOR PERFORMANCE IMPROVEMENT WITH ENDURANCE TRAINING IN OLDER ADULTS: POSSIBLE ROLE OF THE SOMATO-MOTOR NETWORK**

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INTRODUCTION: Ageing leads to cognitive and motor alterations, while aerobic exercise serves as an effective countermeasure, supporting brain health (1). No studies have so far examined the chronic effect of aerobic exercise on the brain connectivity for the neuronal networks involved in the planning and execution of voluntary movements. Therefore, this study investigated whether endurance training could enhance the motor performance and functional connectivity particularly within the somato-motor network in older adults.

METHODS: 24 endurance older athletes (EA, 50% females, competitive runners, swimmers and cyclists, 65.71±4.14 yrs.) and 24 age-matched untrained controls (UT, 50% females, 68.13±4.34 yrs.) were recruited. We recorded quadriceps femoris (QF) force during isometric maximum voluntary contraction (MVC) and normalized it for the Cross Sectional Area, acquired by ultrasonography. Physical performance was assessed using the chair-to-stand test (CST) and the Star Excursion Balance Test (SEBT). Then, participants underwent a resting-state electroencephalography (EEG) acquisition to compute the functional connectivity between the Supplementary Motor Area (SMA) and primary and secondary somatosensory cortices (S1 and S2), and Eriksen flanker test (2), a cognitive test that evaluates the response speed to congruent/incongruent visual stimuli via a bimanual task. Lastly, we measured the concentration of Brain Derived Neurotrophic Factor (BDNF) and Vascular Endothelial Growth Factor (VEGF) in serum, being recognized as neuroprotective factors.

RESULTS: EA showed greater QF force (14.59%) and, in the first 200 ms of muscle contraction, the rate of force development significantly differed between groups ($p<0.0001$). CST time was lower (-18.12%) and SEBT score was higher in EA (8.42%). Then, EA performed better in the flanker test, with a 9.7% faster response to visual stimuli. For EA vs UT, the power analysis over time of the EEG signals in different frequency bands revealed: (i) a higher connectivity between SMA and lS2 in beta1 (13-20Hz), (ii) a lower connectivity between SMA and rS1 and lS1 and rS2 in delta (1-4Hz), (iii) a lower connectivity within S1 and between lS1 and S2 in gamma (30-50Hz). BDNF did not differ between the two groups, whereas a trend for VEGF to lower in EA vs UT was observed.

CONCLUSION: Endurance-trained older adults exhibited improved motor performance and response speed compared to age-matched untrained individuals. Our EEG findings suggest that this improvement may be mediated by changes in the somato-motor network that assists the primary motor cortex to generate voluntary movements by integrating sensory stimuli. Indeed, the combination of low connectivity in beta1 and high connectivity in gamma may imply an increased motor memory consolidation and decreased effort in movement planning and execution, respectively (3).

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**THE IMPACT OF AGEING IN HEAVINESS PERCEPTION**

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INTRODUCTION: Perception of heaviness is influenced by the actions we perform and how we process visual and proprioceptive information. Both the expectation of the weight of the object being moved and the dynamic information from interacting with it determine the perception (1). Ageing leads to changes in proprioceptive structures (2), a decrease in strength and a consequent impoverishment of the motor experience. The aim of this work is to test how the perception of the weight of an object changes with age.

METHODS: Twenty-six volunteers were enrolled and divided into two groups according to their age, young adults (n=13, 7 female, mean age = 25±4 years) and older adults (n=13, 9 female, mean age: 69±5 years). They performed a weight estimation task; they were asked to lift a box from a desk to their chest with both arms and to estimate the weight of the box. The box weights were 4 kg, 7 kg or 10 kg. The perception of heaviness was assessed based on the load estimation error. A 1kg-box was used as a reference and for familiarisation.

RESULTS: The ANOVA showed a main effect of group ($p=0.03$), with the older group having a higher error than the younger group. Furthermore, the error was greater when they lifted 10kg than 7kg ($p=0.001$) and 4kg ($p<0.001$).

CONCLUSION: The present results show that the perceived heaviness of objects is altered in older adults compared to young adults. These results suggest that age plays a key role in perceiving the object weight, which affects the ability to adequately assess loading. A decline in this ability may suggest an overestimation of ones own strength capacity, and could affect the correct handling of heavy objects with a consequent increase in the risk of injury during activities of daily living.

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## Oral Presentations

### OP-MH30 Metabolic Syndrome and Diabetes II

**INCIDENTAL PHYSICAL ACTIVITY AND TYPE 2 DIABETES: A PROSPECTIVE COHORT STUDY**

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INTRODUCTION: Type 2 diabetes (T2D) is a leading contributor to premature death and disability worldwide. While structured exercise is a critical component of T2D care and prevention, the health effects of incidental physical activity, such as commuting, domestic, or occupational activity are less understood. Therefore, this study aimed to determine the association between device-measured incidental physical activity and T2D incidence in adults.

METHODS: We were able to study the effects of incidental physical activity by restricting analyses to consenting UK Biobank accelerometry sub-study participants who self-reported not engaging in any structured exercise (including sports, gyms, and fitness classes). Participants were excluded if, at baseline, they had prevalent T2D, were undergoing exogenous insulin therapy, or were diagnosed with T2D within 12 months of follow-up. Device-captured incidental physical activity duration was quantified in minutes/day and intensities were categorised into light, moderate, and vigorous (LIPA, MIPA and VIPA) using a validated two-stage machine learning-based intensity and posture classification schema. Additional analyses were conducted by stratifying participants into two groups based on whether they met the moderate-to-vigorous physical activity (MVPA) guidelines. T2D diagnosis was obtained from multiple data sources, including self-reports, primary care records, and hospital inpatient records. The reference group included participants who did not engage in MIPA or VIPA.

RESULTS: The analysis included 23,100 non-exercisers, 748 of whom developed T2D over a 7.9-year follow-up period. MIPA and VIPA, but not LIPA, exhibited near-linear inverse associations with T2D risk. Compared to undertaking no MIPA or VIPA, the median 2.8 minutes of VIPA was associated with a hazard ratio (HR) of 0.57 (95%CI: 0.47 to 0.69) and the median 24.2 minutes of MIPA was associated with a HR of 0.53 (95%CI 0.41 to 0.69). Participants who met or did not meet the MVPA guidelines displayed strong inverse associations between VIPA and T2D (HR 0.64, 95%CI: 0.47 to 0.86 and HR 0.67, 95%CI: 0.52 to 0.88, respectively). However, the dose-response curve was steeper among those who did not meet the physical activity guidelines, and required less time for the same risk reduction (4.02 min/day and 1.43 min/day, respectively).

CONCLUSION: The results of this study demonstrate the importance of incidental MVPA within the context of T2D prevention by showing that even small amounts may be associated with a stark reduction in T2D incidence. These findings support public health recommendations that any MVPA is better than none, especially among individuals who do not meet current physical activity recommendations.

**PHYSIOLOGICAL AND GLYCEMIC RESPONSES TO WHEY PROTEIN DURING EXERCISE IN TYPE 1 DIABETES**

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INTRODUCTION: Exercise-induced hypoglycemia remains a significant challenge for individuals with type 1 diabetes (T1D), even with advanced technology such as automated insulin delivery (AID) systems. A key contributor to hypoglycemia risk in T1D is an impaired glucagon response. In T1D the glucagon response to protein ingestion (unlike exercise or hypoglycemia) remains intact, and ingestion of rapidly digestible protein (such a whey protein), which has potent glycemic action may represent a novel strategy to mitigate exercise-induced hypoglycemia in T1D.

METHODS: An ongoing multi-stage, block-randomized, crossover study is being conducted in adults with T1D using the Medtronic 780G AID system. After a cardiopulmonary exercise test, all participants completed two 60-minute moderate-intensity (50% VO2max) exercise sessions, as well as two 60-minute seated rest sessions in the afternoon. Each session was performed 4 h post a standardized meal with a temporary glucose target set 2 h prior to the session to minimize insulin on board, and 10g fast-acting carbohydrate was given 10min pre-exercise if sensor glucose was <7.0mmol/L. Each session included consumption of either 0.5g/kg body weight of whey protein with water (rest-protein and exercise-protein) or water only (rest-control and exercise-control) 30 minutes before exercise/rest. Blood samples were taken pre-ingestion (-30min), exercise/rest commencement (0min), 30, 60 and 90min for plasma glucagon quantification. Continuous glucose monitoring (CGM) was used to collect interstitial glucose readings every 5min throughout.

RESULTS: Preliminary data is available from five adults with T1D (5 male, mean; HbA1c 6.8%, age 58.6 yrs, body mass 80kg, BMI 26kg/m2, VO2max, 36.3) who completed all exercise sessions (n=2 completed both rest sessions). The mean ± SD protein dose was 40 ± 4g. Fast-acting carbohydrate was supplemented pre-exercise for CGM glucose <7.0mmol/L once (n=1 exercise-control, n=0 exercise-protein). The average change in CGM glucose from start to end of exercise (i.e. 0-60min) was lower for protein ingestion (-0.40 ± 1.04 mmol/L, mean ± SD, n=5) vs control (-2.94 ± 1.87 mmol/L, mean ± SD, n=5). For both rest-control and exercise-control conditions, the average peak change in glucagon (n=2) was negligible (0.96-fold versus 0.95-fold, respectively). The average peak change in glucagon (n=2) was similar for both the rest-protein and exercise-protein conditions (4.01-fold versus 3.15-fold, respectively).

CONCLUSION: Preliminary data indicates that whey protein promotes glucagon secretion equally at rest and during exercise and does not appear to work synergistically. Importantly, whey protein represents a novel strategy to mitigate dropping glucose during exercise in people with T1D, is readily available and could be easily translated into current exercise guidelines and clinical practice for people with T1D wishing to exercise.

**IS THERE A RELATIONSHIP BETWEEN GLYCEMIC CONTROL AND PHYSICAL PERFORMANCE IN ADULTS WITH TYPE 1 DIABETES?**

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INTRODUCTION: Optimal glycemic control (GC) is essential in people with type 1 diabetes (T1D) for long-term health. In fact, GC is associated with the prevention of diabetes complications. Evidence underlines that health benefits are potentiate by a regular practice of physical exercise (PE). Specifically, PE improves the metabolic profile contributing to blood glucose management and reducing daily insulin requirements. Dealing with daily PE implies for people with T1D several practical issues because of its duration, intensity and typology impact in a different way on the glycemic trend. However, it remains unclear the relationship between a stable GC and physical performance (PP) in this population.

METHODS: 59 adults (24F/35M; aged (95% C.I.; 40.189, 46.794)) with type 1 diabetes participated in the study. The data collection consisted of a series of clinical metrics and PP tests. Performance tests evaluate aerobic, strength and flexibility parameters. They were assessed through the Six-Minute Walking Test (6MWT), Yo-Yo Intermittent Recovery Test (Yo-Yo IR), Standing Broad Jump (SBJ), Handgrip Strength Test (HG) and Sit-and-Reach (SaR). HbA1c values were obtained from medical records while Time in Range (TIR), Time Above Range (TAR), Time Below Range (TBR), Coefficient of Variation (CV) and Glucose Monitor Index (GMI) were tracked by a continuous glucose monitor. A linear regression analyses adjusted by sex, age and insulin therapy was conducted to determine the relationship between clinical and motor variable.

RESULTS: Results indicated that there were no significant association between 6MWT and Yo-Yo IR with HbA1c (6MWT: β= -0.228, p=0.177; Yo-Yo IR: β=-0.223, p=0.460), TIR (6MWT: β=0.337,p=0.050; Yo-Yo IR: β= -0.012,p=0.968) and CV (6MWT: β=-0.387, p=0.011; Yo-Yo IR: β=0.017, p=0.948). Similarly, no relationships were observed for the SBJ, SaR and HG tests with these metabolic parameters (all p>0.05). Also TAR and TBR values showed no significant association with all performance tests (all p>0.05).

CONCLUSION: These findings highlighted the concept that better GC is not associated with higher PP levels. Since there is an absence of a significant correlation between PE measure and optimal glycemic management, we can affirm that

multiple factors such as insulin therapy, diet strategies and supplementation influence GC in people with T1D. Therefore, these results indicated that a multidisciplinary approach is necessary in this field.

**EFFECTS OF EXERCISE INTERVENTION ON 24-HOUR CONTINUOUS GLUCOSE IN NON-DIABETIC POPULATION: A SYSTEMATIC REVIEW**

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INTRODUCTION: Maintaining optimal blood glucose regulation is critical for metabolic health, even in non-diabetes. Recently, more and more studies using continuous glucose monitoring (CGM) have explored diverse exercise modalities—including aerobic, resistance, and high-intensity interval training (HIIT)—on glucose regulation in non-diabetic populations. There have been systematic reviews of CGM to assess the effects of exercise on glycemic variability in diabetic patients, however, a comprehensive analysis of the non-diabetic population is lacking. The objective of this review is to quantify the effects of exercise intervention on 24-hour continuous glucose profiles in non-diabetic individuals.

METHODS: Adhering to PRISMA guidelines, PubMed, Web of Science, Embase, CNKI, and WanFang databases were searched up to January 23, 2024. Following eligibility screening, variables of basic information, population characteristics, intervention, results, and CGM Sensor/System were extracted and processed through qualitative synthesis. The risk of bias was evaluated using the revised Cochrane risk-of-bias tool v2.0 (RoB2).

RESULTS: From 8,356 initially identified articles, 2,134 duplicates and 6,183 irrelevant records were excluded, resulting in the inclusion of 19 interventional trials (312 participants) in the final analysis. Study designs included 6 parallel-group RCTs, 11 crossover RCTs, and 2 non-RCTs. Among the included studies, exercise interventions demonstrated reductions in specific CGM outcomes: 8 out of 9 studies reported decreases in the incremental area under the curve (iAUC), 4 of 10 studies observed reductions in the mean amplitude of glycemic excursions (MAGE), 3 of 10 studies showed lowered standard deviation (SD). Risk of bias ratings indicated 36.8% (7/19) low risk, 47.4% (9/19) some concerns, and 15.8% (3/19) high risk.

CONCLUSION: The systematic review revealed limited and methodologically heterogeneous evidence suggesting that exercise interventions may modestly improve continuous glucose monitoring (CGM)-derived metrics, including reductions in incremental area under the curve (iAUC), mean amplitude of glycemic excursions (MAGE), and standard deviation (SD). These effects were observed across diverse study designs (6 parallel-group RCTs, 11 crossover RCTs, and 2 non-RCTs) but lacked statistical significance in most outcomes ($P > 0.05$). Notably, 80% of trials exhibited uncertain or high risk of bias, underscoring concerns about evidence reliability. Future rigorously designed RCTs with larger cohorts, standardized interventions, and prolonged follow-up are warranted to confirm these trends and elucidate the clinical relevance of exercise-induced glycemic improvements in broader populations.

**THE IMPACT OF A MULTIDIMENSIONAL PHYSICAL ACTIVITY INTERVENTION ON GLYCEMIC CONTROL IN TYPE 1 DIABETES**

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INTRODUCTION: Type 1 diabetes is characterized by hyperglycemic episodes influenced by diet, sleep quality, chronotype and physical activity, among others. While aerobic exercise is known to improve glycemic control, its effect on blood glucose regulation remains underexplored. Thus, this case study aimed to evaluate the effects of a prolonged and differentiated (indoor and outdoor exercise) physical activity intervention on glycemic control in an individual with type 1 diabetes.

METHODS: The participant (age: 23years; weight: 95kg; height: 1.90m; Body Mass Index (BMI): 26.3kg/m2; waist to hip ratio: 0.98; basal metabolic rate: 2015kcal; Heart Rate Maximum (HRmax): 197beats·min-1) completed two outdoor session (~3800m) and two indoor session with self-selected speed, in the initial 2-min stage, at 0% grade slope. The grade increased 2% each stage during the uphill phase until reaching volitional fatigue, followed by a 2% decrease at each stage during the downhill phase until returning to 0% grade. Blood pressure was assessed before and after each session. Daily nutrition intake, insulin intake and blood glucose were continuously monitored. Dietary adherence (PREvención con DIeta MEDiterránea), sleep quality (Pittsburgh Sleep Quality Index), chronotype (Morningness–Eveningness Questionnaire), and physical activity levels (International Physical Activity Questionnaire) were assessed before each session. Physical Activity Enjoyment Scale was used to measured enjoyment after each session.

RESULTS: The sessions were completed in ~44 and ~39 minutes with the participant achieving the 84% (outdoor) and 96% (indoor) of his theoretical HRmax. The intervention resulted in glycemic improvements, with time spent in hyperglycemia (>250mg/dL) decreasing from 56.46% to 0%, while time in the normal range (70–180mg/dL) increasing to 63.96%. A 47% reduction in insulin units showed that also insulin sensitivity improved.

CONCLUSION: Despite differences in intensity, indoor and outdoor activities yielded comparable benefits, with outdoor activities perceived as more enjoyable, positively impacted glycemic control, advocating for tailored strategies in diabetes care.

# Oral Presentations

## OP-MH08 Injury Prevention

### DEVELOPMENT OF A PRELIMINARY MULTIVARIABLE MODEL PREDICTING HAMSTRING STRAIN INJURIES DURING PRESEASON SCREENING IN SOCCER PLAYERS: A MULTIDISCIPLINARY APPROACH

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INTRODUCTION: Hamstring strain injuries (HSI) remain a major concern in soccer. Yet existing prediction models fail to account for the multifactorial nature of injury risk. Key factors such as sprint kinematics, performance fatigability, and psychological influences have been largely overlooked. The aim of this study was to develop a parsimonious and multidisciplinary model to identify players at risk of HSI using a single preseason screening session. Additionally, we compared this model's predictive accuracy to that of individual predictors.

METHODS: A total of 120 male and female soccer players competing at regional and national levels underwent preseason assessments, including psychological, physiological, biomecanical, and behavioural variables. Injury occurrence was prospectively monitored throughout the competitive season. After variable selection, logistic regression with the Wald backward stepwise method was used to refine the model. The predictive abilities of the final model and individual variables were determined using the area under the receiver operating characteristic curve (AUC).

RESULTS: Twenty-nine players sustained an HSI during the follow-up period. The final model included eight predictors: age, sex, HSI history, knee flexor performance fatigability, sprint performance (best sprint time and maximal theoretical velocity), perceived vulnerability to injury, and subjective norms regarding pain and fatigue in soccer. It demonstrated strong predictive accuracy (AUC = 0.82, sensitivity = 79%). No individual predictor, when considered independently, reached sufficient discriminative power (AUC $\leq$ 0.65).

CONCLUSION: Assessing single risk predictors does not allow for accurate HSI prediction in soccer players. In contrast, our multidisciplinary model achieved high accuracy in identifying at-risk players. Parsimonious in its design, it highlights the interest of both multifactorial and multidisciplinary approach. Notably, knee flexor performance fatigability following repeated sprints emerged as a key predictor, emphasizing the role of fatigue in HSI occurrence. Additionaly, sprint performance and psychological variables significantly contributed to injury prediction, reinforcing the need for an integrated approach to injury prevention. If externally validated, the present model could serve as a valuable tool for injury prevention strategies. in soccer teams.

### TACKLER AND BALL-CARRIER TECHNICAL PROFICIENCY DURING MODERATE AND SEVERE TACKLE INJURIES IN ELITE RUGBY UNION

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INTRODUCTION: Tackle injuries have the highest injury incidence, may cause the greatest number of days lost (severity) and carry a high injury burden. Moderate and severe injuries in particular may have financial, psychological and team performance implications. To develop effective injury prevention strategies, an understanding of how tackle injuries occur in their specific context is required. Video analysis has been shown to be a useful tool to understand injury mechanism during competition. Therefore, the purpose of this study was to analyse tackler and ball-carrier technical proficiency during moderate and severe contact injuries in professional rugby union and compare with non-injury event controls from the same player and from the same team.

METHODS: Injury surveillance was conducted during The Currie Cup (South Africa's annual premier domestic senior male professional level rugby union competition) between 2022 and 2023 as part of the SA Rugby Injury and Illness Surveillance and Prevention Project (SARIISPP). Using the SARIISPP injury surveillance data, video footage of injuries with a 'moderate' and 'severe' severity ($\geq$8days' time loss) were identified. Player-matched and team-matched

non-injury events were also identified as controls. Technical proficiency for 46 (moderate and severe; $\geq$8 days lost) tackler and ball-carrier injuries and 182 matched non-injury events (90 own controls, 92 team controls) were examined using a standardised list of technical criteria.

RESULTS: Mean technical proficiency scores for tackler front-on injury events was 10 (95% CI 9.2-11), and for side-on/behind injury events was 6.7 (95% CI 5.7-7.7), which was significantly different to their team controls 12 (95% CI 11-12, p=0.0053, ES=0.62, moderate) and 7.7 (95% CI 7.1-8.2, p=0.0696, ES=0.66, moderate), respectively. Side-on/behind injury events was also significantly different to their own controls 7.3 (95% CI 6.9-7.7, p=0.4755, ES=0.35, small). Mean technical proficiency scores for ball-carriers during front-on tackles was 6.7 (95% CI 5.9-7.5), which was significantly different to their team controls 8 (95% CI 7.5-8.4, p=0.0074, ES=0.62, moderate), and own controls 7.4 (95% CI 6.9-7.9, p=0.2223, ES=0.3, small).

CONCLUSION: Both tackler front-on and side-on/behind tackler proficiency scores were lower than the team's non-injury tackles. For the ball-carrier, only front-on tackle events had lower proficiency scores than the team's non-injury tackles. By comparing technical proficiencies during injury events and matched controls, technique deficiencies exposing players to injury were highlighted. These highlighted deficiencies may inform injury prevention strategies and assist coaches in optimising training to reduce tackle injury risk.

**WHAT DOES SHOE CUSHIONING PERCEPTION TELL US ABOUT INJURY RISK IN RECREATIONAL RUNNERS?**

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INTRODUCTION: The protective effect of shoe cushioning against running-related injuries has recently been demonstrated in a large, randomised trial including 800+ leisure-time runners. The underlying mechanism includes a decrease in loading rate and an increase in time to impact peak of the high-frequency signal in softer shoes. However, runners cannot easily assess these biomechanical factors when testing new running shoes. Alternatively, the comfort filter had previously been suggested as a new paradigm relating running shoes and injury risk, suggesting that runners should select a comfortable product according to this filter to reduce injury risk. Therefore, the objective of this study was to investigate whether the perception of cushioning and the overall appreciation of running shoes were associated with injury risk.

METHODS: This is a secondary analysis of a randomized trial on the effect of shoe cushioning on injury risk. Running exposure and injury data were prospectively collected over 6 months. Healthy recreational runners were asked to fill in a questionnaire on 1) shoe cushioning perception at the heel, 2) ideal shoe cushioning level at the heel, and 3) global appreciation of the study shoe using numerical rating scales (score from min. 1 to max. 9). The difference between shoe cushioning perception and ideal shoe cushioning level was computed to reflect the difference between perceived and ideal cushioning. The variables related to perception were then categorised in tertiles. A Cox proportional hazards model was used to estimate adjusted hazard rate ratios (HR), taking right censoring and competing risks into account, and using hours of running as time scale.

RESULTS: The analysis includes 527 participants (35.3% females, mean age (SD): 41.1 (10.2) years, and body mass index: 24.3 (3.1) kg.m-2). The participants ran 172,307 km over the follow-up, and 60 of them (11.4%) reported at least one running-related injury. Compared to the second tertile (ref; >3 to <6), those with low value for cushioning perception (≤3) had greater injury risk (HR [95%CI]: 2.51 [1.30; 4.86], while no difference was observed between the second tertile and those with high values (≥6; HR: 0.77 [0.29; 2.04]). Similarly, compared to the second tertile (ref; >-2 to ≤0), those with low values for perceived-ideal difference in cushioning (≤-2) had greater injury risk (HR [95%CI]: 2.00 [1.12; 3.57], while no difference was observed with those with high values (>0; HR: 0.81 [0.37; 1.79]). No significant association was found between global appreciation of the shoe and injury risk.

CONCLUSION: The present study demonstrates that greater perceived shoe cushioning is associated with lower injury risk. Therefore, the study suggests that cushioning perception, and potentially comfort filter, may be a valuable approach for shoe selection to prevent running-related injuries, although the validity of this paradigm deserves further research and the causal pathway has yet to be explained.

**GYROKINESIS® REDUCES PAIN AND RESULTS IN GREATER IMPROVEMENTS IN POSTURAL SWAY WHEN COMPARED TO PILATES IN INDIVIDUALS WITH OSTEOARTHRITIS: A 24-WEEK PILOT STUDY**

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INTRODUCTION: Osteoarthritis (OA) is the most prevalent musculoskeletal disorder, resulting in pain that significantly impacts quality of life. It is frequently associated with impaired balance, highlighting the importance of balance training to reduce pain and fall risk. Gyrokinesis® (GY) is an innovative exercise modality that enhances proprioceptive control and may address OA-related symptoms, including pain and postural stability, more effectively than traditional exercises such as Pilates (PL). This exploratory study examined whether a 24-week GY intervention produces greater improvements in pain and postural control compared to PL in individuals diagnosed with OA.

METHODS: Twenty female participants with OA were enrolled onto the study (age: 60.4 ± 6.9 years) and non-randomly allocated (based on geographical location) to either 24-weeks of GY (n=12) or PL (n=8). Both modalities comprised a structured training regimen over a duration of 24 weeks, with participants engaging in bi-weekly sessions lasting one hour each. Outcome measures, including perceived pain (Brief Pain Inventory Questionnaire), kinesiophobia (Tampa Scale of Kinesiophobia) and postural sway parameters during left and right single-leg stance tests were assessed at baseline and after the intervention. The amplitude, velocity and mean power frequency were calculated to infer postural performance and strategy.

RESULTS: Statistical analysis was performed using a repeated measures ANCOVA with baseline as the covariate. Both GY and PL significantly reduced pain scores, with greater reductions observed in the GY group ($p<0.001$; 95% CI -4.21 to -2.34 a.u.) compared to PL ($p = 0.025$; 95% CI -2.48 to -0.19 a.u.). Additionally, both interventions improved postural sway, with significant reductions in right leg anteroposterior velocity (GY: $p<0.001$, 95% CI -1.61 to -0.96 cm/s; PL: $p=0.006$, 95% CI -0.99 to -0.19 cm/s). However, GY led to greater improvements than PL in left leg anteroposterior ($p<0.001$, 95% CI -1.44 to -0.54 cm/s) and mediolateral ($p = 0.025$, 95% CI -1.51 to -0.11 cm/s) velocity and anteroposterior root mean square ($p=0.038$, 95% CI -1.70 to -0.05 cm). There were no changes in mean frequency.

CONCLUSION: Both Gyrokinesis® and Pilates were effective in alleviating pain however, the GY group demonstrated greater improvements in some measures of static balance when compared to PL in patients with OA. These findings provide promising preliminary evidence that GY may be a more effective intervention for reducing fall risk in this population. Future research should seek to replicate these initial findings with larger samples sizes and across a range of different healthy and clinical populations.

**TRANSLATING RESEARCH INTO PRACTICE FOR REDUCING INJURY INCIDENCE IN ATHLETES**

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INTRODUCTION: Reducing injury incidence in athletes poses significant challenges due to the numerous variables involved, many of which are sensitive to temporal changes and difficult to control [1]. For those committed to improving athlete health outcomes, a critical question arises: How can strategies be effectively implemented to achieve measurable reductions in athlete injury incidence? This research attempts to address this question by translating epidemiological research into actionable approaches for secondary school sports programs.

METHODS: This study employed a participatory action research approach over two years within a single secondary school sport program. Participants included student-athletes, coaches, school administrators, and parents. Researchers attended weekly practices and games, collaborating with program stakeholders to implement injury reduction initiatives and observe program operations. A mixed methods design was used, involving quantitative analysis of injury incidence from the school's online surveillance database and qualitative data collection through semi-structured interviews, conversational interviews, researcher field notes, and peer debriefs. Injury incidence within the sports program was compared between the two seasons with active guidance and four previous seasons without such guidance.

RESULTS: The group without guidance (n = 139) experienced 12 injuries, resulting in an injury incidence proportion of 0.08. The group with guidance (n = 65) experienced one injury, yielding an injury incidence proportion of 0.01. The relative risk of injuries in the guided group was 0.178 (95% CI: 0.024 - 1.342). Thematic analysis of qualitative data revealed six themes: education in action, shared responsibility, resource allocation, incremental progress, commitment to change, and questioning cultural norms.

CONCLUSION: This study highlights the potential of applying epidemiological data to inform injury prevention strategies in secondary school sports. Further research is needed to better understand how these strategies may influence injury outcomes and to explore their applicability across various contexts. We hope this work encourages practitioners and researchers to consider ways to apply epidemiological research to practices that aim to support athlete health.

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## Oral Presentations

### OP-SH08 Psychobiology

**BEHAVIORAL CHARACTERISTICS AND NEURAL ACTIVATION IN ANTICIPATING DECEPTIVE ACTIONS AMONG BASKETBALL PLAYERS: A TASK-BASED FMRI STUDY**

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INTRODUCTION: Basketball is a complex open-skill sport where deceptive actions are crucial for misleading opponents. Athletes must quickly anticipate these actions, making it essential to understand the cognitive mechanisms behind this anticipation. Research shows that observing actions activates the Action Observation Network (AON) or the Mirror Neuron System (MNS), aiding in recognizing and mimicking actions. The AON includes key brain regions responsible for processing observed actions and their intentions. Expert athletes exhibit superior visual cognitive abilities and greater activation in AON-related regions compared to novices. This study uses fMRI technology to examine behavioral and neural activation differences in anticipating deceptive actions between expert and novice basketball players.

METHODS: This study investigates predictive behavior and brain activation differences through behavioral experiments and fMRI. Thirteen male experts (CUBA championship level) and 14 male novices (ordinary university students) participated. Stimuli included videos of shooting and breakthrough fake actions, totaling 108 valid segments. Participants judged the authenticity of the shots in a block design. Brain functional images were collected using a Siemens 3.0 T MAGNETOM Prisma MRI scanner, and behavioral data were analyzed using SPSS 27.0 with independent samples t-tests and repeated measures ANOVA.

RESULTS: In the shooting fake action anticipation task, the expert group exhibited an overall accuracy of 89.23±5.94, significantly higher than the novice group's 64.13±9.46 ($t=7.56$, $p<0.001$). The expert group also demonstrated superior accuracy at all designated breakpoints: first breakpoint (87.69±7.12 vs. 58.10±13.94, $t=7.15$, $p<0.001$), second breakpoint (91.54±6.47 vs. 65.48±10.18, $t=7.99$, $p<0.001$), and third breakpoint (88.46±10.24 vs. 68.81±12.78, $t=4.49$, $p<0.001$). In the

breakthrough fake action anticipation task, the expert group achieved an accuracy of 80.61±10.15, significantly greater than the novice group's 36.90±15.60 (t=8.55, p<0.001).

The expert group reported a higher confidence level (83.31±6.68) compared to the novice group (62.50±12.23, t=5.43, p<0.001). For fMRI data, both groups activated AON-related brain regions, including the left angular gyrus and left dorsolateral prefrontal cortex. Experts showed significantly higher activation in the bilateral medial frontal gyrus, right hippocampus, and left anterior cingulate cortex compared to novices.

Discussion: This study highlights significant differences in behavioral performance and neural activation between expert and novice basketball players when anticipating deceptive actions. Experts demonstrated superior accuracy and confidence, particularly in shooting fake actions. The findings underscore the importance of the AON and related brain regions in processing deceptive actions, revealing that experts utilize more efficient cognitive strategies and neural mechanisms.

**EXPLORING THE EFFECT OF PHYSICAL EXERCISE ON BODY RECOGNITION NEURAL NETWORKS: EVIDENCE FROM ERPS**

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*UDA*

INTRODUCTION:

The extrastriate body area (EBA), located in the lateral occipitotemporal cortex, responds robustly to human bodies and body parts [1]. Event-related potentials (ERPs) have been used to investigate this response, with studies showing that body perception modulates components like P1 and N1, reflecting early stages of visual processing [2]. Physical exercise has well-documented benefits, promoting neural plasticity and cognition, especially in regions linked to motor control [3]. However, its effect on brain areas involved in body recognition, such as the EBA, remains underexplored. We aim to investigate whether physical exercise influences neural responses in the EBA by examining changes in ERPs related to body perception. We hypothesize that physical exercise modulates electrical activity in response to body stimuli, with these effects reflected in body-related ERPs. Specifically, we expect alterations in the amplitude or latency of body-related components after aerobic exercise, suggesting neural plasticity in response to physical activity.

METHODS:

Young healthy subjects undergoes a 64-channel EEG recording while randomly looking at visual stimuli depicting the whole body, arms, and legs, both static and in motion, along with scrambled image of the same stimuli as controls, before and after 20 minutes of aerobic exercise on a cycle ergometer. Habitual physical activity is assessed using the International Physical Activity Questionnaire (IPAQ), and body image is evaluated using the Body Image Coping Strategies Inventory (BICSI). Hand dominance is assessed using the Edinburgh Handedness Inventory. Based on G*Power calculations with a statistical power of 80% and an effect size of 0.27 for a within-between interaction ANOVA, this protocol will be conducted on 30 participants.

RESULTS:

Preliminary data from 7 subjects (6F; 23 ± 0.47 years; BMI: 22.8 ± 2.77) show no clear difference between control and body stimuli but suggest a modulation of the N1, the P2 and the P3 components following physical activity. Further analysis with 30 participants will also explore potential correlations between questionnaire scores and ERP data.

CONCLUSION: Acute aerobic physical exercise appears to influence body-related ERPs, with preliminary data suggesting modulations in early and late components, supporting the hypothesis that physical exercise can impact neural responses related to body perception. However, further analysis of the full sample is required to confirm these effects and explore the underlying mechanisms.

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(Downing et al., 2001; Mandolesi et al., 2018; Taylor et al., 2010)

**NEURAL CORRELATES OF EXERCISE-INDUCED COGNITIVE GAINS: A META-ANALYSIS OF FMRI STUDIES**

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Cognitive function is fundamental to daily life, and its decline often precedes various diseases. While the general-domain cognitive benefits of physical exercise are well-documented, the underlying neural mechanisms remain poorly understood. This meta-analysis, encompassing 52 studies with 1,503 participants, investigates how physical exercise modulates task-related brain activation and its relationship to cognitive improvements. Results indicate that physical exercise significantly enhances cognitive performance (Hedges g = 0.271) and increases task-related activation, particularly in the bilateral precuneus. Notably, these activation increases correlate positively with performance gains. Furthermore, factors such as exercise intensity, adherence, and social environment significantly modulate changes in brain activation. These findings provide robust neural evidence for the general cognitive benefits of physical exercise and offer critical insights for designing effective interventions. To examine whether physical exercise also exerts specific-domain effects, a secondary analysis focusing on 23 studies of executive function was conducted. During executive function tasks, physical exercise significantly increased activation in the anterior cingulate cortex (ACC), posterior cingulate cortex (PCC), cuneus, and precuneus, while reducing activation in the superior temporal gyrus, insula, midbrain, and thalamus. These findings suggest that the precuneus plays a central role in mediating exercise-induced general cognitive benefits (general-domain

effect). Additionally, they highlight that the observed improvements in specific domains, such as executive function, may be linked to changes in distinct task-relevant brain regions (specific-domain effect). The underlying mechanisms involve a dual process of neural efficiency and neural compensation. Physical exercise enhances cognitive efficiency by reducing activation in non-task-related regions and supports cognitive compensation by increasing activation in task-relevant and integrative hub regions, such as the precuneus and ACC. This dual mechanism optimizes brain function, providing a comprehensive framework for understanding how physical exercise promotes cognition and informing the development of targeted intervention strategies.

**INVESTIGATING THE LINK BETWEEN LIFETIME PHYSICAL ACTIVITIES AND EEG APERIODIC SLOPE IN ADULTS AGED 55+**

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INTRODUCTION: Resting-state EEG (rs-EEG) evaluates spontaneous brain activity, reflecting neural oscillations in different frequencies. Among rs-EEG variables, the aperiodic slope follows a 1/f pattern with higher power at lower frequencies. The steepness of this slope describes the exponential decrease of power across frequencies in the power spectral density. Evidence indicates that a steeper aperiodic slope is associated with better cognitive performance, whereas a flatter slope is linked to poorer performance in healthy individuals. Research also shows that the slope flattens with age. Lifestyle factors, including physical activity, are linked to better cognitive functioning. However, it is unclear whether accumulated lifetime physical activity, defined as motor reserve, affects the aperiodic slope. Therefore, this study aimed to investigate this relationship, given the protective role of physical activity in aging.

METHODS: The study included 33 participants, aged 56-77 years (M=66.06, SD=5.94, 33.3% male). Rs-EEG was recorded with a 32-channel g.Nautilus headset, using gel electrodes placed according to the 10-20 system, with impedance below 50 kΩ. Data were preprocessed with EEGLAB in MATLAB and downsampled to 256 Hz. Recordings lasted 3 minutes each with eyes open and closed. The median aperiodic slope steepness was computed using the FOOOF algorithm in Python. Physical activity data were collected using the Motor Reserve Index questionnaire (MRIq; Pucci & Mondini, 2020).

RESULTS: Spearman`s rank correlation analysis was conducted, and no statistically significant associations were found between the median aperiodic slope and either age or the Motor Reserve Index.

Across the six domains of physical activity, namely, housework, walking, leisure activities, sports, care activities, and workplace activities, a correlation was found only between the median aperiodic slope and housework activities (rs=.432, p=.012).

CONCLUSION: Our results show that within our sample of older adults the aperiodic slope is not correlated with motor reserve; nevertheless, there might be a positive link between lifetime housekeeping activities and the slope steepness.

Housekeeping, as a regular and cognitively engaging physical activity, might play a significant role in cognitive and brain maintenance, thus promoting healthy ageing and contributing to better cognitive performance, as reflected in the aperiodic slope. While our results contribute to the existing understanding of brain maintenance and cognitive reserve, we recognize the limitation of the small sample size and the retrospective nature of the MRI questionnaire, thus further studies in a larger and more varied sample of adults and added objective measures of physical activity are needed.

**RESTING-STATE CONNECTIVITY AND ACTIVATION CHANGES REFLECTING ACUTE MENTAL FATIGUE: AN FMRI STUDY**

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Introduction: Mental fatigue is a temporary psychophysiological state resulting from prolonged effort engagement in a demanding task and generally associated with a decrease in performance and a decrease in sympathetic activity and/or cognitive control over time. However, the brain mechanisms explaining acute mental fatigue are still debated. The principal aim of this study is to examine a possible mechanism implying the triple-network model (Menon, 2023). This model assumes that the salience network (SN), which is mainly anchored in the anterior cingulate cortex and anterior insula, exerts a form of control over the fronto-parietal network (FPN) and the default-mode network (DMN). During an effortful cognitive task, the SN and the FPN are generally co-activated whereas the DMN is deactivated. Previous brain-imaging studies showed that mental fatigue can be associated with changes in connectivity between task-positive (SN and FPN) and task negative (DMN) large-scale neuronal networks which increase attentional lapses and mind wandering (i.e., higher activation of the DMN). The principal hypothesis that will be tested in this experiment is that the decrease in performance over time observed in a demanding task is associated with a decrease in control of the SN over the DMN. Methods: Thirty-eight participants performed a 30-min incongruent Stroop task and a 30-min documentary watching task in two different counterbalanced sessions. Two types of trials were distinguished: 'reading' trials for which participants had to read the word and 'naming' trials for which they had to name the color of the ink. 'Naming' trials require more inhibitory control than 'reading' trials. The functional MRI acquisition was performed on a Siemens 3T MRI scanner. Resting-state sessions were acquired before and after each cognitive task and activation was measured while participants were performing on the Stroop task. Functional connectivity was represented by transformed bivariate correlation coefficients between regions of interest (ROI) involved in the SN, FPN and DMN. Levels of BOLD-response at the end of the task was compared to the beginning of the same task in the same ROI than previously. Results: The larger the effect of time-on-task on reaction time (RT) for 'naming trials' during the Stroop task, the larger the decrease in connectivity between the SN and the

DMN over time. Complementary analyses on the activation of brain ROI should confirm the hypothesis of a decrease of control of the SN over the DMN. Discussion: According to our results, acute mental fatigue will be characterized by a failure of the salience network to exert a control over the DMN. This will result in a higher difficulty for the participant to maintain constantly their concentration on the task, a decrease in the capacity to inhibit effectively the 'reading' responses and a lengthening of the RT for the 'naming' trials in which participants have to inhibit the 'reading' response.

## Oral Presentations

### OP-MH17 Post-surgical Recovery

**EFFICACY, SATISFACTION AND FUNCTIONAL RECOVERY OF TELEREHABILITATION VS. TRADITIONAL REHABILITATION IN PATIENTS AFTER KNEE SURGERY: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: With the advancement of medical technology and sports science, postoperative rehabilitation options for patients are diversifying. After knee surgery, rehabilitation not only restores joint function but also athletic performance and daily activity. For active individuals or athletes, satisfaction with the rehabilitation process plays a crucial role, as it influences engagement and adherence to rehabilitation programs. This study aims to evaluate the efficacy and satisfaction of telerehabilitation for knee surgery patients (including knee arthroplasty, meniscectomy, and ACL reconstruction) and compare telerehabilitation with traditional outpatient and face-to-face rehabilitation in terms of motor function restoration and athletic performance improvement.

METHODS: We conducted electronic searches in six major databases (Web of Science, PubMed, MEDLINE, ScienceDirect, EMBASE, and Cochrane Library) and manually reviewed references in relevant journals to identify randomized controlled trials (RCTs) on telerehabilitations impact on motor function recovery and satisfaction for knee surgery patients. Data extraction and quality evaluation were performed by two independent evaluators. Data were analyzed using RevMan 5.4 software.

RESULTS: Twenty RCTs involving 2242 patients were included. The primary endpoint was patient satisfaction, with secondary endpoints including KOOS, WOMAC, TUG, and ROM. Telerehabilitation showed no significant difference in overall patient satisfaction compared to traditional rehabilitation (mean difference = 0.15; 95% CI = -0.23 to 0.53; p = 0.44). However, satisfaction was significantly higher for interventions using software or web-based platforms (mean difference = 0.56; 95% CI = 0.08 to 1.03; p = 0.02), while videoconferencing and telephone interventions showed lower satisfaction (mean difference = -0.52; 95% CI = -1.02 to -0.02; p = 0.04). Telerehabilitation also outperformed traditional rehabilitation in motor function recovery, especially in knee extension (p = 0.003) and motor performance (p = 0.02), as measured by the TUG test. It also significantly improved WOMAC and KOOS scores (p=0.007 and p=0.01), but the improvement in knee flexion was not significant (p=0.47).

CONCLUSION: Telerehabilitation is superior to traditional rehabilitation in improving motor function and performance after knee surgery, both in objective metrics (TUG, ROM) and subjective scores (WOMAC, KOOS). Using web-based platforms for telerehabilitation not only enhances motor recovery but also increases patient satisfaction. For active individuals or athletes seeking rapid recovery of motor abilities, telerehabilitation using web-based platforms shows great potential as an effective alternative to traditional rehabilitation, especially in improving athletic performance and enhancing motor ability.

**LONG-TERM LOWER EXTREMITY RANGE OF MOTION DISPARITIES FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION IN FORMER SECONDARY SCHOOL ATHLETES USING TRAZER MOTION CAPTURE**

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INTRODUCTION: Knee extension deficits are common following anterior cruciate ligament tear and reconstruction (ACLR) and may remain for multiple years [1]. However, limited literature exists on other knee and lower extremity motions, such as knee flexion and valgus/varus following ACLR. While range of motion (ROM) is commonly recorded in clinical practice statically, using handheld goniometers, recent advancements in technology enable clinicians to analyze ROM and screen for imbalances during dynamic movements. The purpose of this project was to compare long-term knee and lower extremity ROM between ACLR and non-ACLR limbs during an air squat in former secondary school athletes using motion capture technology. We hypothesized that ACLR limbs would have deficits in knee, tibial, and ankle ROM when compared to the non-ACLR limb.

METHODS: Twenty (18 female, 2 male) former secondary school athletes (age=20.2±1.6 years) who had prior ACLR during sport and were medically cleared for unrestricted activity/return-to-sport (range=1-5 years post), completed a 5-repetition, double leg, air squat while being recorded using the TRAZER motion capture system [2]. Measures consisted of average degrees (°) of ROM across the 5 repetitions for knee flexion, knee valgus/varus, tibial angle, and ankle dorsiflexion between the ACLR and non-ACLR limbs. A series of Wilcoxon Signed Rank Tests were used to compare ROM between limbs.

RESULTS: Significant deficits were observed on knee flexion with decreased ROM in the ACLR limb (108.0±9.8°) as compared to the non-ACLR limb (109.7±10.3°; p=0.03). No ROM differences were observed between limbs on knee valgus/varus (ACLR=1.3±4.0° vs. non-ACLR=2.8±4.6°; p=0.10), tibial angle (ACLR=26.1±4.4° vs. non-ACLR=27.0±4.2°; p=0.09), or ankle dorsiflexion (ACLR=10.3±5.5° vs. non-ACLR=11.3±5.3°; p=0.023).

CONCLUSION: Long-term ROM deficits were observed in knee flexion only with less ROM in the ACLR limb. It is possible that these knee flexion deficits mirror knee extension lag, however it is unclear whether these limb disparities become apparent in years following medical clearance or persisted throughout the ACLR rehabilitation. Additionally, knee flexion limb disparities may also only exist in more dynamic tasks and therefore, future research is needed to compare motion capture and goniometer measures.

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**DISTAL-TO-PROXIMAL PROGRESSION OF GROWTH-RELATED INJURIES IN MALE YOUTH ACADEMY FOOTBALLERS: A TWO-SEASON PROSPECTIVE COHORT STUDY OF 16,024 PLAYER-SEASONS**

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INTRODUCTION: Youth football players are particularly vulnerable to apophyseal injuries, which can have long-term consequences for health and performance. The objective was to assess the incidence, severity, and burden of apophyseal injuries among U9–U21 academy football players over two seasons.

METHODS: Time-loss injuries and match and training exposure minutes were tracked in male academy football players (U9–U21) from Premier League and Category One Academies (29 academies in the 2021-22 season and 31 in the 2022/23 season). Apophyseal injuries were identified using OSICS codes, and their incidence, severity, and burden were analysed.

RESULTS: A total of 10,589 injuries were reported, including 603 apophyseal injuries. These injuries followed a distal-to-proximal progression with age, occurring most frequently in the ankle (U9–U11), followed by the knee (U12) and hip/groin (U15–U18). The incidence (~0.4 injuries/1000 h) and burden (~20 days/1000 h) of apophyseal injuries during match and training sessions were highest in the U12–U16 group. A statistically significant trend of increasing injury severity was observed with age: U9–U11 (median: 20 days), U12–U14 (median: 29 days), U15–U16 (median: 38 days), and U18–U21 (median: 35 days). Ankle and knee apophyseal injuries resulted in the second highest injury burden, compared with all musculoskeletal injuries sustained in the U9–U11 and U12–U14 groups, respectively.

CONCLUSION: Apophyseal injuries exhibit a distal-to-proximal progression with age, with the highest injury burden observed in the U12–U16 groups. These findings can help inform injury mitigation strategies adopted in youth academy football.

**INVESTIGATING THE ASSOCIATION OF INTERACTION OF VARIANTS WITHIN THE TYPE I COLLAGEN GENES AND MEASURES OF KNEE JOINT LAXITY**

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INTRODUCTION: Joint laxity is a multifactorial phenotype with a genetic component. Type I collagen (COL1A1) gene variants, rs1107946 (G/T) and rs1800012 (G/T), have been associated with inter-individual variation in knee joint laxity measurements. Specifically, the rs1107946 GG genotype was independently associated with larger external and internal tibial rotation of the non-dominant leg, while the GG genotype occurring at both COL1A1 variants was associated with larger internal, but not external, tibial rotation of the dominant leg. Although not independently associated, a GG genotype occurring at both COL1A1 variants was associated with increased active and maximum tibial displacement of the non-dominant leg. Type I collagen alpha-chains are encoded by COL1A1 and COL1A2. As joint laxity is a polygenic trait, genotype-genotype interactions of variants within functional related genes should be investigated. However, the association of COL1A2 variants, or COL1A1-COL1A2 variant interactions, with knee joint laxity measurements have yet to be investigated. Thus, the aim of this study was to investigate the association of the COL1A2 rs42524 (G/C) variant with measures of knee laxity, both independently and via interactions with COL1A1 variants.

METHODS: 123 participants who had previously been genotyped for rs1107946 and rs1800012 were genotyped for rs42524. Genotype scores were calculated as a proxy for genotype-genotype interactions with rs1107946 GG, rs1800012 GG and rs42524 GG each given a score of 2, such that participants could have a score of 0, 2, 4 or 6. External-internal tibial rotation, anterior-posterior tibial translation, as well as maximal and active tibial displacement were measured in both the dominant and non-dominant legs of each participant.

RESULTS: No significant independent associations between COL1A2 rs42524 and measures of knee laxity were reported. However, there was a significant decrease in external (linear trend p=0.042) and internal (linear trend p=0.025) rotation of

the non-dominant leg, as well as internal rotation of the dominant leg (p=0.029) from the group with a genotype score of 6, a score of 4, a score of 2, to a genotype score of 0. Similarly, the active displacement of the non-dominant leg was significantly greater (p=0.026) when the group with a genotype score of 6 [6.3 mm (3.1; 7.9)] was compared to the groups with scores of 0 or 2 [3.0 mm (1.4; 7.0)]. The anterior tibial translation of the dominant leg was significant higher (p=0.039) in the group with a score of 6 [7.5 mm (5.5; 9.5)] compared to the group with a score of 0 [4.5 mm (3.1; 7.1)].

CONCLUSION: The combined type I collagen genotype effect was associated with measures of tibial rotation, active tibial displacement and anterior tibial displacement. These findings highlight the importance of investigating genotype-genotype interactions within functional related genes with multifactorial traits.

## Oral Presentations

### OP-SH24 Children and Body Image

**"SHUT UP! DON'T LOOK AT ME!": A QUALITATIVE DESCRIPTION OF BODY IMAGE AND ATTENTION AMONG ELITE ATHLETES**

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Elite athletes face numerous, pervasive, and ongoing pressures regarding their bodies' weight, shape, and performance. Due to the body-focused, judgement-based, and highly critical nature of sport cultures, body surveillance and dissatisfaction, disordered eating, and associated negative body emotions (e.g., shame, guilt) are common among elite athletes in a variety of sports. Negative body image, in particular, poses risks to athletes' abilities to focus on competition and perform to the best of their abilities. When attention is biased towards the body, athlete focus is diverted away from sport performance. Given the prevalence of negative thoughts, perceptions, behaviors, and emotions about the body in sport, it is important to understand the ways in which body image affects athletes' attention. Eight elite athletes (Mage = 26.25 years, n = 2 cisgender men, n = 6 cisgender women) were interviewed for this qualitative description study to describe the perceived association between body image and attention. Following an inductive qualitative content analysis, three dominant themes were explored. Theme 1, "Who's the leanest person here?": the pressures of how athletes feel they ought to appear, reflects the effect of incessant body comparisons among other athlete bodies, the intense vulnerability felt in uniforms which distracts from sport, and the effects on athletes' attention from being watched, photographed, and recorded. Theme 2, "It's not only a safety hazard, but you're not going to perform your best": athletes focus on sport not their bodies, refers to the participants taking control of their attention through body image and sport where they can, as well as the consequences to attention from pressures related to eating and weight. Theme 3, "I just flung that over my head, that's incredible!": the supports of body image and attention, is comprised of the strategies utilized by participants to improve their body image and attention in sport, as well as the value of having positive experiences with coaches on their abilities to focus. The findings of this research provide a detailed description of the perceived association between body image and elite athletes' control of attention in sport. In addition to discussion of the detrimental effects of negative body image on attention in the context of sport, participants also described strategies undertaken to manage their attention and body image to deter performance detriments. This research contributes to the literature concerned with maximizing sport performance and the attentional repercussions of well-established body image concerns which are pervasive in elite athletics.

**ACUTE AEROBIC AND COORDINATIVE INTERVENTIONS - EFFECT ON COGNITIVE PERFORMANCE IN PRE- ADOLESCENT CHILDREN**

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Acute Aerobic and Coordinative Interventions - Effect on Cognitive Performance in Pre- Adolescent Children

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INTRODUCTION: The relation between physical fitness, acute exercise and cognitive performance has drawn significant attention in recent years. The cognitive response to an exercise intervention varies between age groups and is affected, among else, by the intensity, duration and type of exercise. The aim of the present study was to investigate the effect of a single aerobic workout versus a coordinative intervention on cognitive performance in pre-adolescent children.

Method:

Eighty-six boys and girls ages 8-9 years participated in the study. The children were randomly divided into two groups: a. The experimental group (group A) performed acute aerobic exercise by skipping rope jumping for 25 minutes continuously: two legs front, two legs back, right and left leg alternately. b. The control group (group B) performed coordinative activity by spinning a dreidel from a sitting position for 25 minutes continuously. Heart rate (HR) was monitored continuously by a POLAR heart rate watch in both groups to evaluate the effect of the exercise vs. the coordinative activity. The Stroop test stages 1-2-3 was applied to assess executive function (EF) as reflecting cognitive function. Tests were performed twice by

each child: once prior to the activity intervention and again within 5 minutes of the activity termination. The number of correct responses was recorded in each of the Stroop test stages.

Results:

Mean HR of group A, the skipping rope group changed from 91±12 prior to the exercise to 193±16 beats/minutes upon termination; mean HR of group B, the coordinative group changed from 88±10 to 113±10 beats/minutes. The skipping group achieved higher scores on the Stroop tests after exercise compared to scores prior to the activity in all three stages ($p<0.001$). A positive effect was observed also in the coordinative group with higher scoring upon termination compared to that prior to the spinning dreidel activity ($p<0.05$). However, the post-exercise outcomes of the skipping group were better compared to those of the coordinative activity group. Interaction between measurement time and type of intervention was found significant for Stroop 1 ($p<0.02$) and Stroop 3 ($p=0.00$).

Discussion:

The results of the present study demonstrate a positive effect of acute, moderate-intensive aerobic exercise on some of EF abilities in pre-adolescent children. Yet, coordinative tasks that involve only very light activity as shown by the HR response, also revealed a beneficial effect on the EF performance. Based on these results it may be suggested that for the benefit of cognitive performance of school age children, acute, short activity interventions, whether aerobic or coordinative, should be part of the daily schedule and integrated routinely in between class hours.

**TACKLING INEQUALITIES AND INCREASING UNDERPRIVILEDGE CHILDREN WELLBEING: PRELIMINARY RESULTS FROM THE "TALENT GARDEN" PROJECT**

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INTRODUCTION: Childhood physical activity is essential for the development of motor skills, cognition, and overall health. Children from low-income backgrounds often face obstacles in accessing structured training programs, which can impact their physical and psychological well-being. The purpose of this study is to investigate the effects of a structured physical training program on children from low-income neighbourhoods in Pescara, Italy.

METHODS: A convenience sample of 28 children from underprivileged neighbourhoods between the ages of 6 and 10 ($M = 8.57$, $SD = 1.26$) was recruited through the ONLUS association which provides the intervention and other support services in this area. A cross-sectional analysis was performed to explore the levels of psychomotor performance, psycho-physical wellbeing and sports gratification. Children underwent the Movement Assessment Battery of Children (M-ABC-2) to examine their fine and gross motor skills, agility, coordination, proprioception, balance, and posture. An ad hoc cognitive test was also implemented to evaluate the overall well-being of each child in relation to their sports participation. The assessment was conducted by kinesiologists in small groups before practice sessions. Data were analyzed by R-4.4. One sample t-test, and Pearson correlation were applied; p-value $<0.05$ taken statistically significant.

RESULTS: The 28.6% of children present a deficit (i.e. Attention Deficit Hyperactivity Disorder), significantly more males (n=7) than females (n=1), $p<0.04$. There was no difference in terms of M-ABC-2 psychomotor tests except for static balance skill in which children with deficits scored 8 seconds compared to 17sec, $p<0.01$. No difference in levels of psycho-physical wellbeing and sports gratification (overall $M = 73.5$, $SD = 12.0$) was detected. Statistically significant correlation was found for coordination and walking ($r= 0.71$; $p<0.001$), strength and walking ($r= 0.62$; $p<0.001$), agility and ball catch ($r= 0.61$; $p< 0.001$) and finally coordination and strength ($r= 0.54$; $p<0.001$).

CONCLUSION: This project is ongoing, and after 23 weeks of intervention, we will do the follow up to evaluate the program's impact. Preliminary results indicate that the psycho-physical background of this sample is in line with the normative trends. The use of sport-specific drills, combined with general movement activities, is finalized to maximize neuromuscular adaptation and overall athletic performance. In addition, the program aims to foster structured socialization, teamwork, and cognitive function, which contributes to the ultimate goal of enhancing psychological well-being. These findings could provide valuable insights into the role of accessible sports programs in promoting overall child development living in disadvantages area.

**EFFECTS OF PHYSICAL ACTIVITIES AND SPORTS ON THE EXECUTIVE FUNCTIONS OF CHILDREN AND ADOLESCENTS WITH AUTISM SPECTRUM DISORDER: SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Autism spectrum disorder (ASD) is characterized by impaired socialization, interaction deficits, and repetitive behaviors [1]. The development of executive functions (EFs) –working memory, inhibitory control, cognitive flexibility – may contribute to the life quality of these children [2]. Structured sports and physical activities (PA) interventions may improve EFs [3] although effects on children with autism are not well-established. This systematic review and meta-analysis aimed to assess the effects of chronic PA and sports interventions on executive functions and social-emotional skills in children with ASD.

METHODS: This systematic review was reported according to PRISMA guidelines (PROSPERO CRD42024558078). Web of Science, Scopus, Cochrane, PubMed, PsycINFO, and Embase were searched in December 2024. The search strategy

terms and the eligibility criteria were determined using the PICOT method, considering: Participant - children and adolescents with ASD aged between 5-13 years old; Intervention - physical activity or sports (duration >2 weeks); Comparison group - children and adolescents with ASD not engaged in physical activity or sports; Outcome - executive functions (working memory, inhibitory control, and cognitive flexibility) and social-emotional skills (communication, socialization, social skills, repetitive behaviors); Type of study - randomized clinical trials, non-randomized trials, and longitudinal intervention studies. The selection of studies and data extraction were independently evaluated by two investigators. The meta-analyses were performed using a between-group, pre- to post-intervention meta-analytic design based on standardized mean differences (Hedges' g) with a random-effect model.

RESULTS: Of 7,630 articles identified, fourteen studies were included. In general, the interventions proposed were effective in improving communication ($g = 0.79$; $p = 0.039$), Social Responsive Scale - 2 score total ($g = 1.24$; $p = 0.003$), socialization ($g = 1.13$; $p = 0.025$), inhibition ($g = 1.63$; $p < 0.001$), and working memory ($g = 1.27$; $p = 0.001$) in comparison to the control groups without interventions. On the other hand, stereotyped behavior ($g = 0.59$; $p = 0.209$), attention performance ($g = 1.95$; $p = 0.533$), cognitive flexibility ($g = 0.49$; $p = 0.116$), and planning ($g = 0.33$; $p = 0.646$) were not affected by the interventions with physical activity or sports in comparison to the control groups.

CONCLUSION: Findings offer insights into how PA and sports contribute to the cognitive development of children with autism, and how teachers and coaches can support their growth by promoting physical and emotional well-being through regular and cognitively engaging activities.

References

1. American Psychiatric Association (2013), 2. Hirota et al. (2023), Pesce et al. (2021)

## Oral Presentations

### OP-MH09 Sports Medicine and Orthopedics II

**MUSCLE STRENGTH AND RANGE OF MOTION IN YOUTH FEMALE OVERHEAD ATHLETES: IMPLICATIONS FOR INJURY PREVENTION**

DOMBROVSKA, L.1, KLAVINA, A.1,2, VARPA, N.3, REIHMANE, D.1

*1 RIGAS STRADINS UNIVERSITY 2 LITHUANIAN SPORTS UNIVERSITY 3 RIGAS TECHNICAL UNIVERSITY*

INTRODUCTION: Youth participation in sports is beneficial for physical and mental health, however early specialization and repetitive movements, can cause overuse injuries and imbalances in the body. One of such groups are overhead athletes where most strain is on the upper extremities (ex: volleyball, basketball, handball and others)[1]. The restricted range of motion and weakness in rotator cuff muscles are the modifiable injury risk factors, that can be caused by muscle imbalances, excessive training loads and poor biomechanics [1,2]. Some studies of overhead athletes show higher shoulder injury rates specifically in 15-18 years old comparing to male athletes [2]. Aim of this research was to present comparison of shoulder range of motion and isometric strength in overhead youth female athletes.

METHODS: Fifty seven youth female overhead athletes participated in pre- season testing representing overhead athletes group basketball (n=9), volleyball (n=19), handball (n=16), tennis (n=4), swimming (n=4), rock climbing (n=5), and non-overhead athletes group n=30, participating in sports: track and field (n=6), gymnastics (n=12), skeleton (n=4) luge(n=8). Bilateral AROM for external rotation (ER) and internal rotation (IR) in the shoulder was measured with EasyAngle goniometer (Sweden). Isometric strength (IS) was measured for ER and IR with EasyForce dynamometer (Sweden). Parameters of AROM shoulder were calculated glenohumeral IR deficit (GRID), glenohumeral ER gain, (GER Gain), total arc of motion (TAM) and total range of motion deficit (TRMD).

RESULTS: Results presented significant differences for overhead athletes have significantly greater AROM comparing to non-overhead athletes with differences IR of shoulder dominant side 7.69 $p<.05$, non-dominant 6.56 $p<.05$ and shoulder ER in dominant side 21.3 $p<.001$ and 13 $p<.001$ in non-dominant side . Significant differences were found in TAM for both dominant 29.0 $p<.001$ and non-dominant side 19.5 $p<.001$. Even with GER gain of 8.31 $p<.001$ for overhead athletes TRMD comes negative -9.44 $p<.01$ for overhead female athletes comparing to non-overhead athletes

CONCLUSION: The results of this study showed the differences in shoulder AROM and strength imbalances in overhead female athletes during preseason testing. Professionals working with female youth overhead athletes should address significant AROM and strength deficiencies to reduce injury risks.

References:

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2. Lau R, Mukherjee S. Prevalence of Shoulder and Elbow Overuse Injuries Among Competitive Overhead Youth Athletes in Singapore. Orthop J Sports Med. 2023 Mar 21;11(3)

**COMBINATORY EFFECTS OF ESTRADIOL AND PROGESTERONE ON PROTEIN SYNTHESIS IN C2 C12 SKELETAL MUSCLE CELLS AND THE TRAINING RESPONSE OF YOUNG FEMALE ATHLETES DURING THE MENSTRUAL CYCLE.**

DIEL, P., CHEN, S., ULLRICH, F., SIEGERT, F., HELD, S., ISENMANN, E.
*DEUTSCHE SPORTHOCHSCHULE KÖLN*

INTRODUCTION: During the menstrual cycle (MC), the fluctuation of 17-ß estradiol (E2) and progesterone (P4), may affect protein metabolism and training adaptations. This study assessed the effects of E2 and P4 and their combinations A.) on myotube diameter and total protein metabolism and molecular mechanisms in differentiated C2C12 myotubes, and B.) through a human intervention study, which analyzed how young women respond to high-volume weight training performed either in the follicular or luteal phase of the MC.

METHODS: A.) Differentiated C2C12 cells were treated with different doses and combinations of E2 and P4. After 3 days of treatment cells were fixed and protein and RNA were extracted. Myotube diameter, protein synthesis rate and the expression of genes of mechanistical interest was analyzed. B.) 12 young women (31,8 ± 3 years, 64,4± 10 kg, 171,2± 7 cm) were randomly assigned to high-volume training in the follicular phase (HVF) or luteal phase (HVL). The HVF group trained four days a week until ovulation occurred, and their volume was reduced to two training sessions a week till menstruation. The HVL group trained in the opposite direction. The MC was monitored via cycle diary, ovulation test and of E2 and P4 saliva concentrations. The training program included squats, deadlifts, bench presses and rows. Every four weeks, strength performance (1RM) was assessed and body composition was evaluated. Nutrition was standardized and monitored via FDDB Explorer.

RESULTS: A.) E2 treatment, in contrast to P4, led to a significant increase in myotube diameter (+40% E2: 1.26±0.11 vs P4: 0.86±0.06; p<.05) and total protein content (+11%, E2: 1.13±0.04 vs P4: 1.02±0.09; p=0.2). These effects could be counteracted by P4. E2, but not P4 treatment, results in an increase of the expression of myosin heavy chain and insulin-like growth factor-1 protein expression. Also, these effects were antagonized by P4. The expression of relevant geness show a comparable regulation. B.): So far, 5 female athletes completed the study. Initial results show significant increases in squat (+15,4 ± 7,7kg) and bench press (7,0 ± 2,9kg) performance as well as an increase in fat-free mass (Δ+1.4 ± 1.8kg; p=0,07), muscle mass (Δ+1.8 ± 1.1kg; p<.01) and thigh circumference (right: Δ+2.4 ± 1.2cm; p<.05; left: Δ+2.1 ± 1.1; p=.09) The available data show no differences between the training response in the follicular phase (HVF) or luteal phase (HVL). Study is ongoing.

CONCLUSION: Our in vitro data demonstrate an anabolic effect of E2 in C2C12 myotubes, which is counteracted by P4. This finding provides mechanistic evidence that hypertrophy training may be more effective during the follicular phase compared to the luteal phase, where progesterone levels increase significantly. Preliminary results from our training study in female athletes align with strength performance data; however, due to the low number of participants who completed the study, show no significant differences between the HVF and HVL groups thus far.

**EFFECTS OF DIFFERENT ARTERIAL OCCLUSION PRESSURES DURING BLOOD FLOW RESTRICTION TRAINING ON MUSCLE DAMAGE: A DOUBLE-BLIND RANDOMIZED CONTROLLED TRIAL**

HAPP, K., BARAWI, S., NIEDERER, D., SCHWIETE, C., HEINRICH, C., FRANZ, A., WAHL, P., BEHRINGER, M.
*GOETHE UNIVERSITY FRANKFURT*

INTRODUCTION: Blood flow restriction (BFR) training usually combines low-load (LL) resistance exercise with vascular occlusion, leading to strength and hypertrophy adaptations similar to or even exceeding those of conventional strength training [2]. However, despite its benefits, concerns remain about exercise-induced muscle damage (EIMD) from BFR training due to mixed findings [2]. The potential for increased EIMD is plausible, as metabolic stress can trigger various interlinked mechanisms leading to muscle cell damage or amplify mechanically induced muscle damage [1]. The applied arterial occlusion pressure (AOP) is a key factor influencing metabolic stress and therefore potentially EIMD. However, its relationship with EIMD near muscle failure remains unexplored. This study investigates how different occlusion pressures affect EIMD compared to free-flow training

METHODS: This double-blind, randomized controlled trial examined EIMD across different AOPs in 40 participants, divided into 4 groups: no pressure (NP), low pressure (LP; 50% AOP), medium pressure (MP; 75% AOP), and high pressure (HP; 100% AOP). Participants performed unilateral knee extensions at 30% 1RM up to a maximum of 4 sets of 20 repetitions or until failure. Oxygen saturation (SmO2), respiratory exchange ratio (RER), lactate concentration, perceived exertion, and thermographic images were assessed. EIMD was primarily evaluated by isokinetic peak torque change 24h post-exercise (Δ24h), with secondary markers including pain (VAS), blood markers (CK, MB), swelling, stiffness, contractility, and skin temperature. Measurements were taken before, and at 1h, 24h, 48h, and 72h post-exercise. A one-way ANOVA analyzed strength changes (Δ24h-baseline) and acute exercise responses. Repeated measures ANCOVAs examined secondary markers over time.

RESULTS: NP (74±9) and LP (67±15) groups completed more repetitions than MP (42±7) and HP (39±2). HP showed greater ΔSmO2 decrease (-55±24%) and higher ΔRER (64±20%) than NP (-19±22%). Perceived exertion was higher in MP (18±1) and HP (19±1) compared to NP (16±2), but lactate and skin temperature did not differ. NP had greater strength reduction than MP (MD=-9.95, p=0.045, 95%CI [-19.7, -0.2]) and HP (MD=-10.51, p=0.038 95%CI [-20.5, -0.5]). NP had higher VAS scores than MP and HP over time [F(6.29, 71.34) = 2.24, p = .046].

CONCLUSION: Our findings support the safety of BFR training, as EIMD did not exceed levels observed in conventional training. LP BFR resulted in similar EIMD to unrestricted training, while MP and HP led to even lower strength loss and

DOMS. However, AOPs above 75% reduced mechanical load, potentially limiting long-term adaptations. LP preserved mechanical load while reducing training duration, making it a safe and time-efficient option.

[1] Behringer et al., 2014 Exhaustive exercise-a near death experience for skeletal muscle cells?

[2] Queiros et al., 2021. Effect of resistance training with blood flow restriction on muscle damage markers in adults: A systematic review.

**THE EFFECT OF WHOLE-BODY CRYOTHERAPY ON MUSCLE INJURY: A MORPHOLOGICAL STUDY IN RATS**

NUKADA, H., HOTTA, R.1, KAMIMURA, T.2, GOTO, K.3

*1 TOHO UNIVERSITY, FACULTY OF MEDICINE, 2 MAYEKAWA MFG, CO., LTD. 3 RITSUMEIKAN UNIVERSITY,*

INTRODUCTION: Whole-body cryotherapy (WBC) is widely used in sport medicine as a therapeutic method for acute muscle injury and to promote faster recovery after intense physical activity. WBC has been shown to decrease levels of inflammatory markers, suggesting its potential role in managing systemic inflammation. However, the morphological investigation of the effects of WBC has not been conducted. We assessed the histological effect of WBC on acute muscle injury induced by bupivacaine (BPVC) using rats.

METHODS: BPVC (0.5% BPVC hydrochloride 0.5ml) (Marcain, Aspen Japan) was injected into the middle portion of the left tibialis anterior muscle in Sprague-Dawley rats (male, 300-350g). One session of WBC involves the following procedure: under anesthesia, the rat is placed in a cryochamber (approximately -100°C) designed by Mayekawa MFG, Co., Ltd. for 60 seconds. This procedure is repeated three times with a 3-minute interval between each session. Rats treated with WBC were divided into two groups: 1) those that received WBC immediately (0), 2 and 4 hours after BPVC injection (BPVC+WBC 0h group), and 2) those that received WBC 24, 26, and 28 hours after BPVC injection (BPVC+WBC 24h group).

The tibialis anterior muscle was then collected 24 hours after the WBC treatment for morphological assessment. The area of intramuscular edema was evaluated using binary image analysis in ImageJ. Edema was identified as expanded interstitial spaces filled with black pixels, in contrast to the white areas representing muscle fibers. Artifact regions were similarly identified and excluded from the analysis. The area of cellular infiltration was also analyzed using binary imaging. The control groups included rats with BPVC injection only (BPVC group), saline injection and sham surgery.

RESULTS: Muscle edema and cellular infiltration were significantly less in the BPVC+WBC 0h group compared to the BPVC group. The severity of cellular infiltration was more pronounced in the BPVC+WBC 24h group than in the BPVC+WBC 0h group. Morphometrically, the area of edema was significantly smaller in the BPVC+WBC 0h group compared to the BPVC group: 0.06±0.02% vs. 0.13±0.02% (as a percentage of the whole muscle area), p=0.02, respectively. The transverse area of the whole muscle was not significantly different between BPVC+WBC and BPVC rats.

CONCLUSION: When WBC was performed immediately after acute muscle injury, muscle edema and cellular infiltration were significantly inhibited. However, when WBC treatment was delayed after injury, the effect was limited. Since a notable decrease in pro-inflammatory cytokines with WBC has been reported, these results suggest that WBC performed immediately after injury suppresses the release of inflammatory cytokines during the acute phase of injury. In conclusion, WBC suppresses the acute inflammatory response after muscle injury and is more effective when performed immediately after the injury.

**EVALUATING LOWER LIMB ASYMMETRIES THROUGH STRENGTH, RATE OF FORCE DEVELOPMENT AND FORCE CONTROL ASSESSMENT: A MULTI-METRIC APPROACH ACROSS HOMOLOGOUS AND HETEROLOGOUS MUSCLES**

DEMANUELE, S., BOCCIA, G., MARCANTONIO, A., MASSAGRANDE, C., GHIOTTO, L., SCHENA, F., TARPERI, C.

*UNIVERSITY OF VERONA*

INTRODUCTION: Asymmetries are a constantly debated topic with often conflicting results due to different outcome measures. A multi-metric approach is becoming increasingly crucial for the need for an individual approach to data analysis and the need to perform multiple different tests. Among the various parameters that can be taken into consideration, maximum voluntary force (MVF) is the most common, but other parameters, such as the rate of force development (RFD) or motor control metrics evaluated through linear or non-linear approaches, are continuously growing and can provide different points of view[1].

This study, through a multi-metric approach, has several objectives: 1) to quantify the prevalence of asymmetries; 2) to determine whether dominance influences muscle function; 3) to examine whether asymmetries in muscle function are specific to certain muscles or whether one side consistently outperforms the other regardless of muscle group; 4) to assess whether the direction of asymmetry within each muscle group is consistent across different muscular-strength and motor control performance metrics.

METHODS: 71 participants (30F, 31 M; 23±2 years) visited the laboratory once to undergo assessments for knee extensors (KE) and flexors (KF) in both limbs, including MVF, rapid ballistic contraction at the submaximal level to evaluate the RFD at peak (RFDpeak) and time-locked intervals (RFD50,100,150), scaling factor (RFD-SF), and assessments of approximate entropy (ApEn), coefficient of variation, and Detrended Fluctuation Analysis (DFAα) during sustained contractions (50% of MVF). Bilateral Strength Asymmetry (BSA) was used to calculate the level of asymmetry. Repeated measures within- and between-factor ANOVAs assessed differences in each metric between muscle groups and limbs. Kappa coefficients (K) were calculated to determine the level of agreement for the direction of asymmetry.

RESULTS: Except for MVF (d = 0.113), RFD150 (d = 0.156) and RFD-SF (d = 0.409) for KF and RFD50 (d = 0.426) for KE, no differences were achieved for the other metrics showing no clear superiority of one limb over the other, with asymmetries dependent on muscle group and performance metric. All K values were null, slight or fair (all $K \leq 0.23$). No significant gender differences in asymmetry were found (all $p \geq .123$).

Based on the Smallest Worthwhile Change, 75 – 78 % of participants can be considered asymmetrical. On average, the absolute values of BSA ranged between 14 and 18%, considering both muscular-strength and motor control performance metrics.

CONCLUSION: These results showed that asymmetry should be considered the norm, not the exception. From a practical point of view, these results highlight the importance of comprehensive assessment across multiple metrics to identify imbalances rather than relying on a single test and, consequently, the need to structure personalized programs to correctly address performance or motor control asymmetries by trainers.

References:

[1] DEmanuele et al., JSCR, 2024

## 09:30 - 10:45

Invited Symposium

IS-AP05 Investigating the Causes of Fatigue in Endurance Activities: Societal Benefits, Physiological Markers, and Interdisciplinary Approaches

**SOCIETAL BENEFITS OF INVESTIGATING FATIGUE**

MEIJEN, C.
*ST MARYS UNIVERSITY*

The first presentation explores how investigating fatigue contributes to societal well-being. Fatigue affects millions, impacting productivity, health, and quality of life. By comprehensively understanding mental and physical fatigue, we can devise targeted interventions that enhance performance in sports, workplaces, and education. For example, in sports, recognizing the signs of fatigue allows athletes and coaches to adjust training loads, thereby reducing injury risks and improving performance outcomes. Understanding fatigue can lead to advancements in occupational health, as workers suffering from fatigue are more prone to accidents and lower productivity levels. By identifying the causes of fatigue, organizations can implement preventive measures, such as optimizing work schedules and promoting health and wellness programs. In educational settings, students often grapple with fatigue that hinders their academic performance. Understanding the psychological and physiological contributors to student fatigue can lead to more effective learning strategies and improved mental health support, fostering an environment where students can thrive. Fatigue often combines with negative mood states, and understanding and addressing fatigue can alleviate negative mood, thereby reducing stress and the likelihood of intense emotional reactions.

**CONCEPTUAL AND HEURISTIC CHALLENGES IN DEFINING AND MEASURING FATIGUE**

DOMINIC, M.
*UNIVERSITY OF ESSEX*

The second presentation will explore the challenges we face in finding a universally agreeable definition of fatigue, given the prevalent use of this term in such a wide array of everyday, academic and clinical domains. Previous propositions about antecedent factors and mechanisms, both interoceptive and exteroceptive, that lead to subjective experience of fatigue are now so numerous and context specific that the prospect of theoretical parsimony seems, for now at least, beyond reach. Nevertheless, the subjective feeling of fatigue can be measured, and this has great practical utility is understanding the conditions that lead to fatigue and what can be done to prevent its occurrence or ameliorate its impact.

**PSYCHOLOGICAL INTERVENTIONS AND THE NEED FOR INTERDISCIPLINARY APPROACHES**

LANE, A.
*UNIVERSITY OF WOLVERHAMPTON*

The third presentation explores the psychological aspects of fatigue in endurance activities and the necessity for interdisciplinary interventions. Psychological fatigue often manifests as mental exhaustion, characterized by decreased motivation, impaired cognitive function, and negative emotional states. Interventions focusing solely on psychological factors may overlook the underlying physiological contributors, leading to incomplete solutions. Research by Meijen et al. (2023) emphasizes the importance of psychological strategies, such as goal setting, motivational self-talk, and distraction techniques, in managing fatigue during endurance activities. However, these strategies should be complemented by physiological assessments to ensure a comprehensive approach to fatigue management. An interdisciplinary framework that integrates psychological and physiological insights can enhance the effectiveness of fatigue interventions. For instance,

athletes could benefit from tailored psychological strategies that account for their physiological state, leading to improved performance outcomes. This holistic approach not only addresses fatigue more effectively but also promotes overall well-being, recognizing the interplay between mind and body. Conclusion In summary, understanding the physiological markers of fatigue and their relationship to performance is essential for developing effective interventions. Psychological strategies are vital, yet they must be integrated with physiological assessments for a comprehensive integrated approach. Equally, understanding that physiological driven strategies can alleviate fatigue and repair negative mood. By fostering interdisciplinary collaboration, we can enhance our understanding of fatigue in endurance activities and develop more effective strategies for individuals in various contexts. References Beedie, C. J., Lane, A. M., Udberg, R., & Terry, P. C. (2022). The 4R model of mood and emotion for sustainable mental health in organizational settings. Sustainability, 14(18), 11670. https://doi.org/10.3390/su141811670 Meijen, C., Brick, N. E., McCormick, A., Lane, A. M., Marchant, D. C., Marcora, S. M., Micklewright, D. P., & Robinson, D. T. (2023). Psychological strategies to resist slowing down or stopping during endurance activity: An expert opinion paper. Sport and Exercise Psychology Review, 18(1), 4-37. https://doi.org/10.53841/bpssepr.2023.18.1.4 Micklewright, D., St Clair Gibson, A., Gladwell,V., & Al Salman, A. J. S. M. (2017). Development and validity of the rating-of-fatigue scale. Sports Medicine, 47, 2375-2393. https://doi.org/10.1007/s40279-017-0711-5

## Oral Presentations

### OP-AP37 Blood Flow Restrictions

**THE EFFECT OF BLOOD FLOW RESTRICTED, HEAVY, AND DE-LOADED RESISTANCE TRAINING ON PERCEPTUAL AND PHYSIOLOGICAL RESPONSES DURING EXERCISE AND RECOVERY**

DE MARCO, K., GOODS, P.S.R., BALDWIN, K.M., HISCOCK, D.J., SCOTT, B.R.

*MURDOCH UNIVERSITY*

INTRODUCTION: Athletes often incorporate resistance training (RT) to enhance strength and performance, however during certain training phases, RT is de-loaded (DLRT), possibly limiting its effectiveness. Blood flow restricted RT (BFRRT) can elicit muscular adaptations similar to heavy load RT (HLRT), while only requiring low loads, making it a potential solution during de-loading periods. However, differences between these RT strategies in the acute physiological responses and any subsequent fatigue remains unclear. Therefore, this study aimed to compare the physiological, perceptual, and performance effects of BFRRT, HLRT, and DLRT acutely and for 48-h post-training.

METHODS: Eighteen resistance-trained females completed half squat (1RM = 96.2 ± 18.0 kg) and split squat (1RM = 72.4 ± 14.6 kg) under 3 exercise conditions: 1) BFRRT (half squat = 1 set: 30 repetitions, 3 sets: 15 repetitions; split squat = 4 sets: 15 repetitions on each leg; 30%1RM, 30 s inter-set rest, 60% arterial occlusion pressure), 2) HLRT (5 sets: 5 repetitions, 80%1RM, 3 min inter-set rest), 3) DLRT (3 sets: 3 repetitions, 75%1RM, 45 s inter-set rest). Follow-up testing was conducted 24- and 48-h after each condition. Blood lactate was recorded pre- and 2 min post-exercise. Session rating of perceived exertion (sRPE) was recorded 20 min post-session. Maximal voluntary contraction (MVC), countermovement jump (CMJ) height, and muscle soreness were measured before and after experimental sessions, and at all follow-up sessions. Data were log10 transformed and analysed using a linear mixed model with Bonferroni post-hoc comparisons.

RESULTS: Blood lactate increased post-exercise for all conditions, with BFRRT (+90.0%, dz = 2.2) and HLRT (+71.4%, dz = 1.7) significantly higher than DLRT, and BFRRT also higher than HLRT (+22.1%, dz = 0.6). sRPE was significantly higher in BFRRT (+54.6%, dz = 1.6) and HLRT (+41.7%, dz = 1.2) compared to DLRT; but were not different from each other. MVC significantly decreased from pre- to post-exercise (-11.8%, dz = 0.6), but with no between-condition differences. Muscle soreness in BFRRT (+84.1%, dz = 1.2) and HLRT (+93.2%, dz = 1.5) were significantly higher than DLRT at all time points. Within-condition analysis showed increased soreness 48-h post-exercise in BFRRT (+80.9%, dz = 0.7) and HLRT (+137.85%, dz = 1.3) compared to pre-exercise. Muscle soreness at 48-h post-exercise was significantly lower in BFRRT than HLRT (-63.9%, dz = -0.6); however, BFRRT was higher than DLRT (+88.2%, dz = 0.6). There were no significant effects for time or condition for CMJ.

CONCLUSION: BFRRT elicits similar acute physiological and perceptual responses to HLRT, with reduced post-exercise muscle soreness and no difference in performance during the recovery period. Therefore, BFRRT may be a viable alternative to HLRT when muscle soreness is contraindicated, but the long-term efficacy of this approach requires further investigation.

**EFFECTS OF BLOOD FLOW RESTRICTION ON MUSCLE STRENGTH THICKNESS AND SPORTIVE MOTIVATION IN ELITE CANOE ATHLETES**

UGUR TOSUN, B., ANGIN, E., KIRMIZIGIL, B.

*EASTERN MEDITERRANEAN UNIVERSITY*

INTRODUCTION: Canoeing requires coordination, core stability, and strength, engaging both aerobic and anaerobic energy systems [1]. While upper extremity strength is often emphasized, lower extremity strength is equally important for optimal performance. Strength training enhances both performance and endurance, with resistance exercises at ≥65% one-

repetition maximum (1 RM) promoting muscle hypertrophy [2, 3]. Blood Flow Restriction (BFR) training provides a low-intensity (20-30% 1 RM) alternative, simulating the effects of high-intensity exercise through hypoxia [4]. Research shows that BFR training improves muscle size, strength, and psychological motivation [5], a key factor in athletic success [6]. This study investigates the effects of BFR training on lower extremity strength, muscle thickness, and sportive motivation in elite male canoe athletes.

METHODS: Seventeen male national team canoe athletes (aged 18-25) participated in this study. Muscle thickness and cross-sectional area (CSA) of lower extremity muscles were measured using ultrasound, while isokinetic strength was assessed at 60°/s with a Biodex System. Motivation was evaluated using the Sport-Specific Achievement Motivation Scale (SSAMS). The 8-week BFR training program utilized KAATSU C3 cuffs at 30% of 1 RM for Quadriceps, Hamstrings, and Leg Press exercises, with progressive pressure increases. Training sessions included warm-up, three to four sets of exercises, and cool-down. Measurements were taken pre- and post-training to assess outcomes.

RESULTS: The participants included in the study had an average age of 18.59 ± 0.71 years, an average sports age of 6.88 ± 1.17 years, an average weekly training frequency of 7.24 ± 1.64 days, an average height of 177.28 ± 7.27 cm, and an average body weight of 74.74 ± 11.19 kg. Muscle measurements showed notable bilateral increases, including Rectus Femoris Thickness (RFT) rising from 1.74 ± 0.24 cm to 1.91 ± 0.22 cm ($p<0.001$) on the right and from 1.56 ± 0.26 cm to 1.79 ± 0.29 cm ($p<0.001$) on the left. Cross-sectional area (CSA) of the Rectus Femoris (RF) and Hamstrings also significantly increased. Isokinetic strength tests demonstrated enhanced Quadriceps Femoris (QF) peak torque (PT), with right QF PT increasing from 198.16 ± 36.58 Nm to 227.12 ± 46.91 Nm ($p=0.002$) and left QF PT from 191.52 ± 27.33 Nm to 224.45 ± 42.51 Nm ($p=0.001$). Motivation scores also improved, particularly in the "Motivation to Approach Success" and "Avoiding Failure" subscales ($p<0.001$).

CONCLUSION: BFR training effectively enhances muscle performance and psychological factors in elite athletes [1]. The findings highlight the unique benefits of BFR training, which enhances hypertrophy through hypoxic conditions and recruits fast-twitch muscle fibers without requiring high-intensity loading, significantly reducing the risk of injury [2].

REFERENCES

1- Paquette et al., 2018

2- McArdle et al., 2010

3- Riebe et al., 2018

4- Pignanelli et al., 2021

5- Wortman et al., 2021

6- Abe et al., 2006

**EXAMINING SEX DIFFERENCES IN NEUROMUSCULAR AND HYPERTROPHIC ADAPTATIONS TO SEQUENTIAL LOW-LOAD BLOOD-FLOW-RESTRICTION AND HIGH-LOAD RESISTANCE TRAINING**

LEDERGERBER, R., RITSCHE, P., LICHTENSTEIN, E., KELLER, M.

*UNIVERSITY OF BASEL*

INTRODUCTION: Low-load Blood Flow Restriction training (BFR) is a viable alternative to high-load resistance training (HL), due to its lower mechanical tension, where still comparable or slightly lower gains in muscle hypertrophy and strength are seen (1). However, neural adaptations remain poorly understood and are hypothesized to be less pronounced, while sex differences have hardly been studied at all (2). Thus, this study aimed to investigate the sequential application of HL following BFR on neuromuscular and hypertrophic adaptation and compare its sex-dependent effects (3).

METHODS: In this 10-week randomized controlled trial, 37 healthy male and female adults (35-60 years) completed progressive resistance training for knee extensors either 8 weeks with low-load BFR followed by 2 weeks of HL, or exclusively HL training. Measurements at baseline including familiarization (PRE1 and PRE2), 8 weeks (MID) and 10 weeks (POST) included maximal voluntary contraction of knee extensors (MVC), voluntary activation (VA, via electrical muscle stimulation) and vastus lateralis and rectus femoris muscle volume (VL_RF, via ultrasound at 30-70% femur length). Linear mixed models were used to analyze group differences over time and between sex, reporting Cohen's d effect sizes.

RESULTS: The HL group showed greater increase in MVC at MID and POST (d=0.49*[-0.01;0.99]) compared to the BFR group, with females benefiting slightly more at MID (d=0.15[-0.47; 0.78) but not at POST (d=-0.15[-0.78;0.47]). VA changes at MID and POST were slightly negative for HL (d=-0.25[-1.54; 1.03]), however, females demonstrated larger improvements at MID (d=0.62[-0.97;2.22]) and POST (d=0.77[-0.83; 2.36]). While the BFR group showed greater improvements in VL_RF at MID (d=0.25[-0.29; 0.80]), HL was more beneficial for females (d=0.48[-0.24; 1.20]).

CONCLUSION: Our findings suggest that HL is more effective for neuromuscular adaptations, whereas BFR may offer short-term hypertrophic benefits. However, as the differences were small on a group level and large variability was present, it seems that not just mechanical tension, but also metabolic stress is a driver of neuromuscular adaption (3). Notably, HL was particularly beneficial for females, leading to greater increases in muscle size and neuromuscular function. Future research should further deepen sex-specific responses to optimize resistance training protocols.

**EFFECT OF BLOOD FLOW RESTRICTION TRAINING ON ACUTE AND LONGITUDINAL OUTCOMES IN EARLY POSTOPERATIVE ACL REHABILITATION: A RANDOMISED CONTROLLED TRIAL**

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries represent the most prevalent type of knee injury, with surgical reconstruction being the prevailing treatment modality. However, postoperative pain and muscle weakness are common occurrences. Blood flow restriction (BFR) training has demonstrated potential in enhancing muscle adaptation and reducing pain; nevertheless, its efficacy in the early postoperative period following ACL reconstruction remains to be determined. The present study investigates whether the incorporation of BFR into low-load strength training confers additional clinical benefits in comparison to low-load exercise alone.

METHODS: 30 participants (6 females; age 32.3 years) who had undergone primary ACL reconstruction were randomised to receive either low-load strength training with (LL-BFR) or without (LL) BFR. The interventions consisted of four sets of leg press exercises (30 repetitions for the first set, 15 for subsequent sets) performed twice a week for four weeks, as an adjunct to standard rehabilitation protocols. The primary outcome measure was pain perception, assessed by pressure pain thresholds (PPT) at four sites (quadriceps femoris affected/ un-affected, biceps brachii and trapezius on the dominant side) and a visual analogue scale (VAS) for knee pain at rest and during a stair climb. Secondary outcomes included knee joint ROM, rectus femoris thickness, maximum strength and knee joint effusion. Exertion levels during the exercise were measured using the BORG scale, and knee function was assessed using the IKDC questionnaire.

RESULTS: Mixed linear models were employed for the statistical analysis. Participants in the LL-BFR group reported significantly greater perceived exertion during training (p=0.01). However, no statistically significant between-group differences were observed for primary or secondary outcome measures for acute effects. Similarly, no group-time interactions were identified for longitudinal results. However, significant time effects were observed for muscle thickness (p=0.014); maximum strength (p=0.002); knee joint effusion (affected p=0.004, unaffected p=0.007); active (ext. p=0.035, flex. p<0.001) and passive ROM (ext. p=0.029, flex. p<0.001) on the affected side; VAS scores (rest p<0.001, stairs p=0.003) and IDKC scores (p<0.001).

CONCLUSION: The present study shows that a combination of BFR and low-load strength training does not provide additional clinical benefits to low-load training alone in the early postoperative phase, following ACL reconstruction. The studys limitations encompass imbalances in sex distribution, minimal baseline pain levels, and inherent variability in subjective pain reporting. Conversely, the studys strengths encompass high study adherence and a homogenous patient population characterised by standardised surgical and rehabilitation protocols. Further research is required to explore the potential of BFR in specific patient subpopulations, with different training loads or at later stages of rehabilitation.

**EFFECTS OF WHOLE-BODY VIBRATION WARM-UP TO ACHIEVING THE BEST SPORTS SKILL-RELATED PERFORMANCE: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Several studies focused on the long-term effects of whole-body vibration (WBV) training on health. However, to date, conflicting results are on its acute use to optimize performance, and no one has tested the effect of a warm-up with WBV on team sports-related skills like power, reaction, flexibility, and reactive strength of leg muscles simultaneously. No standardized warm-up protocols have been tested to verify the effectiveness of WBV on sports skills. This study aims to evaluate the effects of a 5-minute, single-bout WBV protocol on team sports-related performance to understand if WBV is a possible faster, space-saving warm-up before competition or used by the bench players waiting to perform.

METHODS: We included 93 volunteer participants (age: 23.48±5.1 y; BMI: 24.03±3.3 kg/m²) in data analysis. All participants were assessed before (T0) and after (T1) the experimental protocols through the following tests: lower limb reaction time test (RTT), countermovement jump test (CMJ), sit and reach test (SR), and the Reactive Strength Index (RSI) to evaluate the reactive strength of leg muscles skill. The s-EMG signal for the tibialis anterior and gastrocnemius lateralis muscles was monitored during the tests to investigate the mechanisms of action through which the WBV could influence performance. After the T0 assessment, participants were randomized into three groups: the WBV group (WBVg), which did a 5-minute WBV warm-up; the free body group (FBg), which did the same but with the WBV turned off; and the control group (CONg), which performed no protocol between T0 and T1. After the 5-minute WBV intervention, all tests were repeated. Mixed ANOVA was performed to check between and within-group effects. Bonferroni correction was used to investigate the differences between conditions. The association between variables was examined.

RESULTS: After a 5-min WBV warm-up, the WBVg significantly improved the performances of the CMJ (cm) (T0:36.69±10.9, T1:38.37±8.9; p<0.01), SR (cm) (T0:27.27±9, T1:29.26±9.1; p<0.01), and RTT (s) (T0:0.52±0.1, T1:0.49±0.1; p<0.01). No significant change was found in CONg for CMJ(cm) (T0:34.58±10.9, T1:35.37±10.5; p:0.05), RTT (s) (T0:0.52±0.09, T1:0.51±0.1; p>0.05); RSI (m/s) showed a significant decrease (T0:0.62±0.3, T1:0.56±0.3;p<0.05). FBg improved test scores between T0 and T1 for the CMJ (cm) (T0:37.22±8.2, T1:39.01±9.1;p<0.01), SR(cm) (T0:24.54±7.8, T1:27.22±7.4; p<0.01) and RTT (s) (T0:0.52±0.1, T1:0.48±0.1;p<0.01). Although the decreasing trend agrees with the literature, no statistical difference was found in EMG activation post-warm-up in both muscles indexing, and no fatigue occurred.

CONCLUSION: Our 5-minute WBV warm-up was adequate to optimize performance. This warm-up before performances needing flexibility, power, reactive strength of leg muscles, and quick reaction time has no adverse event like fatigue or

performance decrease. Future studies could test the effectiveness of the same protocol before and during real sports competitions

## Oral Presentations

### OP-AP38 Wearable Technologies

**AN INTRA- AND INTERINDIVIUAL COMPARISON BETWEEN DIGESTIVE PILLS AND A WEARABLE SENSOR TO MEASURE CORE BODY TEMPERATURE DURING REPEATED RUNNING BOUTS.**

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*JGU MAINZ*

INTRODUCTION: Heat strain is a significant external factor that should not be underestimated when it comes to optimizing physical performance in sports. Studies have shown that better acclimatization, along with improved thermoregulation, is positively correlated with enhanced performance [1]. In monitoring core body temperature, telemetric digestible pills represent the gold standard of measurement systems. However, the expenses and limited reusability are major drawbacks. New measurement methods, such as wearable sensors, offer a non-invasive, and cost-effective alternative. Nevertheless, the accuracy of these sensors requires further investigation in different exercise settings.

METHODS: Twelve endurance-trained participants [6=male; 6=female; age=24.83J (±2.17); bodyweight=67.87kg (±8.01); height=173.75cm (±6.06); maximal oxygen uptake: 52.1 mL/min/kg (±7.45)] were enrolled in the study. Each participant performed two running bouts on a treadmill (46 min; at 85% of the individual anaerobic threshold) on a treadmill (Saturn, h/p/cosmos, Germany). The external load was determined by percentage of individual anaerobic threshold (IAT) via cardiopulmonary exercise testing. Core temperature (°C) was measured continuously with the wearable CORE sensor (greenTEG AG, Switzerland) and the telemetric pills eCelsius-Performance (BodyCAP, France). The tests were conducted in a thermally controlled environment (24.03°C±1.28). For statistical analysis, we performed spearman correlation analysis to detect the agreement between both measurement systems. Significance level was set to $p<0.05$.

RESULTS: A strong correlation was found between pill and CORE sensor in both protocols (T1: $r = 0.86$, $p < 0.001$; T2: $r = 0.79$ $p < 0.001$). In later stages of both protocols, the sensor slightly overestimated the core body temperature compared to the pill (+0.3°C).

CONCLUSION: The wearable sensor seems to be a cost-effective alternative to the digestive pill when operating in a thermally controlled environment. Due to the slight overestimation of temperature in the later stages of the investigation, the risk of overheating seems to be minimized when relying on the sensor data. However, field studies involving additional stress conditions and different thermal environments will be necessary to further assess the reliability of the sensors in the future.

**CONTINUOUS MONITORING OF HEART RATE, CORE BODY TEMPERATURE, AND SLEEP IN REAL-LIFE SETTINGS: A PROOF-OF-CONCEPT**

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INTRODUCTION: Sleep deprivation and heat stress impair human performance and may disrupt thermoregulation, leading to increased physiological strain. As both conditions are prevalent in basic military training, this underscores the need for continuous, real-life monitoring. Wearable technologies provide a non-invasive solution, with upper-arm wearables offering a well-tolerated option. However, their validity across various activity intensities and environmental conditions remains underexplored. This research aimed to (1) validate the upper-arm-worn devices, the Calera Research for core body temperature (CBT) and the Polar Verity Sense for heart rate (HR), as HR is integral to both the CBT estimation and sleep detection algorithms, and (2) evaluate the performance of a self-developed sleep detection algorithm using acceleration (ACC) and HR data from the upper-arm.

METHODS: In a semi-controlled validation study, 16 healthy participants (age 27.4±5.8 years; height 173.5±9.2cm; weight 69.9±9.4kg) completed two test sessions under two heat stress conditions, performing nine activities from rest to vigorous intensity. HR and CBT were validated against reference measures (Polar H10 for HR, rectal sensor for CBT) using mean absolute error (MAE) and agreement analysis. In a 15-week military field study, continuous HR (1 Hz) and ACC (52Hz) data from 46 participants (age 19.8±1.4 years; height 177.5±6.9cm; weight 73.9±10.8 kg) were collected to develop an upper-arm-based sleep detection algorithm. Adapted from the Hypnospy framework [1], the algorithm integrates a customized cleaning process, physiological and movement-based thresholds, smoothing, and volatility analysis. Daily self-reported sleep windows served as a reference for comparison.

RESULTS: The Polar Verity Sense demonstrated strong accuracy across most activities (bias -0.05 bpm; MAE 1.43 bpm). The Calera Research showed moderate accuracy, with a systematic overestimation and temporal shift (bias 0.21°C; MAE 0.39°C). The sleep detection algorithm provided estimations comparable to self-reports for each participant.

CONCLUSION: These findings highlight the performance of the Polar Verity Sense and Calera Research for continuous monitoring across rest and various activity intensities, providing reliable and actionable data. The sleep detection algo-

rithm provided reasonable estimates but showed some discrepancies compared to self-reports, likely due to inaccuracies in participant responses rather than algorithmic limitations. While these findings indicate potential for automated sleep and physiological monitoring in real-world conditions, further validation against objective sleep measures is needed. Overall, this research supports the potential applicability of upper-arm-worn wearables for 24-hour monitoring.

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**VALIDATION OF WEARABLE DEVICE ALGORITHMS FOR PERSONALISED PHYSIOLOGICAL STRAIN MONITORING DURING REAL-WORLD OCCUPATIONAL TRAINING.**

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INTRODUCTION: Real-time heart rate (HR) and body core temperature (Tc) monitoring is key for mitigating heat-related injury risk and optimising training in hot and/or humid environments. However, validated methods for monitoring Tc are impractical for use in the field due to their invasiveness (e.g. rectal probes) and prohibitive cost (e.g. telemetric capsules). Wearable technology enables non-invasive estimation of HR and Tc to facilitate real-time physiological strain monitoring. Yet, their validity for personalised physiological monitoring during field training is unclear. Hence, we selected and validated consumer wearable devices for physiological strain monitoring during real-world occupational training.

METHODS: We reviewed the existing literature and selected four wearables for an initial laboratory validation based on four criteria: safety, suitability, accuracy, and data accessibility. Fitbit Sense (FB, Coolbit Tc algorithm) CALERAresearch (CA, CALERAresearch arm Tc algorithm) and Equivital Lifemonitor (EQ, ECTemp) were selected for further validation in the field. Eighty healthy firefighters (age = 30 ± 5 years, female = 5) completed up to three firefighting training activities based on their individual training requirements. All training activities, namely breathing apparatus proficiency test (BAPT), confined space rescue (CSR), and marine firefighting scenario (MFS), were conducted in warm and humid conditions (Tdb = 29.5 ± 1.2°C, RH = 78 ± 10%). Criterion for HR validity was set at a mean absolute percentage error (MAPE) <10% and Intraclass Correlation Coefficient (ICC) ≥0.9. Validity criterion for prediction of group and individual Tc responses were set at a mean bias error (MBE) <±0.27°C and 95% prediction errors within ±0.40°C (PTA ± 0.40°C) respectively.

RESULTS: HR and Tgi ranged between 41 to 203bpm (6359 data points) and 36.5 to 40.6°C (6341 data points) respectively. EQ displayed excellent HR accuracy across all training activities (MAPE = 5 ± 14%, ICC = 0.900 to 0.956). FB exhibited poor-to-moderate accuracy (ICC = 0.215 to 0.559) with larger underestimations at higher HR values. Group prediction errors were acceptable (MBE<±0.27°C) in FB (-0.07 ± 0.68°C) and CA (-0.25 ± 0.35°C) during BAPT. While FB and CA had a similar MBE and PTA ± 0.40°C (all $p > 0.05$), FB exhibited larger 95% CIs across all training activities (FB = ±2.45°C, CA = ±0.86°C). Percentage of individual Tc prediction errors within ±0.40°C was poor in all devices (FB = 41%, CA = 55%, EQ = 18%).

CONCLUSION: The EQ had the highest accuracy for HR monitoring. While FB and CA were valid for estimating group-based Tc responses during BAPT, both devices failed to meet our validity criterion in other firefighting training activities. All wearable Tc algorithms displayed individual prediction errors that were too large for personalised physiological strain monitoring during field training. Further refinement of selected consumer wearables is necessary to enable their deployment in real-world physiological strain monitoring.

**PROPOSAL OF A METHOD BASED ON THE USE OF A DRONE TO MEASURE INSTANTANEOUS SPEED DURING NONLINEAR SPRINTS OVER OUTDOOR AREAS**

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INTRODUCTION: Current approaches for assessing Change-of-Direction (COD) performance, COD deficit, and asymmetries predominantly rely on photocell systems that measure total task time, yet fail to capture critical kinetic details during COD phases (e.g., peak velocity before turning). Although lab-grade systems (e.g., Vicon) provide 3D kinematic precision, their spatial constraints limit field applications. This study develops a non-contact motion capture system integrating drone aerial imaging with deep learning algorithms to enable precise 2D kinematic analysis of COD maneuvers.

METHODS: Sixteen male collegiate soccer players (age: 19.7 +/- 1.3 yr; body mass: 70.2 +/- 8.9 kg; height: 176.3 +/- 7.8 cm) certified as National First-Class Athletes by Chinas General Administration of Sport performed COD in 90° trials on artificial turf. DJI Air 3 drone equipped with real-time kinematic positioning maintained stable aerial surveillance (60Hz) at 34m altitude. The homography matrix algorithm converted video trajectories to georeferenced coordinates using four ground markers, with a YOLOv8s model trained on 2,000 annotated frames achieving 99.3% mAP@0.5 tracking accuracy. Based on the georeferenced coordinate data, key parameters were subsequently derived from velocity-time profiles: peak velocity, minimum velocity, deceleration duration, deceleration distance, mean deceleration, and maximum deceleration.

RESULTS: The proposed method demonstrated parameter-dependent reliability, with speed-related metrics exhibiting superior consistency. Peak velocity during right-direction COD (90°R) showed the highest reliability (ICC(3,1)=0.818 [95%CI:0.560-0.930], CV=3.4%), followed by right-direction deceleration duration (ICC=0.797 [0.510-0.920], CV=13.3%). Bilateral comparisons revealed stable measurement of key parameters: left-right differences in peak velocity were clinically negligible (Delta=0.06 m/s, SEM=0.10-0.13) with 72% of spatiotemporal metrics exceeding the ICC≥0.70 threshold.

While maximum deceleration parameters showed moderate variability (ICC=0.470-0.640, CV=23.4-24.5%), speed metrics maintained CV<10% across both directions, confirming the systems robustness for dynamic velocity profiling in field settings.

CONCLUSION: This method overcomes the spatial and ecological constraints of conventional timing systems by enabling detailed 2D kinematic analysis of outdoor COD maneuvers, particularly excelling in capturing critical speed parameters (ICC=0.72-0.90, CV=3.4-10.2%) and deceleration phase kinetics. The validated capacity to quantify COD deficit through peak-to-minimum velocity differentials (Delta=2.26-2.35 m/s) and detect bilateral asymmetries (Delta=0.06 m/s in peak velocity) establishes its utility for precision training program design. While maximum deceleration metrics require further refinement (ICC=0.47-0.64), the systems sport-specific validity in measuring COD components-particularly acceleration-deceleration transitions-positions it as a viable method for field-based testing.

**CAN TRAINING WITH A HARNESS-SYSTEM IMPROVE PERFORMANCE FOR YOUNG FIGURE SKATERS?**

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INTRODUCTION: Figure skating is a sport in which athletes are judged on technical perfection, gaining the most points for mastering the most difficult technical elements. Jumps are particularly complex, and the development of new training methods for figure skaters has aimed at improving performance through enhanced technical jump excecution, increasing the number of rotations, and mastering multi-revolution jumps in the shortest possible time. Different types of harness and rotator systems have become popular in the figure skating community, but controlled studies examining their training effects are lacking [1]. This study aims to examine kinematic effects of using the 'Pro-Motion Off Ice Harness System' in the training of young developing figure skaters.

METHODS: An experimental, randomized, controlled, cross-over study design was used with 23 female figure skaters (age: 10-15 years, height: 156.8 ± 7.5 cm, body mass: 47.1 ± 9.3 kg), all of whom completed a four-week training intervention with the harness system. The skaters were tested pre-intervention and after 4 and 8 weeks. The intervention consisted of 10 minutes of harness training followed by jumping, 3 times a week for 4 weeks. Skaters were randomly divided into an intervention group and a control group, switching groups after 4 weeks. The tests consisted of two countermovement jumps (CMJ) with free use of arms, and three maximal rotation jumps (RJ). Flight times (FT) and total degrees of rotation were recorded using video and analyzed by a single scientist. The maximum value among jumps was used for analysis. Typical error (TE) for test-retest variability of flight times among these skaters using this analyst was < 2 % [2].

RESULTS: The main findings showed that there were no statistically significant effects on the kinematic variables in RJ after four weeks of training with the harness system. Pre-intervention, the skaters rotated 598 ± 91 degrees within a FT of 418 ± 42 ms in RJ, which corresponded to 87 ± 6 % of FT in CMJ.

Post-intervention results showed a small, non-significant increase in rotated degrees (M = 12.4, SD = 42.6, 95% CI [-6.0, 30.8], t(22) = 1.401, p = 0.175, d = 0.29) but only trivial changes for FT (M = 3.5, SD = 24.2, 95% CI [-6.9, 13.9], t(22) = 0.691, p = 0.497, d = 0.14). In contrast, four weeks without harness training showed no systematic changes in rotated degrees (M = 0.7, SD = 22.8, 95% CI [-10.0, 11.4], t(19) = 0.137, p = 0.892, d = 0.03) with a TE of 2.2 % for rotated degrees and TE of 2.3 % for FT in RJ.

CONCLUSION: Four weeks of 3 x 10 minutes harness training per week was not enough to achieve significant improvements for the group of 23 figure skaters. A larger sample size and a larger or longer training dose with the harness system might yield significant effects.

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## Oral Presentations

### OP-BM09 Neuromuscular Adaptations to Exercise

**EFFECT OF INTERSET INTERVAL DURATION ON NEUROMUSCULAR RESPONSES TO HIGH-LOAD RESISTANCE TRAINING**

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INTRODUCTION: The interset rest period in resistance training is crucial in determining the total work that can be performed during a training session. When using maximal loads [>85% of one repetition maximum (1RM)], rest intervals ranging from 3 to 7 minutes are commonly recommended1,2. However, scientific evidence supporting these durations is limited although the muscular and neural mechanisms responsible for decreased performance (fatigability) can be influenced by rest duration. This study investigated the effects of rest intervals on fatigability in response to a strength training session with heavy loads.

METHODS: Twenty-two resistance-trained males (mean±SD: age 23±2 years, body mass 74±7 kg, height 180±6 cm) participated in three sessions performed in a counterbalanced order. The protocol consisted of 4 sets of 3 repetitions at 90% of 1RM on a horizontal leg press machine, with rest intervals of 3 (S3), 5 (S5), or 7 min. (S7). Procedures included: isometric maximal voluntary contraction (MVC) of the lower limb, tetanic contraction of the quadriceps (50 pulses at 50 Hz), and triplets (3 pulses at 100 Hz) evoked by femoral nerve stimulation. Electromyographic (EMG) activity of the vastus lateralis (VL), and rectus femoris (RF), tissue oxygenation index (TOI) of the VL, and the rate of perceived exertion (RPE) were also measured.

RESULTS: MVC force decreased more in S3 and S5 compared with S7 ($p<0.001$). The central activation ratio did not show any significant difference in any interset duration ($p<0.05$) while EMG during MVC declined in VL and RF in S3 and S5 ($p<0.05$), but not in S7. The tetanic force declined significantly post-session ($p<0.001$) with greater reductions in shorter interset intervals (34±28% S3; 22±16% S5; 21±17% S7). Triplet force decreased significantly for S3-S5 and S3-S7 ($p<0.05$). TOI decreased more in S3 and S5 compared with S7 ($p<0.001$) thus RPE increased more in S3 and S5 compared with S7 (5±1% S3; 3±1% S5; 2±1% S7, $p<0.001$).

CONCLUSION: Our findings indicate that shorter rest intervals (S3, S5) amplify neuromuscular fatigue. The absence of central activation ratio failure suggests peripheral mechanisms as key factors in reduced performance. Accordingly, the force developed during electrically-evoked contraction decreased to a greater extent for short interset rest duration (S3 and S5). Likely due to increased metabolic stress as suggested by TOI. Additionally, higher RPE scores with shorter rests highlight increased psychophysiological strain which could reflect metabolic changes3.

Overall results suggest a 7-minute interset rest as more optimal for reducing neuromuscular fatigability under high-load conditions.

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**EFFECT OF DIFFERENT TRAINING PROTOCOLS ON MAXIMUM VOLUNTARY ISOMETRIC AND ECCENTRIC TORQUE IN THE ELDERLY**

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INTRODUCTION: Muscle strength is an essential functional parameter during daily life activities. Muscle force typically decreases with age (Bemben et al., 1991), affecting the quality of life (Trombetti et al., 2016). Therefore, training strategies that can improve muscle strength in the elderly are of scientific and practical interest. Several training protocols in this population have been shown to improve cardiovascular function (Craighead et al., 2019), but their role in eliciting improvements in muscle force is still not completely understood. Therefore, this study aimed to compare the effects of different endurance training modalities on maximum isometric and eccentric muscle strength (torque).

METHODS: Thirty-two healthy elderly participated in the study. They were divided into four work-matched training groups: moderate-intensity continuous training (concentric, 4M/4F), heavy-intensity continuous training (concentric, 4M/4F), heavy-intensity continuous training (eccentric, 4M/4F), high-intensity interval training (concentric, 4M/4F). Training modalities were carried out at the cycle ergometer (Lode for the concentric and Cyclus 2 for the eccentric modalities). The participants were tested at baseline and after 4 and 8 weeks of training. Knee extensor torque was measured using an isokinetic dynamometer (Cybex Norm); subjects were seated with the back supported and the hip joint flexed at 70°. They were requested to perform two maximal voluntary isometric contractions at a 90° knee angle and two maximal eccentric isokinetic contractions at five different angular speeds [45, 90, 150, 210, 250 °/s]. The mean torque value during the steady state of the isometric contractions and the maximum torque value during the isokinetic phase (at each angular speed) were calculated.

RESULTS: The four groups were matched for age (66.5±5.2 years), stature (1.7±0.8 m) and body mass (69.2±11.2 kg). Maximum eccentric torque was unaffected by training modality in all groups. Maximum isometric (concentric) torque increased from 130.7±70.8 Nm to 142.3±78.7 Nm ($p=0.041$) in the high-intensity continuous training group after 4 weeks of training; no further improvements were observed after 8 weeks. No significant differences were observed (either after 4 or 8 weeks) in the other training groups in concentric torque.

CONCLUSION: Our data indicate that these training protocols have trivial or no effect on maximum isometric and eccentric torque in an elderly population. Only in the high-intensity continuous training group did torque significantly improve after 4 weeks, indicating a positive impact of training intensity on muscle force capacity. The eccentric training protocol did not affect eccentric torque. Although endurance training improves cardiovascular function in older adults (Craighead et al., 2019), this is not the case for muscle force.

**ARE CHANGES IN MAXIMUM ANATOMICAL CROSS-SECTIONAL AREA ACROSS THE LOWER BODY RELATED TO CHANGES IN MUSCLE VOLUME FOLLOWING 15 WEEKS OF RESISTANCE TRAINING?**

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INTRODUCTION: Quantifying lower body muscle volume (VOL) with magnetic resonance (MR) imaging requires segmentation of a relatively large number of axial images along the length of the muscle (1). In contrast, maximum anatomical cross-sectional area (ACSAmax), can be derived more efficiently as only a small number of images around ACSAmax need to be segmented. Currently the extent to which changes in ACSAmax across individual muscles of the lower body are associated with changes in VOL following resistance training (RT) has received little attention, with prior work only focusing on the relationship between RT-induced changes ACSAmax and VOL for the overall quadriceps femoris (QF; 2). The purpose of this study was to determine the relationship between RT-induced changes in ACSAmax and changes in VOL across individual muscles of the QF, hamstrings (HAMS), and also the gluteus maximus (Gmax).

METHODS: Thirty-nine healthy young men participated in the study. Before and after 15 wk of lower body RT (knee extension, knee flexion, leg press; x3/wk) dominant limb axial MR images between the anterior superior iliac spine and lateral tibial condyle were acquired. Scans were segmented to quantify ACSAmax and VOL of the Gmax, the constituent muscles of the QF and HAMS. Pearson's product moment bivariate correlations were performed between pre to post RT percentage changes in ACSAmax and VOL for each muscle/muscle group.

RESULTS: Percentage changes in ACSAmax and VOL following RT were correlated for the overall QF ($r=0.874$, $p<0.001$) and HAMS ($r=0.966$, $p<0.001$) muscle groups as well as all individual muscles (vastus lateralis $r= 0.699$, vastus intermedius $r= 0.646$, vastus medialis $r= 0.894$, rectus femoris $r= 0.897$, biceps femoris short head $r= 0.923$, biceps femoris long head $r= 0.880$, semitendinosus $r= 0.834$, semimembranosus $r=0.890$, Gmax $r= 0.820$, [all] $p<0.001$).

CONCLUSION: Overall RT-induced changes in QF (76%) and HAMS (93%) ACSAmax explained moderate to high amounts of variance in corresponding changes in VOL. Following RT, the extent that percentage changes in ACSAmax explained variance in changes in VOL across individual muscles differed markedly (42% vastus intermedius to 85% biceps femoris short head). In conclusion, the extent to which RT-induced changes in ACSAmax are related to changes in VOL varied notably across key individual lower body muscles and should not uniformly be accepted as a substitute for or alternative to directly assessing changes in muscle volume.

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**THE EFFECT OF 4 WEEKS HIGH VS. LOW LOAD ISOMETRIC UNILATERAL ELBOW FLEXION RESISTANCE TRAINING ON THE MAGNITUDE OF INTER-LIMB STRENGTH TRANSFER AND RETICULOSPINAL TRACT PROPERTIES**

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INTRODUCTION: Bilateral increases in strength after unilateral resistance training (ULRT) have long been observed but few studies have directly compared the extent that interlimb strength transfer differs when manipulating ULRT prescription. Whilst high load (HL) has been identified as a key ULRT loading parameter, it is currently unclear if low load (LL) ULRT can induce comparable interlimb strength transfer (1,2). The purpose of this study was to compare the effect of 4 wk of HL vs. LL elbow flexion (EF) ULRT on the magnitude of interlimb strength transfer and explore the changes in reticulospinal tract (RST) properties as a potential substrate of adaptations.

METHODS: Over a 4 wk intervention period thirty young, healthy adults (male, n= 19; female, n= 11) completed 15 sessions of isometric EF ULRT with the dominant arm following randomisation to volume-matched HL (70% of maximum voluntary force [MVF], n= 15) or LL (35%MVF, n= 15) conditions. Non-dominant arm EF MVF and RST properties (assessed via: (i) the StartReact paradigm [RST gain ratio] and (ii) the ratio of motor evoked potential [MEP; transcranial magnetic stimulation of the primary motor cortex] and cervicomedullary MEP [CMEP; electrical stimulation of the cervicomedullary junction] conditioned by startling stimuli compared to unconditioned responses during submaximal contractions) were assessed pre and post intervention.

RESULTS: Non-dominant arm MVF increased in both HL (+10.6%; $p=0.006$; Pre: 197 ±73 N; Post: 213 ± 73 N) and LL (+12.5%; $p<0.001$; Pre: 208 ± 82 N; Post: 232 ± 85 N) but did not differ between groups (group x time effect, $p=0.298$). The groups also responded similarly to the interventions for all RST property measures (group x time effect, $0.402 \leq p \leq 0.756$). The RST gain ratio did not change following HL ($p=0.629$; Pre: 1.17 ± 0.18; Post: 1.14 ± 0.14) or LL ($p=0.447$; Pre: 1.12 ± 0.14; Post: 1.15 ± 0.15), nor did the MEP ratio in either condition (HL, $p=0.426$; Pre: 1.04 ± 0.47; Post: 0.98 ± 0.33; LL, $p=0.995$; Pre: 0.96 ± 0.23; Post: 0.96 ± 0.25). However, the CMEP ratio increased (+24.4%, time effect, $p=0.003$) after both LL (Pre: 1.26 ± 0.49; Post: 1.51 ± 0.47) and HL (Pre: 1.33 ± 0.46; Post: 1.53 ± 0.35).

CONCLUSION: Volume-matched HL and LL ULRT both improved isometric strength of the untrained arm. However, the extent of interlimb strength transfer did not differ between conditions indicating accumulated ULRT volume might be a more critical loading parameter than intensity when aiming to maximise interlimb strength transfer. Though the RST gain and the MEP conditioned by the startling stimulus were unaffected by the intervention, the ratio of conditioned to uncondi-

tioned CMEP increased after training, suggesting the possibility that some of the interlimb strength transfer observed was mediated by adaptations within the reticulospinal tract.

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**ACUTE EXCITABILITY CHANGES OF THE RETICULOSPINAL TRACT DURING A SINGLE BOUT OF RESISTANCE EXERCISE IN HEALTHY HUMANS**

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INTRODUCTION: The reticulospinal tract is a key neural pathway implicated in adaptation to resistance training (1). Strength-trained individuals demonstrate greater reticulospinal excitability compared to untrained controls (2); however, its acute response to resistance exercise in humans remains largely unexplored. Ipsilateral motor-evoked potentials (iMEPs) have been proposed as a reliable measure of reticulospinal function, given the RSTs bilateral descent with an ipsilateral predominance (3). This study examined acute changes in reticulospinal excitability due to resistance exercise.

METHODS: 29 untrained healthy adults (9 males, 20 females) participated in this study. Electromyography electrodes recorded contralateral motor-evoked potentials (MEP) from the dominant arm (m. biceps brachii) and iMEPs from the non-dominant arm. MEPs and iMEPs were elicited using transcranial magnetic stimulation (TMS) at 100% stimulator output when participants reached an elbow flexion angle of 110° during bilateral biceps curls with 30% of their one-repetition maximum load, a method previously validated for iMEP elicitation (4). The protocol included one set of 40 repetitions with 20 TMS pulses (administered in cycles of 5 stimulations followed by 5 pauses, until all 40 repetitions were completed). The ipsilateral to contralateral amplitude ratio (ICAR) was calculated to assess the relative importance of the two tracts (i.e., reticulospinal and corticospinal tracts) (5). The Rating-of-Fatigue scale (ROF, 0~10) and velocity loss (%) of maximal concentric contraction speed assessments were performed pre- and immediately post-loading to measure fatigue.

RESULTS: Clear iMEPs were observed in 27 subjects. Immediately after the biceps curl exercise, a significant change in the velocity loss (12 ± 7%, $p < 0.001$) and ROF were observed (1.7 ± 1.1 to 5.1 ± 2.0, $p < 0.001$). Both iMEP ($r = 0.166$, $p < 0.001$) and ICAR ($r = 0.161$ , $p < 0.001$) rather than MEP ($r = 0.067$, $p = 0.117$) correlated with repetitions during 40 repetitions. Furthermore, comparing the median responses of the first 5 with the last 5 of 40 repetition set revealed significant increases in iMEP (37 ± 39 %, $p < 0.001$), MEP (5 ± 13 %, $p = 0.023$ ), and ICAR (33 ± 49 %, $p = 0.004$).

CONCLUSION: The observed increases in iMEP and ICAR with increasing repetitions may suggest a potential involvement of the reticulospinal tract during resistance exercise and provide targets for future research on neural responses to resistance exercise. Further research is needed to determine whether these changes represent a compensatory mechanism for neuromuscular fatigue or are influenced by other factors.

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## Invited Symposium

### IS-PN08 Unraveling Dietary Protein Sources for Skeletal Muscle Health and Performance: 'From Workouts to Wellness

**CONSIDERING THE SOURCE OF DIETARY PROTEIN FOR SKELETAL MUSCLE ADAPTATION IN EXERCISING INDIVIDUALS**

WALL, B.
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Dietary protein ingestion to support skeletal muscle recovery, remodelling and adaptation to exercise training represents a cornerstone within modern sports nutrition. Physiologically, this is due to the exercise induced stimulation of muscle protein synthesis rates being augmented by the ingestion of each protein containing meal over days and weeks. Experimental research into the regulation of muscle protein turnover via exercise and protein has developed well-defined, generally agreed upon sports nutrition guidelines around protein intake for training individuals; most notably, that intakes in excess of currently accepted RDA/Is are more optimal. Recent work has now applied more focus to the adjacent question of what types of protein may be more or less optimal, and to what extent the choice of protein may influence sports nutrition recommendations. This question was traditionally viewed more through the lens of optimising protein supplementation/isolates. However, media (e.g. 'GameChangers' documentary) and societal (e.g. concerns over environmental sustainability) priorities advocating for (more) plant-based diets have encouraged this work to refocus on a broad range of

protein-rich, animal- and non-animal derived food sources. Such research has begun to accumulate data on measurements of daily or weekly whole-sale dietary change, as opposed to a per meal basis, and therefore begins to represent dietary patterns more reminiscent of how protein is habitually consumed in individuals selecting different diets but seeking similar benefits during prolonged training. This presentation will review the growing literature base surrounding the regulation of muscle protein turnover via diverse dietary protein sources. Further, research examining the translation of these mechanistic approaches to protein-rich food choices during longer term, whole-sale dietary changes (e.g. omnivorous vs vegan diets) to more prolonged measures of muscle protein metabolism and adaptive responses to training will be considered. The extent to which we can offer practical recommendations on protein type, in combination with protein amount, will be discussed. The presentation therefore aims to provide content of interest to researchers in the field as well as those wanting a more applied contemporary perspective regarding protein nutrition guidelines for exercisers giving more consideration to from where their protein is obtained.

**CAN THE SOURCE OF DIETARY PROTEIN OPTIMIZE MUSCLE HEALTH WITH ADVANCING AGE?**

BREEN, L.

*UNIVERSITY OF BIRMINGHAM*

The loss of muscle mass, strength and function with advancing age (termed 'sarcopenia') is associated with heightened risk of disease comorbidity, loss of independence and poorer quality of life. Estimates suggest that this condition affects >10% of those aged 65 and over and is more prevalent with advancing age. In line with global population ageing sarcopenia diagnoses are increasing at an unprecedented rate, placing a strain on healthcare resources and economies. Dietary protein is essential for muscle maintenance and health across the life-course, primarily through the stimulation of postprandial muscle anabolic processes. Congruent with data demonstrating that postprandial muscle anabolism is compromised in older age, mounting evidence shows that dietary protein intakes for age-related muscle health should exceed current population-wide recommendations. However, achieving higher levels of dietary protein intake in older age can be challenging for numerous reasons. These include alterations in the regulation of appetite and digestion, sensory issues including smell and taste, chewing efficiency and swallowing function. Beyond protein quantity, dietary protein quality (determined by the metabolic availability of [essential] amino acids) may be important stimulus for skeletal muscle anabolism and maintenance in older age, particularly in the context of lower protein-containing diets. In this regard, animal-derived proteins are typically touted as 'higher quality' than plant-derived proteins based on their EAA profile, superior rate of digestibility, and overall bioavailability for anabolic processes in peripheral tissues such as skeletal muscle. However, the superior muscle anabolic properties of animal over plant-derived proteins in older adults have commonly been demonstrated with single servings of isolated supplemental sources in acute, tightly controlled experimental conditions. In contrast, dietary protein is typically consumed within a whole-food matrix as part of a mixed meal, delivering multiple nutrients in complex structures that alters protein digestibility and the capacity for postprandial muscle anabolism. Recent studies have employed innovative methodologies over longer-term free-living periods to provide fresh insight on the role of dietary protein source and quality for muscle mass regulation in older adults. This talk will provide a detailed overview of the mechanisms through which dietary protein source and quality may influence muscle anabolism and maintenance in older adults, drawing on historic and contemporary research findings. Future directions to determine source-specific protein requirements to promote muscle health in older adults will also be presented. This talk holds relevance for researchers interested in understanding the dysregulated nutrient sensing in ageing muscle and practitioners using diet/nutrition approaches to promote health and general wellbeing in older adults.

**DIETARY PROTEIN SOURCE TO PREVENT MUSCLE DECONDITIONING IN CLINICAL SETTINGS**

WEIJZEN, M.

*MAASTRICHT UNIVERSITY*

Hospitalization or recovery from illness often necessitate a period of physical inactivity which is accompanied by an accelerated loss of muscle mass and muscle strength. This accelerated muscle loss during hospitalization can have particularly detrimental consequences on muscle strength and function in the older population, as many older adults do not recover fully from this catabolic event. Additionally, in hospitalized patients, significant alterations in dietary intake—primarily reduced energy and protein consumption—further complicate recovery. Insufficient protein intake has been shown to accelerate muscle loss, prolong hospital stays, elevate the risk of complications, increase morbidity and mortality, heighten readmission rates, and impair functional recovery. Food intake is typically reduced due to a variety of factors, such as restricted timing of food provision, adverse effects of medication, reduced appetite, and prescribed periods of fasting. It has been recommended that older individuals or individuals with acute or chronic illness should consume 1.2-1.5 g protein/kg/d. However, achieving these intake levels in a clinical setting is challenging. Although protein provision might theoretically meet these guidelines, actual protein consumption often falls short, resulting in protein intake levels far below recommendations. A growing shift toward plant-based proteins in clinical settings adds an additional layer of complexity, as these protein sources often have lower digestibility and an incomplete amino acid profile compared to animal proteins, potentially further compromising protein quality and bioavailability in patients with elevated protein needs. This talk will provide a comprehensive overview of dietary protein consumption in clinical settings. It will highlight research on muscle loss during hospitalization and anabolic resistance associated with (critical) illness, while presenting practical nutritional approaches to optimize protein intake. Special emphasis will be given to future directions and considerations related to dietary protein sources in clinical care. This talk will appeal to researchers in the field, as well as practitioners working with

clinical populations, offering valuable insights into the caution required for implementing the upcoming protein transition in clinical practice.

## Oral Presentations

### OP-BM12 Balance

**SENSORY REWEIGHTING AFTER VIRTUAL REALITY-AUGMENTED BALANCE TRAINING IN YOUNG ADULTS**

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INTRODUCTION: Maintaining balance in an upright stance is a fundamental movement skill. Balance control relies on sensory feedback from visual, vestibular, and proprioceptive systems [1]. Previous research has shown that the relative contribution of each sensory system changes depending on environmental conditions, a process referred to as sensory reweighting [2]. However, the effects of balance training (BT) on sensory integration are currently unresolved. This study aimed to investigate the effects of virtual reality-based BT (BT+VR) versus conventional BT on sensory integration during bipedal stance in young adults.

METHODS: Twenty-two participants aged 22.9±1.1y were randomly allocated to a BT or a BT+VR group. BT participants received conventional BT, while BT+VR participants additionally received visual input manipulations in the form of a tilting visual scene during the performance of BT exercises. Both training protocols were conducted for four weeks with two weekly sessions. To investigate the visual sensory contribution, participants were exposed to two stimulus conditions. The visual scene tilted in pseudo random sequences with peak-to-peak amplitudes of 1° or 4° (pp1 and pp4) while postural sway was recorded in bipedal stance using a force plate. The independent-channel model was applied to estimate the visual contribution to balance [3], i.e., the visual weight (Wv), together with parameters characterizing the dynamics of the feedback system. Specifically, the proportional and derivative feedback-loop gains represent the strength of muscle contraction relative to the deviation from the desired upright position and postural sway velocity. Three-way rmANOVAs were performed with the factors group (BT vs BT+VR), time (pre vs post), and stimulus condition (pp1 vs pp4).

RESULTS: Results revealed a significant main effect of condition ($p<0.001$, part. eta squared effect size [ES]=0.97), with higher Wv observed in pp1 compared to pp4. A significant condition-by-time interaction ($p=0.003$, ES=0.38) was found, with a 15% pre to post decrease in Wv in pp1. However, no significant group-by-time interactions were found. For the proportional and derivative feedback-loop gains, significant main effects of time were observed ($p=0.004$, ES=0.28; $p=0.044$, ES=0.35, respectively).

CONCLUSION: This study demonstrates that both BT and BT+VR can induce adaptations in sensory reweighting by reducing the visual contribution to balance. While neural adaptations following BT have been extensively studied, this study provides novel evidence of adaptations in the feedback system of balance control after BT and BT+VR in healthy young adults. These findings may have clinical implications for patients (e.g., with Parkinson disease) or older adults who often have increased visual dependence during balance control.

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**COMPARISON OF FOUR INTERVENTIONS AIMED AT IMPROVING BALANCE IN OLDER ADULTS**

THEODOSIADOU, A., FABRE, M., SAHINIS, C., PAPAVASILEIOU, A., PATIKAS, D.A., AMIRIDIS, I.G., LAPOLE, T., BAUDRY, S.

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INTRODUCTION: Aging results in a progressive decline of motor control, affecting static and dynamic balance (1). Balance training programs for elderly individuals typically involve exercises targeting various factors, such as visual input, surface type, or foot positioning (2), but rarely incorporate specific stimulation of the neuromuscular system to enhance the training effects. While previous studies have focused on techniques like vibration or electrical stimulation (3,4), the combination of both remains largely unexplored. This study aims to investigate the effects of four balance training interventions that integrate balance exercises and neuromuscular stimulation.

METHODS: Seventy-four healthy older adults (75-87 years old) completed a 6-month protocol that included 8 weeks of tailored balance training consisting of either 40-min session of balance exercises alone (CON group) or combined with concurrent application of electrical stimulation (TENS group), vibration (LV group) or both (LV+TENS group). Four evaluations were conducted: 8 weeks before the training (T1), 1-7 days before the training (T2), 1-7 days after the training period (T3), and after an 8-week retention period with no training (T4). The assessment included the 10-Meter Walking Test (10MWT), 6-Minute Walking Test (6MWT), Timed Up and Go (TUG), Berg Balance Scale (BBS), and Short Physical Performance Battery (SPPB). Linear mixed model (fixed effect: evaluation and group, random effect: participants) were used for analysis.

RESULTS: No significant differences were found between T1 and T2 for any test (p>0.05), without group differences either. No significant effects of training (p=0.138) or group (p=0.525) were observed for the 6mWT. However, an improvement in 10mWT (p=0.004), TUG (p<0.001), SPPB (p<0.001) and BBS (p<0.001) was observed from T2 to T3, without differences between groups. After the retention period, the scores returned to their initial values (as in T2) for the TUG, SPPB and BBS (p=0.002; p=0.049; p<0.001, respectively) without differences between groups (p>0.05).

CONCLUSION: These findings suggest that tailored balance training significantly enhances clinical balance performance, underscoring its importance as a non-pharmacological intervention to combat age-related decline in balance capacity. However, the addition of LV and TENS did not give additional benefits compared to exercises alone. This suggests that while these modalities are often posited to enhance neuromuscular activation and proprioceptive feedback, their contribution to balance improvement may be limited, at least in the context of this study. One possible explanation could be that the balance exercises provided sufficient stimulus for adaptation, leaving little range for additional gains from LV or TENS.

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**HEALTHY YOUNG AND MIDDLE-AGED ADULTS WITH LOW FALL-RESISTING SKILLS IMPROVE BALANCE RECOVERY DURING SIMULATED REAL-WORLD BALANCE DISTURBANCES AFTER PERTURBATION-BASED GAIT TRAINING**

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INTRODUCTION: Perturbation-based balance training during locomotion is recognized as an effective physical intervention to enhance fall-resisting skills across diverse populations [1]. However, its transfer to real-world scenarios remains insufficiently investigated. Given that the generalization of adaptive locomotor stability responses is essential for fall prevention, this study examined whether balance recovery improvements gained either through mechanically or visually induced gait perturbations translate to real-world balance disturbances in high fall risk individuals.

METHODS: 110 healthy young and middle-aged participants (aged 18–63 years, male and female) were randomly assigned to a control group (n=30, no perturbation training) or one of two perturbation training groups: mechanically induced (MEC, n=40) or visually induced (VR, n=40). All participants walked on a treadmill during training. The MEC group experienced posterior and medio-lateral gait perturbations via ankle and waist pulls using a pneumatically operated brake-and-release system. The VR group encountered visually induced perturbations through virtual environment rotations displayed in VR glasses. To assess potential transfer effects to real-world perturbation scenarios, participants completed walkway negotiation tasks before and after treadmill training, encountering tripping, slipping, and misstep elements. Based on pre-training anterior margin of stability (MoS) during trip, slip, and misstep perturbations, participants were classified as high (HIGH) or low performers (LOW) using a median split with a minimum 20% separation threshold. Balance improvements in simulated real-world scenarios were evaluated by analysing MoS pre- and post-training.

RESULTS: For each perturbation type our analysis revealed a similar number of LOW and HIGH performer independent of the analyzed exercise groups. LOW showed an increase in MoS during tripping and slipping in both intervention groups (mean increment in MoS: VR-trip: +8.65 cm, VR-slip: +4.18 cm; MEC-trip: +9.71 cm, MEC-slip: +7.95 cm; p<0.05). In the misstep transfer task, a significant MoS increase was observed only in the MEC group (+3.88 cm; p<0.05). In contrast, HIGH and the control group showed no increase in MoS or any components of dynamic stability from pre- to post-testing during tripping, slipping, or missteps.

CONCLUSION: Our findings show that healthy young and middle-aged adults with low fall-resisting skills can benefit from repeated exposure to unpredictable visual and mechanical induced gait perturbations enhancing their fall resilience during simulated real-world balance disturbances. Thus, implementing such perturbation-based exercise interventions in occupational and clinical settings might be an effective tool to decrease fall risk in various population groups.

[1] Karamanidis et al. 2020 Exerc Sport Sci Rev

**CHANGES IN BALANCE PERFORMANCE IN ADOLESCENT FOOTBALL PLAYERS AT THE BEGINNING OF COMPETITION PERIOD**

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INTRODUCTION: Balance performance, particularly in a one-leg stance, is critical for enhancing a football player's ability to perform high-intensity and explosive actions such as sprints, jumps, accelerations, and decelerations during changes of direction - key physical capacities required for success in competition (Chtara et al., 2018; Rouissi et al., 2018). Kim & Kim (2018), Chtara et al. (2018) proved that shin muscle strength growth causes balance improvement. Lower ankle joint stiffness is associated with a larger range of movement (ROM) in plantar flexion and worse static balance (Loram & Lakie, 2002). Our study aims to assess static and dynamic balance, ankle plantar (PF) and dorsal (DF) flexor muscle strength, and ankle ROM changes in adolescent football players in the competition period's first 8 weeks.

METHODS: Nineteen 15.3±0.9 years old male football players (mean training experience: 8.1±2.6 years, training volume: 8.4±2.1 h/week at the end of the preparation period, and 9.8±2.0 h/week in the competition period, p<0.012) participated. The static and dynamic balance were evaluated using the stabilimeter platform. The ankle PF and DF muscle isometric peak forces were measured using a handheld dynamometer. The torques were calculated by multiplying the peak force with the lever arm length. The ankle PF and DF active and passive ROMs were tested using a goniometer.

RESULTS: The 8 weeks of the competition period led to: One leg stance static balance side-asymmetry appearance standing on the dominant (D) and non-dominant (N) legs (p≤0.037), and improvement solely in the N leg: the ellipse area of the centre of pressure (COP) movements, its perimeter, COP sway distance in the medial-lateral direction, the mean anterior-posterior and medial-lateral sway speed reduced (p≤0.041). Dynamic balance improved: the trunk total deviation angle reduced standing on the D and N legs (p≤0.041). The total stability index transited from the category "poor" (3.2±1.7) to "normal" (2.3±0.91) standing on the N leg. The isometric peak torques of ankle PF and DF muscles were stronger in the D leg than in the N (p≤0.021). After 8 weeks, the ankle DF peak isometric torques increased in both legs (p≤0.0012). The passive PF ROM was reduced in both ankles (p=0.0002), and the active PF ROM increased in the D limb (p=0.033).

CONCLUSION: In sum, in the 8 weeks of the competition period dynamic balance performance improved standing on the D and N legs, but static balance performance enhanced only in the N one-leg stance. The ankle DF muscle became stronger to provide better motor skills in the D leg and larger DF active ROM and stability during landing tasks in the N leg. The ankle passive PF ROM was reduced in both legs due to ankle stiffness growth that improves balance performance.

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**NEUROMUSCULAR ADAPTATIONS TO UNEXPECTED POSTURAL PERTURBATIONS IN HANDBALL ATHLETES.**

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INTRODUCTION: Adapting to unpredictable postural perturbations is essential for handball athletes, where rapid movements and direction changes are common [1]. Vibration-induced sensory perturbations challenge proprioception, requiring quick adjustments to maintain balance. Understanding how athletes respond, provides insights into long-term neuromuscular adaptations from specialized training, crucial for injury prevention [2]. This study examined differences in activation patterns of the soleus and tibialis anterior muscles during and after vibration-induced perturbations.

METHODS: 13 handball athletes (7 females, age: 24.25±2.10 years, BMI: 22.83±1.68 kg/m2, training experience: 9.98±2.46 years) and 12 non-athletes (4 females, age: 28.11±4.83 years, BMI: 23.02±4.19 kg/m2) participated in the study. Participants were exposed to unexpected 12-15 s bilateral vibration on the Achilles tendons while standing on a force plate with eyes blindfolded. Centre of Pressure (CoP) displacement and activation of the tibialis anterior (TA) and soleus (SOL) muscles were recorded and analysed for 8 s after vibration onset and offset. Repeated measures ANOVA identified significant differences in CoP displacement and muscle activation (p<0.05).

RESULTS: Both groups exhibited a significant backward CoP shift (TIME: $F(16, 368) = 27.5$, $p < 0.0001$), starting 1.5 s after the vibration onset (post hoc: $p < 0.05$), while after the perturbation (post-offset), showed a further backward shift (TIME: $F(16, 368) = 19.2$, $p < 0.0001$), followed by a forward displacement within the first 1.5 s.(post hoc: $p < 0.05$). SOL activation began 0.5 s after onset in both groups (TIME: $F(16, 368) = 6.3$, $p < 0.0001$). However, post-offset, handball athletes demonstrated stronger activation (TIME*GROUP: $F(16, 368) = 1.8$, $p = 0.03$) from 1.0 to 1.5 s (post hoc: p<0.001), while non-athletes showed a significant weaker response at 0.5 s (p<0.001). TA activation displayed similar patterns in both groups during the onset of vibration (TIME: $F(16, 368) = 3.0$, $p < 0.0001$), but after the offset, non-athletes exhibited a stronger TA response (TIME*GROUP: $F(16, 368) = 2.4$, $p < 0.01$) to anticipate the forward CoP displacement.

CONCLUSION: Although both handball players and non-athletes compensated similarly for the unexpected vibration-induced perturbation, their neuromuscular strategies differed. Handball players relied more on enhancing agonist (SOL) activation during standing, while non-athletes showed greater antagonist (TA) activation. The reduced involvement of the antagonist muscle in handball players may suggest more efficient recovery mechanisms, highlighting neuromuscular adaptations from training that contribute to better balance control.

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Oral Presentations

OP-AP39 Swimming III - Performance Testing

**KEY PERFORMANCE INDICATORS IN FREESTYLE SWIMMING: COMPARING START, TURN, AND SWIMMING VELOCITY IN TOP-ELITE FEMALE JUNIOR AND ADULT SWIMMERS**

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INTRODUCTION: Due to the increasing importance of start and turn performance in swim races throughout the recent years, the aim of the study was to compare the effect of start performance, turn performance, and swimming velocity on the race result between top-elite female junior and adult swimmers across all distances of freestyle pool races (50 m to 1500 m) and to provide a software tool to predict race outcomes based on the various key performance indicators.

METHODS: In the present study, a total of 289 individual freestyle races from female participants at the European long-course championship, as well as 391 freestyle races at the Junior European long-course championship were analysed. All heats, semi-finals, and finals across all freestyle distances (50 m to 1500 m) were included. Linear regression analyses were used to assess the relationship between overall race time and three independent variables: start performance, turn performance, and swimming velocity. Regression equations were used to develop the predictor software tool.

RESULTS: Start times showed the greatest effect on sprint distances, i.e. 50 m and 100 m. However, the effect diminished towards longer race distances. While swimming velocity had the largest effect on the race results across all distances for both junior and adult swimmers, the effect of turn times increased from 100 m to 400 m for both, junior and adult swimmers. Interestingly, the effect of turn times decreased again for 800 m and 1500 m races. Generally, there was a trend towards a greater effect of turn times in adult swimmers. The regression model explained 98-99% of the variance in race performance (r2 = 0.98-0.99). Based on the regression equations a software tool (potential predictor) was created to allow coaches and federation officials to identify individual swimmers' potentials and create benchmarks for future development.

CONCLUSION: For both junior and adult swimmers, swimming velocity had the greatest effect on race results. While the effect of start performance decreased from short to long race distances, turn performances showed a U-shaped, hence largest effect on middle-distance races, i.e. 200 m and 400 m. The prediction tool that was developed from the regression model allows the prediction of individual performance progressions and rankings at international swimming competitions by combining isolated performance analysis with race analysis data.

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**ANAEROBIC SPEED RESERVE AND CRITICAL SPEED AS PREDICTORS OF 200 M FREESTYLE PERFORMANCE: A PRACTICAL ALTERNATIVE TO PHYSIOLOGICAL TESTING IN TRAINED SWIMMERS**

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INTRODUCTION: The ability to predict performance potential in racing sport events lasting from ~1 to 3 min is complex due to a heavy reliance on both aerobic and anaerobic energy systems. In swimming, this is made more difficult by the practical inaccessibility presented by the aquatic nature of the sport, which interferes with the collection of physiological measures that are commonplace in sports more suited to laboratory testing. Anaerobic speed reserve (ASR) and critical speed (CS) are mathematical models which can be calculated based solely on performance data in both predominantly aerobic (providing an estimate of maximal aerobic speed: MAS) and predominantly anaerobic events (providing an estimate of maximal sprint speed: MSS). However this approach has received limited attention in swimming cohorts, and therefore, the aim of this research was to determine the association between ASR and CS with a mixed energy system performance (200 m freestyle) in trained swimmers. We further examined whether these associations could be strengthened with the addition of physiological markers of aerobic and anaerobic capacity.

METHODS: Trained male (n=8) and female (n=9) swimmers completed three maximal freestyle swims (50, 200, and 400 m) on separate days, with the 50 m (MSS) and 400 m (MAS) speeds used for the determination of ASR and CS. Arterial oxygen saturation, blood lactate concentration, peak oxygen consumption (VO2peak), blood bicarbonate concentration, and blood pH were measured pre- and post-trial. Linear regression models were adopted to assess the best predictors of 200 m freestyle performance, with multivariate analysis of variance used to assess the impact of distance on all variables.

RESULTS: MSS was the strongest predictor of 200 m performance (R2 = 0.83), followed by CS (R2 = 0.69, whilst ASR could only provide moderate predictive capabilities (R2 = 0.36). However, the addition of CS, ASR and ΔpH to MSS in our optimal

regression model accounted for 95% of variance in 200 m freestyle performance, decreasing mean absolute error from 2.41 s to 1.46 s. The removal of physiological data (ΔpH) from the model had only a trivial impact on predictive capabilities (R2 = 0.94). There was a large and significant effect (η2>0.14) of trial distance on all physiological and performance variables; however, post hoc analysis revealed no significant difference for VO2peak.

CONCLUSION: In this investigation, MSS provided the strongest single predictor of 200 m freestyle performance, while the addition of ASR and CS substantially improved the model. Markers of aerobic and anaerobic capacity did not meaningfully improve the model. Modelling of ASR and CS provides a practical alternative to the collection of physiological variables in swimming cohorts for identifying performance potential in this mixed energy system event.

**THE RELIABILITY AND SENSITIVITY OF A 25-M MAXIMAL SWIM TO ESTIMATE VLAMAX**

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INTRODUCTION: The physiological assessment of swimmers has been widely examined, however there is no consensus on the best methodologies to assess fundamental physiological characteristics. For example, whilst it has been proposed that maximal blood lactate accumulation rate (VLamax) is a useful index of glycolytic power, literature investigating methodologies to estimate VLamax is limited. In swimming specifically, currently only four academic articles examine VLamax, each presenting their own novel methodology. Recently, it was found that a 25-m maximal swim effort presented the highest VLamax compared to 35 and 50-m distances (1). This finding aligns with the initial proposed duration of approximately 10-seconds of maximal effort for a VLamax estimation, and validates a 25-m distance for VLamax assessment in swimmers (1). The reliability and sensitivity to training of VLamax derived from the 25-m test however, has not been established.

METHODS: Nineteen state-to-national level swimmers completed a 25-m VLamax test on three consecutive mornings across three consecutive weeks. The first test of each week was conducted following 48-hours of rest to investigate reliability. The test was also conducted 12- and 36-hours post an anaerobic training set to determine the sensitivity of VLamax to anaerobic stimuli. On all occasions, resting blood lactate was measured immediately prior to entering the pool. Swimmers commenced from a push start and were asked to produce their fastest possible velocity across a 25-m distance. Blood lactate was measured 30-s post-test and then every minute until the concentration reached a plateau or decreased. VLamax was calculated as the difference between maximal and resting blood lactate concentrations, divided by the difference between the test duration and the duration during which it is assumed that lactate production has not yet begun (1). Reliability of VLamax was assessed by typical error (TE), coefficient of variation (CV) and intra-class correlation coefficients (ICC). Generalised linear mixed modelling was conducted to understand the sensitivity of VLamax to anaerobic training stimuli.

RESULTS: The VLamax TE was 0.072 mmol·L-1·s-1 (95% CI: 0.051-0.118 mmol·L-1·s-1) with a CV of 19.9% (95% CI: 14.8-30.2%) and ICC of 0.847 (95% CI: 0.609-0.936). VLamax was significantly reduced at 12- (ß = -0.216, p = 0.016) and 36-hours (ß = -0.216, p = 0.014) post anaerobic training compared to baseline.

CONCLUSION: VLamax derived from a 25-m maximal swim is sensitive to changes in glycolytic power within a training cycle. The reliability of the VLamax swim test is deemed 'good', however interpretations on anaerobic readiness within a training cycle or glycolytic power profile should be made with respect to the TE and CV. Future investigations into the magnitude of change in VLamax between different physiological profiles are encouraged.

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**OXIDATIVE AND O2 DIFFUSIVE FUNCTION IN TRICEPS BRACHII OF SWIMMERS FROM RECREATIONAL TO WORD CLASS LEVELS**

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INTRODUCTION: Success in swimming is influenced by several physiological, morphological, neuromuscular, biomechanical and technical factors[1]. Although a small share of the energy during sprint events (50-100m) is provided through the oxidative system, swimmers specializing in this event combine power and endurance training with a greater training volume than other sprint sports[2]. Skeletal muscles engaged in swimming strokes (e.g., deltoid and triceps brachii) express high oxidative enzyme activity[3] and abundant capillaries[4]. However, swimmers incorporate heavy strength training or sprint drills with resistance tools in their weekly routine[5]. This can lead hypertrophy of type II muscle fibers, reducing capillary density and potentially impairing skeletal muscle O2 diffusion[6]. The impact of these muscular adaptations on swimming performance at different competitive levels is unclear. This study aimed to evaluate oxidative and O2 diffusive function measured by near-infrared spectroscopy (NIRS) of triceps brachii muscles of recreational to Olympic level swimmers and explore their relationships with swimming performance.

METHODS: Twenty-eight swimmers were enrolled and assigned into three groups according to their level: "Recreational/Trained" (Tier 1/2;n=8), "National" (Tier 3;n=12), and "International/World class" (Tier 4/5;n=8). Performance was evaluated by 100 metre freestyle trials. Training volume was measured by self-reported distance. The muscle O2 consumption

(mVO2) recovery rate constant (k) of m. triceps brachii was non-invasively estimated by NIRS (Train. Red Plus) through repeated intermittent occlusions under two conditions: well oxygenated (kHIGH) and low O2 availability (kLOW). kHIGH is proportional to muscle oxidative capacity and the difference between kHIGH and kLOW (Δk) is proportional to the relative resistance to diffusive O2 flux.

RESULTS: FINA points and 100m performance differed among groups. Training volume was greater in Tier 4/5 (34.0±5.5km/week) and Tier 3 (35.5±11.6km/week) than in Tier 1/2 (6.4±1.8km/week). kHIGH was greater in Tier 4/5 and Tier 3 (3.18±0.41 and 2.79±0.40min-1) vs. Tier 1/2 (2.10±0.36min-1; all $p<0.002$). kHIGH correlated with FINA points, 100m performance and training volume. Δk was not different among Tiers and not correlated with training volume or performance.

CONCLUSION: M. triceps brachii oxidative capacity was positively associated with performance and training volume in swimmers. However, Δk, which reflects the relative resistance to muscle O2 diffusive flow, was not different from recreational to world class athletes. These data suggest that m. triceps brachii oxidative capacity is closely associated with swimming performance, and that capacity for O2 diffusion is increased in approximate proportion to muscle oxidative capacity across swimmers ranging widely in ability.

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**SUPPORTING SELF-REGULATED LEARNING IN SPORTS SETTING: SWIMMING**

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*UNIVERSITY OF BERN*

INTRODUCTION: The influence of various performance indicators – such as anthropometrical, physiological and biomechanical data – on freestyle swimming performance, has been a common focus in previous research on both elite and young athletes (Lätt et al., 2010; Nasirzade et al., 2015). Apart from such homogenous groups, performance improvement in freestyle swimming also represents a common goal in more heterogenous groups, such as university students in sports programs, where research remains scarce. To bridge this gap and identify how student's skill acquisition can be best supported, despite their various physical characteristics and training backgrounds, our ongoing research aims to track student's learning process and identify key performance indicators influencing final outcomes in freestyle swimming performance.

METHODS: 77 students attending swimming lessons at University of Bern are participating in the study. Student's performance in 200m freestyle swimming (time and technique) is assessed at three time points during the semester using qualitative and quantitative assessments. Anthropometrical characteristics, psychological characteristics (motivation, mindset about self-regulated learning), theoretical subject knowledge and use of digital tools are monitored throughout the study to determine their correlation with and predictive value for students' swimming performance.

Special emphasis is placed on digital tools as a means of supporting students' learning. Students participating in the study have access to a multimedia database that offers differentiated motor learning support for independent use, learning diaries, and various theoretical and self-assessment resources. Engagement with these resources varies, as some are mandatory course components while others are optional and available at students discretion. Throughout the study, we monitor students engagement with non-mandatory digital materials as well as their progression in mandatory digital assignments.

RESULTS: Results of this study will allow us to assess both the effectiveness and utilization of digital resources in sports skill learning within tertiary education.

CONCLUSION: Findings of this study will furthermore help with the identification of key performance indicators in freestyle swimming lessons that extend beyond predisposed physical characteristics of the students, contributing to the knowledge in the field.

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Oral Presentations

OP-MH25 Sarcopenia / Dynapenia / Powerpenia

**DOSE-RESPONSE RELATIONSHIP BETWEEN STATIC BALANCE AND SPATIO-TEMPORAL GAIT PARAMETERS IN SINGLE- AND DUAL-TASK CONDITIONS AMONG ADULTS AGED 40-79 YEARS**

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INTRODUCTION: Gait performance is a critical indicator of physical function and activity of daily living in later life. Extensive research has established that gait parameters are strongly associated with falls, all-cause mortality and other adverse health outcomes. However, the relationship between balance and gait, particularly the dose-response relationship, remains unclear in middle-aged and older adults. Therefore, this study aims to investigate the association between static balance ability and spatio-temporal gait parameters during single-task and dual-task conditions among Chinese adults aged 40 to 79 years.

METHODS: This study involved 297 adults aged 40 to 79 years from Tongzhou District in Beijing and Taiyuan City in Shanxi Province. Static balance was assessed using a one-legged stance test with eyes closed (performed on either the left or right foot), measured by the duration participants could maintain the position. Spatial-temporal gait parameters, including step time, step length, gait speed and cadence, were collected using an accelerometer (Xsense Dot, Netherlands) under two conditions: single-task (walking 20 meters in a straight line on flat ground) and dual-task (walking while performing a random subtraction of three-digit numbers). Restricted cubic splines (RCS) were applied to explore potential dose-response relationships between static balance and gait performance.

RESULTS: The average age of the participants was 53.6±11.0 years. Under the single-task condition, the step time was 0.48±0.09 s, step length was 0.66±0.11 m, gait speed was 1.12±0.18 m/s, and cadence was 124.0±17.7 counts/min. Under the dual-task condition, the step time was 0.49±0.08 s, step length was 0.63±0.09 m, gait speed was 1.03±0.19m/s, and cadence was 119.5±16.9 counts/min. Significant differences were observed in gait parameters between single-task and dual-task conditions ($P<0.05$). After adjusting for covariates, no significant linear trends were found between one-legged stance duration with eyes closed and any gait parameters under the single-task condition ($P>0.05$). For the dual-task condition, linear regression analysis revealed that, compared to the lowest quartile of standing time (Q1) of standing time, there was a significant positive correlation between standing time in Q2 ($P=0.039$) and Q3 ($P<0.001$) with step time. Additionally, a positive association was observed between standing time in Q3 ($P=0.027$) and step length. However, no significant linear relationship was found between standing duration and gait speed or cadence ($P>0.05$). RCS analysis indicated a nonlinear relationship between one-legged stance duration and dual-task step time (P for nonlinear=0.029). Specifically, a standing time of less than 12.4s was negatively correlated with step time, while a standing time greater than 12.4s was positively correlated with step time. This suggests that 12.4s may represent a minimum threshold for improved dual-task step time performance.

CONCLUSION: Static balance ability was associated with gait parameters under dual-task conditions in adults aged 40-79 years. A dose-response relationship was identified between one-legged standing duration and step time, particularly during dual-task conditions. To mitigate age-related declines in gait parameters, middle-aged and older adults should prioritize improving static balance ability, as it plays a critical role in maintaining walking capacity and overall mobility.

**CLINICAL RELEVANCE OF AGE- AND SEX-SPECIFIC CHANGES IN ISOKINETIC TORQUE-VELOCITY PROFILES IN FRENCH OLDER ADULTS (65–99 YEARS)**

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INTRODUCTION: The use of force-velocity profiling to assess individual physical capacities has gained considerable interest in geriatric screenings over the past few years (e.g., Alcazar et al., 2023). Recent studies have applied this approach to knee extensor muscles using isokinetic devices (e.g., Piche et al., 2021). However, interpreting isokinetic torque-velocity profiles in older adults remains challenging due to the lack of reference values for key parameters (e.g., theoretical maximal torque [T0] and velocity [V0]). Moreover, the functional significance of these parameters is still unclear.

METHODS: A cross-sectional study was conducted on 959 French older adults (272 men, 687 women) aged 65–99 years. Relative knee extensor peak torque was measured at six isokinetic angular velocities (30°/s, 60°/s, 90°/s, 120°/s, 150°/s, 180°/s). Absolute torque data were expressed relative to participants' body mass, allowing for the identification of isokinetic torque-velocity profiles and extraction of key parameters (e.g., T0, V0). In addition, comfortable walking speed was assessed using a 10m OptoGait walkway, and frailty status was determined.

Participants were stratified by sex and age in 5-year increments, except for the 90–100 age group. Age-related differences in isokinetic parameters were analyzed using one-way ANOVAs separately for men and women. Furthermore, Pearson correlations were performed between walking speed and parameters derived from isokinetic torque-velocity profiles to explore their functional relevance.

RESULTS: Statistical analyses revealed a progressive ≃50% decline in absolute and relative isokinetic torque values in both men and women, starting at 75 years of age. Normalizing torque to body mass reduced disparities between adjacent age groups. While force-related parameters (e.g., T0) showed a significant decline with age, velocity-related parameters (e.g., V0) remained statistically unchanged. Thus, aging, irrespective of sex, altered the force-velocity profile by flattening its shape and reducing force-related values. Additionally, moderate but significant correlations were found between comfortable gait speed and force-related derived from torque-velocity profiles.

CONCLUSION: This study provides updated sex- and age-specific reference values for key isokinetic knee extensor torque-velocity parameters in older adults. Our findings suggest that force-related parameters derived from isokinetic torque-velocity profiles are functionally relevant, whereas velocity-derived parameters might not correspond to physiological indices.

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**ACCELEROMETER-DETERMINED PHYSICAL ACTIVITY, SARCOPENIA AND SARCOPENIC OBESITY IN COMMUNITY-DWELLING OLDER ADULTS**

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INTRODUCTION: Sarcopenia (i.e., the age-related muscle mass and muscle strength loss) can lead to disabling consequences in older adults [5] as well as sarcopenic obesity (i.e., when increased adipose tissue accompanies sarcopenia) that is considered a strong and independent risk factor for frailty, diverse comorbidities and mortality [2, 3]. Evidence suggests that exercise reduces body fat and improve muscle strength and mass in older people in community dwelling settings [1]; however, it is not completely clear if daily physical activity (PA) is beneficial enough to prevent sarcopenia and sarcopenic obesity in this population [4]. The aim of this study was to analyse the cross-sectional associations of daily accelerometer-measured PA with sarcopenia, sarcopenic obesity and their components in older adults.

METHODS: We analysed data from 2628 older adults (65-94 years) from the Seniors-ENRICA-2 cohort study collected from 2015 to 2017. Participants wore the Actigraph GT9X Link accelerometer on their non-dominant wrist for seven consecutive days, removing it only for water-based activities. The average daily acceleration and steps were used as reliable proxies of daily PA. Muscle strength was evaluated using a hand grip dynamometer (HGS) and the sit-to-stand test (StoS). Fat mass (FM%) and skeletal muscle mass adjusted by height (SMM/height) and weight (SMM/weight) to characterize sarcopenia and sarcopenic obesity respectively, were estimated by bioelectrical impedance analysis. Sarcopenia and sarcopenic obesity were treated as continuous variables, standardized to Z-scores. Associations between the study variables were examined using linear regression models adjusted for main covariates.

RESULTS: Daily acceleration in mg and a 1000-step increase showed an inverse association with StoS (s) [unstandardized ß (95%CI): -0.05 (-0.07, -0.03) and -0.08 (-0.11, -0.04) respectively]. Inverse associations were observed between daily acceleration and FM% [unstandardized ß (95%CI) -0.04 (-0.08, -0.00)] and between daily steps and SMM/height (kg/m2) [unstandardized ß (95%CI)-0.03 (-0.06, -0.01)]. No significant associations were observed between PA and HGS, SMM/weight or the sarcopenia and sarcopenic obesity scores.

CONCLUSION: Daily PA, as assessed by accelerometer, was directly associated with muscle strength and inversely with fat mass in older adults. Although PA does not seem to be directly related to sarcopenia and sarcopenic obesity in this population, it is related to some of their components.

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**EXERCISE INTERVENTION ALLEVIATES SARCOPENIA THROUGH OPTIMIZING FUNCTIONAL STATUS OF AUTOPHAGY MEDIATED BY THE MIR-34A/SIRT1/FOXO3A SIGNALING AXIS**

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INTRODUCTION: Sarcopenia significantly compromises the health and quality of life of elderly individuals, while exercise intervention is recognized as an effective approach for the prevention, therapy and rehabilitation of sarcopenia. However, the precision molecular mechanisms for the rehabilitation of sarcopenia upon exercise intervention remain unclear.

METHODS: In the present study, aging population and 24-month-old naturally aging mice subjected to exercise intervention were utilized to systematically explore the role and molecular mechanisms of miR-34a-mediated functional status autophagy in mitigating sarcopenia through RNA-Seq and microRNA screening. Histological analysis, RT-PCR and Western blot were conducted to evaluate atrophic rate of skeletal muscle and corresponding signal pathways associated with

sarcopenia. Moreover, the skeletal muscle-specific miR-34a gene knockout and Atg7 gene knockout mouse models were used to validate the determinant role of miR-34a-mediated functional status of autophagy for sarcopenia upon exercise intervention.

RESULTS: Exercise intervention can effectively delay atrophy of skeletal muscle from both elderly individuals and aged mice, and improve their movement capacity, as shown in the suppression of declined cross-sectional area and strength of skeletal muscle. Meanwhile, miRNA screening revealed miR-34a as the critical miRNA and its corresponding hub gene Sirt1. Moreover, the skeletal muscle-specific miR-34a gene knockout mice revealed similar atrophic rate with the normal mice subjected to exercise intervention, when compared with aged mice with obvious skeletal muscle atrophy without exercise intervention, suggesting that miR-34a suppression exhibited exercise mimetic function. Furthermore, the skeletal muscle-specific Atg7 gene knockout mice upon exercise intervention resulted in the aggravation of skeletal muscle atrophy, suggesting that the functional status of autophagy is the determinant role in aging-induced atrophy of skeletal muscle.

CONCLUSION: Exercise intervention can delay sarcopenia through rescuing aging-induced abnormal miR-34a-mediated autophagy functional status of autophagy. The suppression of miR-34a has the potential to be exercise mimetics. This study may provide a novel research idea and direction for precision and targeted prediction, diagnosis, treatment, and rehabilitation of sarcopenia; evaluation and monitoring of exercise interventions for sarcopenia; the design of precision and targeted interventional strategies for sarcopenia; as well as the development of exercise memetics for sarcopenia. Furthermore, this study also provides a reference for precision and targeted research on active health strategies or the development of exercise mimetics to cope other chronic diseases in the future.

**HANDGRIP STRENGTH HAS DECLINED AMONG PEOPLE FROM MACAO SPECIAL ADMINISTRATIVE REGION: A TEMPORAL TREND ANALYSIS FROM 2001 TO 2020**

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*UNIVERSITY MACAU*

INTRODUCTION: Handgrip strength is a key indicator of overall muscular strength and health, with strong associations with morbidity and mortality (1, 2). While global trends in handgrip strength have been extensively studied, limited research exists on temporal trends within specific populations, particularly in Asian regions. This study examined temporal trends in handgrip strength among individual aged 6 to 69 years in the Macao Special Administrative Region between 2001 and 2020.

METHODS: Repeated cross-sectional data were obtained from a nationally representative sample of 41,685 participants (48% male, 52% female) across five survey years: 2001, 2005, 2010, 2015, and 2020. Temporal trends in means were analysed using general linear models, adjusted for sex, age, height, and weight. Trends in distributional characteristics were described visually and quantified as the ratio of coefficients of variation.

RESULTS: Over the 20-year period, handgrip strength declined significantly by 4.5 kg [effect size (ES) = -0.82)], with males (6.0 kg; ES = -0.91) experiencing a larger decline than females (2.2 kg; ES = -0.49). The greatest declines were observed in children (ES = -0.20), adolescents (ES = -0.55), and young adults (ES = -0.52). Middle-aged adults showed a small improvement (ES = 0.20), while older adults displayed no significant change. Trends in distributional characteristics were negligible.

CONCLUSION: The findings highlight a concerning decline in muscular strength among Macao residents, particularly the younger demographic. These trends are concerning for population health, as low handgrip strength is linked to chronic diseases and mortality. Continuous surveillance and interventions are essential to enhance muscular strength and public health.

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## Oral Presentations

### OP-AP40 Mixed Session - From Powerlifting to HRV

**OPTIMIZING POWERLIFTING PERFORMANCE THROUGH CONTEXTUAL INTERFERENCE TASK CHOICE**

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INTRODUCTION: Contextual interference (CI) refers to the alteration of a training pattern structure by disrupting practice continuum throughout unrelated tasks (1). The interference effect has been shown to enhance motor skill learning by challenging the ability to integrate various motor patterns. A previous study in powerlifters found that the CI group had a greater improvement in 1RM execution technique than control (2). However, in that study CI was generated by dart-

throwing, and the authors explained that using such unrelated task could have been a limit of their CI intervention. For this reason, we decided to address this concern and use a distinct yet pertinent CI secondary task. Our hypothesis was that high CI training would further improve technical execution.

METHODS: Fifteen amateur powerlifters were randomly assigned into two groups (high and low CI) for a six-week powerlifting training program, using the seal row exercise between bench press sets to create interference. Performance was tested as 1RM bench press and max velocity lift (MVL) at baseline (t0 by 1RM test), week two (t1 by MVL), week four (t2 by MVL), week six (t3 by MVL) and week eight (t4 by MVL). Technical execution was evaluated at the same timepoint by means of 13 technical items Likert Scale (used in powerlifting competition).

RESULTS: Two-way repeated measure (TWRM) ANOVA was performed to test whether CI affected two groups' strength at a different rate over time. There was no group x time interaction (F (3.48, 45.28) = [1.407], p = 0.250), nor main effect of group in strength capacity (F (1,13) = [0.057], p=0.816), but a statistically significant main effect of time (F (3.48, 45.28) = [9.397], p < 0.001). Wilcoxon Test with Bonferroni corrections showed significant comparisons respectively at: t0 – t3 (p = 0.025), t0- t4 (p = 0.047), t1-t3 (p = 0.015), t1-t4 (p = 0.035). Technical execution was also tested using TWRM ANOVA. Global technique entailed analyzing all 13 items and resulted in a main effect of time (F (64.832) = [3.045], p < 0.001), with no interaction nor main effect of group. Whereas an item-by-item analysis showed: an effect of group (F (1,13) = [4.675], p = 0.050) for item 1 (dorsal arch); an interaction group x time (F (2.98, 38.76) = [4.118], p = 0.013) for item 2 (scapula adduction).

CONCLUSION: Both groups of powerlifters significantly improved their strength. However, our more pertinent CI task did not induce a greater strength improvement. Our CI task did show some effects on bench-press technical execution, in particular scapula adduction. Further studies should focus on the appropriate choice of CI tasks.

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**DELAYED RECOVERY OF LINEAR AND NON-LINEAR HEART RATE VARIABILITY METRICS AFTER VIGOROUS INTENSITY EXERCISE: A CROSS-SECTIONAL RANDOMIZED CROSS-OVER STUDY**

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INTRODUCTION: The present study explored acute responses of heart rate (HR) variability (HRV) metrics and selected hemodynamic parameters during the recovery phase following two exercise bouts of different intensity. The main focus was to advance current research by incorporating the non-linear index alpha 1 of detrended fluctuation analysis (DFAa1), providing additional qualitative information about autonomic nervous system regulation and reorganization during passive recovery.

METHODS: Recreationally active female (n=13) and male (n=13) participants (age: 24.8±4.0 years, body mass: 68.3±10.8 kg, height: 171.2±9.6 cm, habitual physical activity: 7.3±3.5 h/week) were included in the study. In a first session a graded exercise test was conducted to determine peak HR (HRPEAK) and peak oxygen consumption (VO2PEAK) for exercise intensity prescription. In a second and third session, participants completed an endurance training with moderate intensity (MOD) on a treadmill and an exergaming training with vigorous intensity (VIG) in a randomized and counterbalanced order. Before and up to 45 minutes after the respective exercise sessions, RR-interval and hemodynamic measurements (peripheral systolic, SBP; diastolic blood pressure, DBP; pulse wave velocity, PWV) were conducted (supine body position). Blood lactate concentration (BLC) was measured before and immediately after the exercise bouts.

RESULTS: Internal load analysis of MOD vs. VIG revealed significant differences and appropriate prescription of intensity domains for mean %HRPEAK (~66% vs 86%), %VO2PEAK (~48% vs. 66%), as well as for blood lactate concentration (~1 mmol/l vs. 5 mmol/l). The present data showed significant main effects of time, intensity, and their interaction for all RR-interval outcomes, PWV, and SBP. Higher exercise intensity resulted in greater perturbations during recovery, delayed reorganization, and decreased values of linear HRV metrics. DFAa1 demonstrated a stronger correlated reorganization and overcompensation after VIG, with higher values throughout the evaluated recovery process.

CONCLUSION: The present data suggests that VIG transiently delays the recovery of cardiac parasympathetic activity and the normalization of correlation properties of HR time series. Regarding acute early and delayed recovery processes, higher correlation properties may reflect more order (less complexity) and interaction of involved physiological subsystems, supporting the assumption of increased systemic control to process the demands of higher exercise intensity. The assessment of standardized post-exercise (e.g., submaximal test procedures, benchmark workouts) linear and non-linear HRV metrics could serve as a valuable tool for fine-tuning monitoring processes in endurance athletes. By evaluating recovery states, acute fatigue, and overreaching phenomena it can complement resting physiology analysis. This could potentially help to guide structuring micro-cycle programming tailored to individual cardiac reactivation patterns.

**ASSOCIATION BETWEEN INCREMENTAL AND SUPRAMAXIMAL TEST PERFORMANCE**

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INTRODUCTION: Incremental tests to determine maximal power output and maximal oxygen uptake (VO2max) are often conducted as a prior parameter to determine resistance parameters for subsequent submaximal, maximal and supramaximal exercise tests. Incremental tests rely heavily on aerobic metabolism while supramaximal tests rely heavily on anaerobic metabolism [1,2]. Since oxidative capacity is associated with a predominance of slow-twitch muscle fibers, this may suggest that anaerobic capacity in those with high oxidative capacity might be reduced compared to those with lower aerobic capacity. This study aimed to determine the association between incremental and supramaximal exercise capacity.

METHODS: Seventy-one physically active males (age 26±5 y, body mass 77.9 ± 11.2 kg) performed an incremental cycling test to determine Powermax (Wmax) prior to a familiarization and main visit to perform a cycling capacity test at 110% of Wmax (CCT110%). All cycling was performed on a cycle ergometer (Lode Excalibur, The Netherlands). The incremental test started at a power output of 100 W and increased by 6 W until exhaustion. The last completed stage plus the fraction of time spent in the final non-completed stage multiplied by 6 W was defined as a participant's Wmax. The CCT110% started with a 10-min warm-up at 100 W, followed by 15 s at 80% of individual Wmax, 15 s at 95% Wmax followed by 110% Wmax until exhaustion. Time to exhaustion (TTE) and total work done (TWD) were recorded as the outcome measures. Pearson correlations were performed to evaluate the correlations between Wmax (absolute [aWmax] and relative [rWmax] to body mass) and CCT110% performance (TTE and the TWD). The significance level was set at $p < 0.05$.

RESULTS: There was a positive association between rWmax and TWD ($r = 0.290$: $0.06 < 95\%CI < 0.49$; $p = 0.014$), and between aWmax and TWD ($r = 0.734$: $0.60 < 95\%CI < 0.82$; $p < 0.001$) indicating that a higher Wmax is associated with a greater TWD. However, no significant correlation was found between rWmax and TTE ($r = -0.076$: $-0.30 < 95\%CI < 0.16$; $p = 0.529$), and between aWmax and TTE ($r = 0.220$: $-0.01 < 95\%CI < 0.43$; $p = 0.065$).

CONCLUSION: These data highlight a significant relationship between Wmax and TWD during the CCT110%. This is likely a reflection of the higher power output during the test. However, the absence of a correlation between Wmax and TTE suggests that an individual's ability to sustain effort at 110% Wmax is not reflective of their incremental test performance and challenges the notion that a higher oxidative capacity is inherently linked to reduced anaerobic performance. Future studies should investigate additional metabolic and neuromuscular factors influencing performance at supramaximal intensities.

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**EXPLORING INTER-LIMB ASYMMETRIES RELATIONSHIPS USING ISOKINETIC, JUMP AND CHANGE OF DIRECTION TESTS**

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INTRODUCTION: Inter-limb isokinetic (ISOK) strength asymmetries (ASYM) are commonly used to monitor return to sport process and to prescribe specific training interventions, since ASYM has been suggested to be a risk factor for non-contact related injuries (1). Furthermore, ASYM can also be measured in a more sport specific task, characterized by closed-chain movements and fast muscle action with stretch-shortening cycle such as vertical jump (CMJ). However, little is known about the relationships between ISOK and CMJ ASYM with imbalances measured using a repeated CODs test with different degrees of ASYM in evoked knee extension (KE) strength.

METHODS: A total of 464 young (age:17±1 yrs; weight:74±6 kg; height:180±5cm) and 563 adult professional soccer players (age:25±5 yrs; weight:78±6 kg; height:182±6cm) were involved in the analysis that included 3216 observations of both CMJ and CODs and 177 observations of ISOK. ISOK KE strength ASYM were evaluated at 60°/s and 240°/s, while peak force (PF) ASYM was retained for CMJ. In the CODs test, four intensity levels of continuous shuttle-run over 8m, lasting approximately 30-s each, were performed. Immediately after each level, right and left KE were electrically stimulated in resting isometric conditions to evoke a twitch response, from which peak twitch (PT) torque after the first (PT1) and fourth (PT4) levels as well as the highest absolute PT value (PTmax) were recorded for both sides to evaluate ASYM. All the ASYM were calculated as (stronger-weaker)/stronger*100, with positive (+) or negative sign (-) arbitrarily assigned to indicate respectively when right side or left side were stronger.

Linear Mixed Models were used to investigate the relationships between ISOK and CMJ ASYM with ASYM measured during CODs test. Effect Size was reported as Cohen's d. Significance was set at $p<0.05$.

RESULTS: No significant correlations were found between ASYM in ISOK and CODs both at 60°/s (PT1: $p=0.985$; $d<0.01$; PTmax: $p=0.560$; $d=-0.06$; PT4: $p=0.223$; $d=-0.13$), and 240°/s (PT1: $p=0.886$; $d=0.02$; PTmax: $p=0.237$; $d=-0.13$; PT4: $p=0.069$; $d=-0.19$). No significant correlation was found between ASYM in CMJ and CODs at PT1 ($p=0.837$; $d=0.01$), while trivial negative correlations were found between ASYM in CMJ and CODs at PTmax ($p=0.001$; $d=-0.08$) and PT4 ($p=0.002$; $d=-0.08$).

CONCLUSION: As previously reported in literature (2), the lack of association in the ASYM measured in different tests confirmed the independent nature of imbalances quantified in specific tasks. Namely, the differences might be explained using open vs closed-chain movements, concentric only vs stretch-shortening cycle, low vs high speed motion and simple vs complex multiplanar exercise. Although weak, the inverse relationship between ASYM in the CMJ and CODs suggest a higher level of fatigue of the CMJ's stronger limb during CODs. This may be due to a higher degree of involvement during the CODs. In conclusion, practitioners are encouraged to use multiple tests to detect existing ASYM.

**AN EVALUATION OF THE ACUTE EFFECTS OF DIFFERENT TRAINING LOADS ON NIGHTTIME SLEEP PATTERNS AND AUTONOMIC NERVOUS ACTIVITY IN MILITARY PERSONNEL**

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INTRODUCTION: Sleep is the primary means for the body to recover from fatigue associated with physical training. Insufficient sleep not only impacts the effectiveness of training adaptation but also increases the risk of training injuries and more severe issues such as cardiovascular disease, metabolic disorders, and impaired immune function. Although evidence exists that individuals who regularly engage in high-intensity training often suffer from sleep problems, a definitive causal relationship between training load and insufficient sleep has yet to be established. The aim of this study is to investigate the impact of low, medium, and high training loads on sleep patterns and autonomic nervous activity in military personnel.

METHODS: Sixty healthy, trained military personnel were recruited, all of whom had no significant sleep disorders in the past six months (PSQI $\leq$ 5 points). Participants followed a fixed daily routine throughout the study period. This study monitored training load over 12 consecutive days. Training days were categorized into three groups based on the intensity of training load:Low (<50% HRmax); Medium (50-70% HRmax); High (>70% HRmax). During the training period, daily training loads were monitored using the Firstbeat SPORTS system and session-RPE, recorded using a modified CR-10 scale, after each training session. These values were used for subsequent classification of the participants into different training load groups. Participants were required to wear the GT3X+ accelerometer and the Firstbeat Bodyguard 2 chest strap to monitor their sleep patterns and autonomic nervous system activity during sleep. The sleep patterns and autonomic nervous system activity were then compared between the groups based on the collected data. Data were presented as mean ± standard deviation (Mean ± SD). One-way ANOVA was used to analyze basic participant characteristics and sleep-related indicators. A two-way ANOVA with repeated measures was employed to analyze session-RPE data.

RESULTS: Time in Bed was found to be significantly increased on high training load days when compared to medium training days ($P = 0.002$). When compared to low training load days, Sleep Efficiency significantly decreased after medium and high training load days, with Total Wake After Sleep Onset and the Low/High Frequency ratio significantly increasing ($P < 0.001$; $P = 0.002$).

CONCLUSION: The findings of this study suggest that high training loads might cause individuals to prepare for sleep earlier on the night of training, as indicated by an increase in TIB. Medium and high training loads before sleeping disrupted sleep continuity and increased sleep fragmentation. Future should investigate the potential mechanisms through which training loads influence sympathetic nervous activity and physiological stress, to better understand the biological pathways involved.

## Oral Presentations

### OP-MH32 Epidemiology II

**IMMUNOLOGICAL CHANGES IN THE CIRCULATION OF CANCER PATIENTS IN RESPONSE TO 10- AND 30-MINUTE ACUTE EXERCISE**

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INTRODUCTION: Exercise has many systemic effects. Epidemiological studies suggest that exercise can improve the prognosis of cancer patients, but the mechanisms are largely unknown. In animal models, exercise has been shown to slow tumor growth by enhancing the immunological response to tumors. The aim of this study was to investigate the effects of acute exercise on circulating immune cell and cytokine levels in humans with newly diagnosed lymphoma or breast cancer.

METHODS: Participants were 15 lymphoma patients (mean (SD) age 59 (17) years) and 29 breast cancer patients (57 (10) years) who had not yet started their cancer treatments. The patients performed either a 10-minute or a 30-minute exercise bout on a bicycle ergometer. Venous blood samples were drawn before, during, and 30 minutes after the exercise to analyze immune cell mobilization and cancer-specific cytokines.

RESULTS: Acute exercise increased the number of circulating neutrophils, lymphocytes, monocytes, eosinophils, basophils, CD4+ T cells, T helper (Th) 1 cells, Th2 cells, Th17 cells, regulatory T cells, CD8+ T cells, CD4-CD8- T cells, CD19+ B cells, and

CD56+ natural killer (NK) cells. The mobilization of the immune cells was similar in lymphoma patients during the 10- and 30-minute exercises. In breast cancer patients, the mobilization of CD4+ T cells and NK cells was greater during the 30-minute exercise compared the 10-minute exercise, but other cells mobilized similarly during the exercises. The level of IP-10 increased during exercises in both lymphoma and breast cancer patients. Further, the level of Eotaxin, IL-1β, IL-13, and MIP-1α increased during the exercises and the level of MIP-1β, PDGF-BB, and TNF-α decreased 30 minutes after the exercises in breast cancer patients. The levels of Eotaxin and IP-10 increased more during the 30-minute exercise compared to 10-minute exercise in breast cancer patients.

CONCLUSION: Acute exercise stimulates the mobilization of anti-tumoral and pro-tumoral immune cells, which is fairly similar during and after 10- and 30-minute exercises. Further studies on the effects of exercise on the tumor microenvironment and tumor growth are needed in humans.

**ARE TRAINING VOLUME AND HEART RATE VARIABILITY INJURY RISK FACTORS AMONG CROSSFIT ATHLETES IN SOUTH AFRICA?**

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INTRODUCTION: Reported CrossFit injury rates are high; however, there is a paucity of research on injury risk factors. This study investigated if training volume (TV) and heart rate variability (HRV) are injury risk factors among CrossFit athletes.

METHODS: This observational longitudinal study included 33 non-elite CrossFit athletes who completed weekly online injury surveys and daily TV. Training volume was calculated as session duration multiplied by the rating of perceived exertion (sRPE) and expressed in arbitrary units (AU). The A:C ratio "safe zone" was set at (0.8-1.3 AU). Acute (total TV over seven days) and chronic (three-week rolling average of the acute TV) TV ratios (A:C ratios) were also calculated. Heart rate variability was assessed using the "HRV4Training" mobile application. Injuries were surveyed using the Oslo Sports Trauma Research Centre (OSTRC) Overuse Injury Questionnaire, adapted to collect data on acute injuries.

RESULTS: Mean weekly TV was 1299 ± 675.4 AU, session duration 55.2 ± 32.4 minutes and sRPE 7.4/10. Of the 33 participants, 65.6% of A:C TV was outside the "safe zone." Thirteen participants (40.9%) sustained injuries and 51 injuries were reported, of which 69% were overuse and 31% acute injuries. The shoulder and ankle were the most common sites of acute and overuse injuries. In the univariate model, TV and HRV were not associated with injury risk. Injury rates were higher among participants aged ≥ 51 years, males, commitment levels four to five (medium), and training two to three times per week. Non-competing CrossFit Open participants had a higher overall injury count with a more significant percentage of injuries than competing participants. Injury probability increased from 11% in week one to 31% in week 16, peaking in those with two years of training experience.

CONCLUSION: Training volume (A:C ratios) and HRV were not associated with injury risk. Injury rates were higher among males, participants older than 51 years, with medium training commitment, medium to high frequency of training, and less experience. Although TV and HRV were not identified as individual injury risk factors, they might be related to an increased risk of injury when considered with other variables. Future studies with larger sample sizes should investigate these variables using a multivariate model.

**REALLOCATION OF TIME BETWEEN DEVICE-MEASURED 24-HOUR MOVEMENT BEHAVIOURS AND INCIDENCE OF HIP AND KNEE OSTEOARTHRITIS**

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INTRODUCTION: Osteoarthritis is the second most prevalent musculoskeletal disorder and mostly affects hip and knee joints. Hip and knee osteoarthritis (HKOA) age-standardized prevalence is 3,867 per 100,000 inhabitants in Western Europe. In absence of a curative treatment for HKOA, literature supports that physical activity is one of the major treatment option to reduce pain and increase physical function in these patients. In addition, sedentary behaviour was associated with poor health outcomes, including osteoarthritis. Yet, previous studies that investigated physical activity and sedentary behaviour consequences in this population were based on questionnaires, which are sensitive to recall bias and do not capture the full movement behaviours spectrum. Indeed, these studies did not take into account sleep time nor the compositional nature of movement behaviours. This prospective study aims to investigate the association between objective device-measured movement behaviour and HKOA incidence in participants from the UK Biobank cohort, while addressing the compositional nature of movement behaviours.

METHODS: Data from the UK Biobank cohort were used, which included individuals from England, Scotland and Wales registered in the National Health Service and aged 40-69 years old. Incident HKOA cases were ascertained on hospital inpatient data. Movement behaviour was measured with a wrist-worn triaxial accelerometer used during 7 days. Raw data was processed with the GGIR R-package in order to classify the time spend in different movement behaviours, such as sleep, sedentary behaviour, light physical activity (LIPA) and moderate to vigorous physical activity (MVPA). Compositional cox proportional hazard models with age as the time scale and adjusted for sex were used to investigate how reallocating time from one movement behaviour to another (one-to-one reallocation) was associated with HKOA incidence.

RESULTS: In total, 90,028 participants without KHOA diagnosis in 2013-2015 were included. During a mean follow-up of 8 years, 5,641 participants developed HKOA. Results showed that reallocating 30min/day to MVPA from sedentary behaviour (HR=0.95, 95%CI=0.94-0.96) or LIPA (HR=0.91, 95%CI=0.89-0.93) was associated with lower HKOA incidence. In addition, reallocating 30min/day to sleep from sedentary behaviour (HR=0.96, 95%CI=0.95-0.97) or LIPA (HR=0.92, 95%CI=0.90-0.93) was also associated with lower HKOA incidence.

CONCLUSION: This is the first study using objective measures of physical activity to provide evidence that moderate-to-vigorous physical activity plays a role in HKOA prevention, while accounting for the other movement behaviours. Our results also highlight that increasing sleep duration may help prevent HKOA. This study warrants further studies to elucidate the mechanisms underlying these associations.

**HIGH RISK OF LOW ENERGY AVAILABILITY, EATING DISORDERS AND EXERCISE ADDICTION AMONG PERSONAL TRAINERS IN NORWAY.**

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INTRODUCTION: Personal trainers (PTs) work in an environment where body pressure and striving for well-trained bodies are commonly experienced. Previous research indicates a high prevalence of disordered eating behaviors and exercise addiction (ExAdd) among fitness instructors, but less is known among PTs. PTs are often engaged in extensive exercise and dietary regimens which, intentionally or unintentionally, may increase their risk of low energy availability (LEA), eating disorders (EDs) and ExAdd. These behaviors may all lead to a range of negative health consequences, in addition to reduced physical and mental performance.

Thus, the purposes of this study were firstly to investigate the risk of LEA, EDs and ExAdd among PTs in Norway, and secondly investigate possible associations between the risk of LEA, EDs, and ExAdd in the same sample.

METHODS: In this cross-sectional study, n=49 Norwegian PTs answered a digital questionnaire. Risk of LEA was assessed using the LEA in Females Questionnaire (LEAF-Q) for females and the LEA in Males Questionnaire (LEAM-Q) for males. Risk of EDs was assessed using the Eating Disorder Examination Questionnaire (EDE-Q) and risk of ExAdd using the Exercise Addiction Inventory (EAI).

RESULTS: Totally, 28 females and 21 males (mean age 34.4 ±9.9 years, mean hours weekly exercise 5.8 ±3.5) were included. As much as 40.8% of the participants had increased risk of LEA, 50.0% of the females and 28.6% of the males ($p > 0.05$). Increased risk of EDs was found among 16.3% of the participants, 21.4% of the females and 9.5% of the males ($p = 0.041$). Increased risk of ExAdd was found at 14.2% of the participants, 17.8% of the females and 9.5% of the males ($p < 1.00$). A low association between the risk of LEA and EDs was found among the females ($r = 0.467$, $p = 0.012$), but not among the males ($r = 0.381$; $p = 0.088$), or the total sample combined ($r = 1.86$; $p = 0.173$). Moderate associations were found between EDs and ExAdd among the females ($r = 0.457$; $p = 0.015$) and the total sample (0.385, $p = 0.006$), but not among the males (0.337, $p = 0.135$).

CONCLUSION: This is the first known study investigating LEA, EDs and ExAdd among personal trainers, and our findings indicate that a significant proportion of PTs in Norway are at risk for all three conditions, especially female PTs. Furthermore, the study suggests an association between the risk of LEA and EDs, as well as between EDs and ExAdd among female PTs. Future research including higher sample sizes and objective measures is warranted.

**MOST COMMON INJURY AMONG A FOOTBALL REFEREE COHORT IN FRIULI VENEZIA GIULIA: A CROSS-SECTIONAL STUDY**

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INTRODUCTION: While extensive research exists on injuries in soccer players, limited data is available on injury patterns and management in soccer referees. They may experience distinct injury profiles, with a higher prevalence of overuse injuries compared to players (1, 2, 3). This study aimed to investigate (i) injury incidence, (ii) characteristics and (iii) physiotherapy utilization among Italian football referees.

METHODS: A cross-sectional design study was conducted to investigate injury patterns and management among football referees in the Friuli Venezia-Giulia region, Italy. Data were collected from August 2023 to June 2024 via an online questionnaire administered to referees from various playing levels. Inclusion criteria included refereeing within the region and a minimum of 3 years of refereeing experience. The questionnaire assessed training habits, injury history, treatment modalities and risk factors. Data were collected at three time points: early (Sep-Oct), mid (Jan-Feb), and late season (May-Jun).

RESULTS: This study investigated injury incidence and management in 235 Italian football referees (22±7 years, 88.1% were male) during the 2023-2024 season. An injury incidence of 14.1 per 1000 total hours and 15.9 per 1000 hours of play were observed, with a higher incidence early in the season. Lower limb musculoskeletal injuries, particularly muscle injuries (60.4%) and Achilles' tendinopathies (23.3%) were the most prevalent. Physiotherapy was reported in 77.7% of cases, with active exercise and manual therapy being the most common interventions. The findings highlight the importance of injury prevention strategies and accessible physiotherapy services for football referees, and a low recurrence rate in referees who underwent physiotherapy sessions (22%).

Overuse injuries, such as Achilles' tendinopathy were particularly common, in line with previous literature (2, 4), which also reports high rates of overuse injuries in this population. An injury rate of 15.9 per 1000 hours of play was observed, consistent with previous findings by Wilson et al. (4) reporting (16.4 per 1000 hours).

CONCLUSION: This study suggests a high prevalence of overuse injuries among football referees, aligning with previous research (2,3). As such, these findings emphasize the need for targeted prevention programs to address these injuries, also highlighting the crucial role of physiotherapy in injury management. Future research is recommended to investigate long-term injury trends in referees, comparing data across different populations and regions.

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## Oral Presentations

### OP-MH31 Neurological Diseases

**THE USEFULNESS OF FUNCTIONAL TESTING IN PREDICTING PERIPHERAL NEUROPATHY: A VALUABLE ASSISTANCE FOR MEDICAL DIAGNOSIS?**

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INTRODUCTION: Diabetes and Chronic Kidney Disease (CKD) are two distinct pathologies with a common complication: the peripheral neuropathy (PN) defined as a progressive degeneration of sensory and motor neurons, leading to a wide range of painful symptoms while impairing force production capacity. PN can affect more than 50% of these patients. If PN is not identified in time, it can worsen and may require limb amputation, which is a dramatical burden for patients and society. Among the diagnostic tests available, clinical assessments suffer from time-consuming protocols and a high variability due to human subjectivity, while electrophysiological tests remain difficult-to-access and can only detect large axons only, in the later stages. Our recent findings suggest that the quantification of postural balance and single-leg balance time has been shown to accurately predict diabetes-related PN. Therefore, the aim of the current study is to validated these previous results and to collect diversified physical and balance performance tests in order to determine whether physical performances can accurately predict PN in individuals with diabetes and CKD.

METHODS: The study is prospective and interventional. Inclusions lasted from February to May 2025 in endocrinology and nephrology outpatients' unit. The inclusion criteria require participants to be aged between 60 and 80 years, with a body mass index ≤35 kg.m-2 and a diagnosis of diabetes (type I or II) and/or CKD with a renal function <30 ml/min not in dialysis. The exclusion criteria include disabling cognitive, neurological, musculoskeletal, osteoarticular comorbidities or recent lower limb fractures.

Participants were tested for PN using the validated Michigan Neuropathy Screening Instrument. They performed 6 tests in order to quantify walking abilities, proprioceptive performances and lower-limb muscle force: 10m walk test, timed-up and go, joint position sense, star excursion balance test, balance tests and ankle muscles strength assessment. The predictive equation will be developed using a regression method.

RESULTS: Given the previous results reporting a very high area under the ROC curve (0.960), a high specificity (97.4%) with moderate sensitivity (77.8%) using balance tests compared to clinical diagnosis, the expected results of the present study, focusing even more on proprioceptive capabilities, are promising.

CONCLUSION: Due to the limited availability and reliability of screening tools, many patients live with undiagnosed PN, which can lead to severe consequences in the event of foot injuries or bedsores. Physical performance declines even in the early stages of PN, accompanied by intrinsic foot muscle remodeling and gait impairments. A systematic, low-cost, rapid, and validated method for estimating PN risk would facilitate timely medical referral, thereby reducing the physical and socioeconomic burden of undiagnosed PN in patients with diabetes and CKD.

**RESEARCHING THE MOST EFFECTIVE ROBOTIC OR CONVENTIONAL TRAINING TO IMPROVE WALKING ABILITY IN PEOPLE WITH MULTIPLE SCLEROSIS: PRELIMINARY RESULTS FROM THE PROGR-EX STUDY**

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INTRODUCTION: Gait disorders are frequent in people with multiple sclerosis (PwMS) and the use of robotic devices as exoskeletons has been proposed as effective for gait rehabilitation. Previous studies showed an inverse relationship between the intensity of exercise and the improvement in walking speed. Furthermore, benefits of a low-intensity training have been observed from clinical, muscular and hemodynamic perspective in several neurologic conditions. For this

reason, this study aims to evaluate the effects of a low-intensity RAGT at progressively increasing intensity (LowRAGT) compared to conventional RAGT and OGT in PwMS and moderate to severe walking impairment.

METHODS: In this randomized control trial, we recruited PwMS aged 18-65 years with disability rate defined by an Expanded Disability Status Scale score 6-7. All participants received three weekly treatment sessions of 3 hours each for 4 weeks. In the first two hours of treatment, each patient received a personalized, intensive, and task-specific rehabilitative intervention. During the last hour, subjects received specific gait training according to the assignment group. Subjects allocated to the LowRAGT group received gait rehabilitation on the Lokomat device set at 60% robotic assistance, 50% load suspension, and a speed initially set at 1.0 km/h, with progressive increments of 0.1 km/h at each training session. The working time consisted of bouts of 3 minutes of work alternated by 1 minute of recovery, to be repeated 8 times. Subjects allocated to the RAGT group received gait rehabilitation on the Lokomat device, and the parameters for setting the machine was determined on patients characteristics; the effective duration of treatment was 30 minutes. Subjects allocated to the OGT group received one-hour supervised walking training session. Mobility, walking function, balance, and patient-reported outcomes measures (PROMs) were assessed before and after treatment and at the three-month follow-up.

RESULTS: One-hundred twenty-two PwMS were screened and twenty-four were enrolled (17 female, median age 55 years). All the enrolled subjects safely completed the study protocol. Significative improvements in walking function at post treatment evaluation were recorded only in LowRAGT and OGT group (endurance +30m, speed +0.11m/s, $p<0.05$); mobility (-2.12s, $p<0.05$), and balance (+7pts, $p<0.05$) improved in all three groups, without differences between them. At the three-month follow-up only the PwMS in the LowRAGT group retained improvements in walking endurance (+27m, $p<0.05$), mobility (-1.97s, $p<0.05$), and balance (+6.5pts, $p<0.05$).

CONCLUSION: Mobility and gait improvements represent a realistic and achievable goal in PwMS and severe walking impairment. LowRAGT and OGT are effective in improving walking function, mobility, and balance; the retention of treatment effects at the three-month follow-up makes the LowRAGT a valuable strategy to maintain positive changes over time, also outside the rehabilitation setting.

**ASSOCIATION OF FITNESS TESTING BATTERY, PHYSICAL ACTIVITY, HEALTH-RELATED QUALITY OF LIFE AND THE IMPACT OF THE DISEASE IN WOMEN WITH FIBROMYALGIA**

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*UNIVERSITAT RAMON LLULL - FUNDACIÓ BLANQUERNA*

INTRODUCTION: Fibromyalgia (FM) is a chronic disease characterized by chronic widespread pain, fatigue, unrefreshing sleep, cognitive and gastrointestinal disorders, anxiety, depression, headaches, and dizziness. Such symptoms often incapacitate patients, hindering their ability to engage physical activity (PA), perform daily living tasks and are associated with significant impairment in perceived function and reduced physical performance. This study aimed to assess the association of spontaneous physical activity, performance on a set of functional tests, health-related quality of life (HRQoL) and the impact of the disease in women with FM based on their employment status and in comparison with healthy women.

METHODS: A cross-sectional observational study was carried out, in which 81 women with FM aged 52,06±9,21 years were evaluated. PA level (sedentary, light, moderate, moderate to vigorous, and vigorous) was assessed using triaxial accelerometery. Physical fitness was assessed using the 6-min walk test, handgrip strength and the 8 feet up and go test, and HRQoL domains and the overall disease impact were assessed using the 36-item Short-Form Health Survey (SF36) and Revised Fibromyalgia Impact Questionnaire (FIQR) respectively. An ANOVA analysis was performed to assess group differences.

RESULTS: Participants were divided into four groups: 1) Women with FM who are actively working (n=28); 2) Women with FM on sick leave and claiming disability (n=17); 3) Women with FM with permanent work disability (n=13); and 4) A control group of sedentary women without FM (n=23). Patients with FM showed less PA level and more sedentary time than control women. Moreover, participants with FM performed worse than control women in all the fitness tests studied ($p<0.05$). Regarding groups with FM, handgrip strength test showed significant differences between actively working group and claiming disability group ($p<0.05$). No significant differences were found between FM groups in the 6MWT and 8 feet up and go test.

CONCLUSION: Women with FM show less level of PA, more sedentary time and significantly worse results than healthy women in the 6mwt, handgrip, and 8 feet up and go tests. This battery of tests has been shown to be capable of distinguishing between women with the condition and those without it. Furthermore, strength appears to be the key component for differentiating between subgroups based on employment status, as promising results have been observed between the active group and the group claiming disability.

**ASSESSING THE EFFECTS OF A NOVEL PHYSICAL-COGNITIVE TRAINING ON CHILDREN WITH AUTISM SPECTRUM DISORDER AND IDENTIFICATION OF THEIR NEURAL CORRELATES**

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INTRODUCTION: Autism Spectrum Disorder (ASD) is characterised by deficits in social communication and restricted, repetitive behaviours. The predictive impairment hypothesis suggests that abnormal neural development and dysfunction in

synaptic plasticity in the prefrontal cortex impair anticipatory motor and cognitive processes. Recent evidence indicates that physical activity can enhance social interaction, communication, and self-regulation in individuals with ASD, with dual-task cognitive-motor training (CMDT) proving more effective than exercise alone.

METHODS: This study evaluated the efficacy of a 12-week CMDT programme in enhancing anticipatory mechanisms and normalising prefrontal activity in children with ASD compared to Typically Developing Children (TDC). We hypothesised that children with ASD would exhibit suppressed anticipatory brain activity in the prefrontal cortex relative to their TD peers. Twenty children (10 with ASD, 10 TD), aged 9 to 14 years, participated. Pre- and post-intervention assessments included electrophysiological recordings via EEG and motor performance evaluations using the Movement Assessment Battery for Children–Second Edition (M-ABC2). EEG analyses focused on event-related potentials (ERPs): the P3 component, associated with cognitive resource allocation and stimulus evaluation, and the Bereitschaftspotential (BP), linked to motor preparation. Data were analysed using repeated-measures ANOVA.

RESULTS: The analysis of variance revealed significant effects of both group (ASD vs. TD) and time (pre- vs. post-intervention) on response times, as well as a significant interaction between these factors ($p < 0.05$). Specifically, TD children exhibited faster response times, while the ASD group demonstrated a marked post-intervention improvement that effectively eliminated the significant pre-test difference between groups.

In addition, the M-ABC2 scores demonstrated significant post-training improvements in motor coordination and dynamic balance ($p = 0.02$), with the ASD groups performance approaching that of their TD peers.

CONCLUSION: These findings support the efficacy of CMDT in enhancing sensorimotor integration in children with ASD by improving anticipatory processing and cognitive-motor performance. This work contributes to the development of evidence-based clinical and rehabilitative interventions aimed at improving socialisation and autonomy in daily life.

## Oral Presentations

### OP-MH10 Sports Medicine and Orthopedics III

**MUSCULAR FATIGUE AND PERCEIVED PHYSICAL EXERTION IN ESPORTS ATHLETES – A QUASI-EXPERIMENTAL TRIAL**

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INTRODUCTION: Muscular fatigue is a key determinant of health, performance, and safety in both daily activities and sports. Esports or competitive gaming involve sedentary behavior with monotonous postures and repetitive upper extremity movements, which may elevate the risk of muscular fatigue. Consequently, sustained engagement in competitive gaming can lead to increased muscular fatigue and perceived exertion, potentially contributing to long-term musculoskeletal disorders (MSD). This study examines the effects of competitive gaming on muscular fatigue and perceived exertion, addressing a critical gap in the literature.

METHODS: Thirty-two healthy male esports athletes (23.8 ± 3.4 years) participated in two competitive video gaming sessions lasting 90-120 minutes each, interrupted by a 10-minute passive sedentary break. Surface electromyograpic (EMG) data of upper trapezius and wrist extensors were recorded for both body sides during video gaming sessions. The median frequency (MDF) and root mean square (RMS) were used to quantify muscular fatigue. RMS was normalized with the baseline average of the first 2 min of recording. Additionally, repeated measures of perceived physical exertion (Borg Category-Ratio-10 scale) were recorded before and after each video game session (T0-T3). One-way repeated measures ANOVA with Bonferroni correction for post-hoc comparisons was used for statistical analysis.

RESULTS: The Borg scale increased significantly over time (T0: 1.0 ± 0.95, T3: 3.0 ± 1.63; $F(2.23, 69.2) = 41.23$, $p < 0.001$). Post-hoc analysis confirmed a significant increase after both the first and second gaming sessions ($p < 0.001$), followed by a reduction after the sedentary break ($p < 0.001$). MDF in wrist extensors decreased significantly over time ($p < 0.001$), with reductions observed in both the left (99.24 ± 20.10 Hz to 95.59 ± 20.40 Hz, $F(3, 90) = 9.18$) and right side (97.86 ± 15.47 Hz to 94.60 ± 15.42 Hz, $F(1.64, 45.82) = 10.83$). Similarly, RMS amplitude declined significantly ($p < 0.001$) in both wrist extensors (Left: 103.28 ± 14.70% to 90.78 ± 26.63%, $F(2.57, 74.48) = 8.21$; Right: 103.28 ± 7.52% to 84.50 ± 14.80%, $F(1.71, 47.96) = 24.06$). For the upper trapezius, only the MDF of the right side showed a significant decrease over time (77.31 ± 22.98 Hz to 72.52 ± 22.96 Hz, $F(1.79, 53.65) = 4.81$, $p = 0.015$). No significant changes were observed in any EMG parameter after the sedentary break.

CONCLUSION: The findings indicate a progressive increase in physical demand in esports over time, especially following consecutive gaming sessions. Only the Borg scale showed a reduction after a sedentary break. The lack of neuromuscular recovery post-break suggests a risk of cumulative muscular fatigue. Without compensatory physical activity, these repetitive loads may increase the risk of MSD. Therefore, the results indicate the necessity of preventive holistic training approaches and regular active breaks in esports.

**AN INVESTIGATION INTO THE INFLUENCE OF MENTAL HEALTH ON SCAT6 BASELINE SYMPTOMS IN FEMALE RUGBY UNION PLAYERS**

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INTRODUCTION: Concussion-related symptoms often overlap with those associated with mental health conditions, potentially posing challenges for health care professionals. This relationship may mean clinicians struggle to distinguish between symptoms related to mental health and those emerging post-concussion. This study aims to investigate whether females with a mental health diagnosis exhibit increased baseline symptom count and severity compared to those without a diagnosis.

METHODS: Sixty female university-level rugby union players completed a baseline (pre/early-season) assessment utilising the Sport Concussion Assessment Tool, 6th Ed (SCAT6). The present study focused on the symptom checklist which measures the presence and severity of 22 symptoms, with each symptom rated on a scale from 0 (none) to 6 (severe). Individual ratings are combined to produce an overall symptom severity score (/132) and total symptom count (/22). Participants also provided information about their mental health background, specifically, whether they had received a diagnosis for anxiety, depression or any psychological disorder. This information was used to divide participants into two groups: a control group (n = 51) and a mental health group (n = 9). Mean symptom count and severity were calculated for each group and individual symptom, which were then compared between groups.

RESULTS: The mental health group exhibited a greater symptom severity score (28.8 vs. 9.8) and increased total symptom count (12.3 vs. 6.2) relative to the control group. Severity scores were elevated in all symptoms of the mental health group with eleven symptoms rated as severe. 19.7% of participants diagnosed with a psychological disorder reported at least one symptom rated three or above, in contrast to only 4.3% of the control group. The most pronounced differences in severity were observed in nervousness or anxiety (2.8 vs. 1.2), trouble falling asleep (2.1 vs. 0.6), irritability (2.1 vs. 0.6), and neck pain (1.56 vs. 0.29). Furthermore, 21 of the 22 symptoms were reported more frequently in participants with a mental health condition, with the largest increases observed in neck pain (+47.1%), sensitivity to light (+45.1%), and trouble falling asleep (+44.4%).

CONCLUSION: These findings demonstrate that individuals with mental health disorders experience greater symptom severity and frequency at baseline. This indicates that mental health conditions may influence SCAT6 symptoms, potentially complicating concussion evaluation and treatment within this population. Thus, Health Care Professionals may be setting unrealistic standards post-concussion when comparing individuals with mental health issues to normative data. Finally, this research further highlights the importance of baseline assessments for athletes when diagnosing concussions.

**EXPLORING SPORT SCIENCE AND MEDICINE RESEARCH IN HIGHLY TRAINED, ELITE AND WORLD-CLASS FEMALE ATHLETES: A SCOPING REVIEW**

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INTRODUCTION: The paucity of sex-specific data to optimise female athletes health and performance, can be attributed to: (i) sex-based bias in sport science and medicine (SSM) research; (ii) a translational gap between research and practice; and (iii) the underrepresentation of high-performing athletes in SSM literature. While publication volume on female athletes is increasing, a structured inclusive approach is needed. This review will identify demographics, and female-specific SSM research themes, creating a contemporary evidence map whilst surfacing future research needs for highly trained, elite and world-class female athletes.

METHODS: A systematic search was conducted in PubMed, Scopus, SPORTDiscus, Web of Science (last search, June 2024), and BASE for grey literature, to identify studies involving highly trained (Tier 3), elite (Tier 4), or world-class (Tier 5) female athletes (including retired within 10 years; >16 years old), and/or female athlete support staff. Title, abstract, full-text screening and data extraction were conducted by a total of 10 reviewers. Descriptive statistics (publication counts with percentages) for demographics, SSM (general SSM fields) and female-specific (prevalent topics in current female athlete health literature) research themes are presented.

RESULTS: From 12,579 records, 3,566 publications were eligible, including 2,990 (84%) original and 576 (16%) non-original research (e.g., literature reviews, recommendations) spanning 54 years. Among original research, 2,968 (99%) focused on athletes [Tier 3: n=1,158 (39%); Tier 4, n=1,743 (59%); Tier 5, n=379 (13%)], with 128 (4%) on athletes with disabilities, 54 (1.8%) on retired athletes, and 37 (1.2%) on master athletes. The most researched SSM themes were physiology (994, 33%), performance analysis (872, 29%), and injury (762, 25%), while equipment (79, 3%), law (17, 1%) and business (8, 0.3%) were the least common. The most researched female-specific SSM themes were musculoskeletal health (358, 23%), mental health (228, 16%), and cardiovascular health (175, 12%), while pelvic floor health (24, 1.7%), breast health (11, 0.8%), and menopause (2, 0.1%) were the least common. In 2023 specifically, the top SSM themes remained the same, while the most researched female-specific themes were mental health (36, 24%), musculoskeletal health (30, 20%), and menstrual (& other gynaecological) health (21, 14%).

CONCLUSION: Although representation in SSM research on female athletes appears low across competition level (i.e., world-class), career stage (i.e., retired and master), and those with disabilities, these subpopulations are proportionally small and challenging to access. However, we should still strive to access them appropriately, given their specific needs. Furthermore, while certain female-specific themes (e.g., menstrual health) are not represented among overall top themes in this review, they are within 2023, suggesting a shift towards recognising the importance of contemporary female-specific topics.

**COMBATING GENDERED MICROAGGRESSIONS EXPERIENCED BY FEMALE PHYSIOTHERAPISTS WORKING IN MEN'S PROFESSIONAL SPORT**

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INTRODUCTION: While graduates of physiotherapy programs globally are predominately female, the number working in professional sport is considerably low [1]. Advances in gender equality in sport have been made, but it is still known that females in the sport workforce experience regular gendered microaggressions and discrimination [2]. Despite these barriers being well known, few concrete strategies have been suggested to address these. Therefore, the purpose of this study was to better understand the nuances for female physiotherapists working in professional sport and allow those who are a voice to better support the inclusion of more females into this domain.

METHODS: Applying a phenomenological research design, 12 female physiotherapists who work in professional men's rugby union (average 5.3 years) were interviewed. A semi-structured interview guide, developed from literature on the experiences of females working in sport [2], [3], was utilised, to explore the barriers faced and to encourage discussion of strategies to increase the recruitment and retainment of female physiotherapists in the professional sport.

RESULTS: Initiatives suggested by the physiotherapists include offering more flexibility to better work-life balance, creating family-friendly support structures and robust back-to-work processes, and ensuring that travel, uniform, and facilities are accessible and intended for all. Physiotherapists identified that having a supportive mentor alleviated the challenge of being the only female in the workforce and played a crucial role in enabling them to stay in their roles.

CONCLUSION: Female physiotherapists in professional men's sport continue to experience gendered microaggressions and structural barriers despite broader efforts towards gender equity. These challenges often discourage long-term retention in the field. To promote gender equity in the sports workforce, it is vital for organisations to take decisive action toward increasing female representation and dismantling gendered structures. Policy frameworks and equity position statements need firmer enforcement, so initiatives are not just symbolic but lead to change. Addressing these issues requires targeted policy reforms, mentorship programmes, and organisational support systems to foster inclusivity and equity. Transparent recruitment processes and increased visibility of women in these roles can challenge traditional norms and inspire greater female representation in men's professional sports.

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**THE EVALUATION OF NEUROCOGNITIVE FUNCTION AND MOTOR ABILITIES OF PROFESSIONAL FORMER SOCCER PLAYERS**

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*HEALT SCIENCES*

INTRODUCTION: Soccer is a popular sport globally, with more than 265 million people, amateur or professional. Soccer is the only contract sport in the world where the ball is headed intentionally to control or direct the ball. It is thought that heading into soccer may cause acute traumatic brain injuries, concussion, or neurodegenerative dysfunction experienced by soccer players, negatively affecting the players in sociological, psychological, and physiological terms. This study aims to compare former players neurocognitive and motor skills with those of licensed former swimmers.

METHODS: A total of 47 participants, n=27 soccer players and n=20 swimmers, aged between 45-65 years, were included in this study. The anthropometric values of the soccer players were age 54,7±7,33, height 176 ± 5,2, body mass: 82,5 ± 7,19, body mass index: 26,58±1,95, and body fat percentage 23,6±3,85 the anthropometric values of swimmers were age: 54,52 ± 6,44, height: 179±4,6, Body mass:87,32±4,5, body mass index:27,25 ± 1,45 Body fat percentage: 25,55±2,98. In this study, Stroop, an immediate memory task delayed memory task, was used to evaluate participants cognitive function. Biodex SD Balance System (Biodex, Shirley NY) device was used to measure the balance ability of the participants. Descriptive anthropometric and demographic data statistics were calculated as mean value and percentage distribution. Data normality distribution was determined by the Shapiro-Wilk statistical method. An independent sample t-test was applied to determine the difference between soccer players and swimmers. All statistical analyses were carried out with the SPSS 23,0 package program. In all statistical analyses, the alpha value was considered to be 0.05.

RESULTS: A statistically significant difference was found between the soccer player (893.269 ± 163.841) and the swimmer (767.239 ± 114.518) groups according to the comparison of the mean reaction time values of the Stroop test (p = 0.005).

According to the comparison of control reaction time values, a statistically significant difference was found between the football player (856,610 ± 151,811) and swimmer (752,244 ± 105,597) groups (p = 0.013)

CONCLUSION: As a result of this study, the Stroop test compatible trial, incompatible trial, and control reaction scores of the soccer players were statistically significantly higher than the swimmers. A statistically significant difference was found between players immediate memory task expression on commission error and swimmers immediate memory task expression on commission error. There was no statistically significant difference between other parameters in an immediate and delayed memory task. In line with these results, it is seen that the executive functional functions of soccer players differ from those of swimmers of similar age. Also, according to the results of the instant memory task test, the soccer players impulsivity control was greater than that of the swimmers.

# Oral Presentations

## OP-SH25 Anxiety and Stress

### PRE-SEASON ASSESSMENT OF SLEEP & SELECTED PSYCHOLOGICAL PARAMETERS IN UNIVERSITY ATHLETES

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INTRODUCTION: Pre-season training is a time of physical and psychological transition for university athletes. While pre-season physical performance assessments are germane, health assessments related to sleep/sleep behaviours and psychological parameters are understudied. We assessed sleep (i.e. quantity, quality and hygiene), stress and mood in university athletes during pre-season.

METHODS: University athletes (n=159; 55% male; 20.6±2.3 years) completed an online survey (August-September 2023) including the following validated questionnaires: Athlete Sleep Screening Questionnaire [1], Athlete Sleep Behaviour Questionnaire [2], Perceived Stress Scale [3] and Brunel Mood Scale [4]. Data is mean±SD ($p<0.05$).

RESULTS: Average sleep duration was 7.6±0.9 hours (67.1% reported ≥7 hours) with 58.1% 'somewhat' to 'very satisfied' with sleep quality. Despite 85.5% exhibiting poor sleep behaviours, 67.7% reported 'none' to 'mild' sleep difficulty. 77.5% of athletes reported 'moderate' psychological stress. The highest mood dimensions were 'vigour' (e.g. active, alert) (7.7±3.5) and 'fatigue' (e.g. tired, worn out) (6.9±3.6). Sleep difficulty was associated with 'confusion' (e.g. mixed up, uncertain) (r=0.412) and poor sleep behaviours (r=0.389). Stress was associated with 'confusion' (r=0.548), sleep difficulty (r=0.381), and poor sleep behaviours (r=0.316). Females reported poorer sleep behaviours, higher stress, less 'vigour' and greater 'fatigue' than males. First-year athletes reported greater 'confusion' versus returning athletes which was associated with greater stress (r=0.730 vs. r=0.496) and sleep difficulty (r=0.491 vs. r=0.392).

CONCLUSION: Pre-season is opportune to address sub-optimal sleep behaviours and psychological health of university athletes. Sleep education is warranted, particularly for females, to develop optimal sleep hygiene before the academic/competitive season, given sleep's association with stress. While increased 'vigour' and 'fatigue' vis-à-vis physical training in pre-season is expected, the relationship between 'confusion', psychological stress, and sleep difficulty, particularly for first-year athletes, warrants additional consideration by athlete support personnel.

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### EFFECTS OF DIVERSE HIGH-INTENSITY INTERVAL TRAINING PROTOCOLS ON INHIBITION FUNCTION IN ADULTS WITH MILD ANXIETY

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INTRODUCTION: Anxiety disorders, a common mental health issue, are increasingly prevalent and significantly impact cognitive functions. Traditional treatments primarily address emotional symptoms, often neglecting cognitive deficits. Recent evidence suggests that high-intensity interval training (HIIT) can enhance cognitive function, but its effects on inhibitory function under negative emotional states are still unclear. This study explores how different HIIT protocols influence inhibitory function in individuals with mild anxiety.

METHODS: This study recruited 45 participants aged 18–24 years, randomly assigned to three groups (A, B, and C; 15 each). Inclusion criteria included: State-Trait Anxiety Inventory (STAI) ≥50, Self-Rating Anxiety Scale (SAS) 40–48, International Physical Activity Questionnaire (IPAQ) <600 MET-min/week, no exercise contraindications, and no use of medica-

tions that affect metabolism or the nervous system in the past six months. Groups A and B performed HIIT at 85–90% and 90–95% of maximum heart rate, respectively, with 1 minute of exercise followed by 1 or 2 minutes of rest and repeated 10 times. Group C received neutral health education. Pre- and post-intervention assessments included the Stroop Task, Event-Related Potentials (ERP) data, and salivary cortisol levels.

RESULTS: Exercise intensity and interval ratio did not significantly affect the accuracy of the Stroop Task ($P > 0.05$), but their interaction was significant ($P < 0.05$). At a 1:1 interval ratio, higher-load exercise improved accuracy more than lower-load exercise ($P < 0.05$). For reaction time, the interval ratio had a significant effect ($P < 0.05$), with both 1:1 and 1:2 intervals improving reaction time compared to baseline ($P < 0.05$). ERP data showed no significant main effects for P300 amplitude at Fz ($P > 0.05$), but significant interaction effects at Cz and Pz. At Cz and Pz, higher load with a 1:1 interval reduced P300 amplitude compared to baseline and lower-load exercise ($P < 0.05$). Cortisol levels significantly increased only in the higher-load, 1:1 interval group ($P < 0.05$).

Discussion: The study explores that the effectiveness of HIIT in improving inhibitory function among individuals with anxiety is influenced by both exercise intensity and interval ratio. Specifically, a 1:1 interval ratio combined with higher exercise intensity (90-95% HRmax) significantly enhanced behavioral performance in inhibitory function but simultaneously reduced neural efficiency. This suggests that while such HIIT protocols can improve cognitive performance, they may also impose greater physiological stress. Therefore, when designing HIIT interventions for individuals with anxiety, it is crucial to balance behavioral gains with neural workload and physiological stress. Future research should focus on identifying optimal HIIT protocols that maximize cognitive benefits while minimizing negative impacts on neural efficiency and stress levels.

**CARDIORESPIRATORY FITNESS MODERATES STUDENTS PHYSIOLOGICAL AND PSYCHOLOGICAL REACTIONS DURING A MATHS EXAM**

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Objectives: The influence of physical activity and fitness on physiological and psychological stress reactivity has long been the subject of scientific research. Under laboratory conditions, research has shown that fitness can leads to a blunted stress reaction. In this study, we examined whether cardiorespiratory fitness is effective as a moderator of the physiological and psychological stress reactivity in adolescents during a real-life stress situation (maths exam relevant for the end-of-the year results).

Methods: The study was conducted with 79 students ($M = 14.19 \pm 0.79$ years; 49.4 % girls) from grade 8 and 9. Physiological stress reaction was measured via heart rate variability during a maths exam and a normal maths lesson (baseline). Low frequency (LF) was used as main indicator. A psychological questionnaire was used to assess current mood and anxiety. Cardiorespiratory fitness was assessed with the 20-meter Shuttle run test. Participants were categorized into groups with low vs. high fitness via median split (separately for boys and girls). Stress reactivity was compared via rANOVAs with test-condition as a within-subject factor (baseline vs. stress) and group (low vs. high fitness) as a between-subject factor.

Results: Statistically significant condition by group interaction effects were found for heart rate variability (LF), mood and anxiety. Whereas the fitness groups did not significantly differ from each other during baseline, the high fit group had lower LF scores, more positive mood and lower anxiety levels during the stress condition.

Conclusion: Cardiorespiratory fitness acts as a moderator of the physiological and psychological stress reactivity also under real life conditions. These findings show that students with higher cardiorespiratory fitness are better equipped to cope with everyday problems. Improving fitness is one possible pathway how young people can be empowered to better master the everyday challenges. Programs are needed that meet young people's needs and efficiently improve their cardiorespiratory fitness.

**EFFECTS OF A SINGLE BWM-T SESSION ON STRESS RESPONSE HRV IN AMATEUR ATHLETES DURING A STRESSFUL TASK: A PILOT STUDY**

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*UNISA*

The management of stress and anxiety is vital for athletic performance and well-being. Techniques modulating autonomic nervous system responses, such as biofeedback and controlled breathing, effectively reduce anxiety and enhance coping skills (Lehrer et al., 2020; Sakakibara et al., 2022). The Brain Wave Modulation Technique (BWM-T), a mind-body intervention integrating relaxation, visualization, and controlled breathing, aims to reduce stress and promote psychological well-being. However, its application in sports contexts remains underexplored.

This pilot study investigates the effects of a single BWM-T session on physiological and psychological stress responses in amateur athletes during a cognitive stress task. Eighty amateur athletes were randomized to either a BWM-T group or a control group (passive relaxation). Heart rate variability (HRV), perceived stress (PSS), and coping abilities (CISS) were measured at baseline (T0), post-intervention (T1), and after a mental arithmetic task (T2, T3). The intervention consisted of a 16-minute BWM-T session, while controls experienced 16 minutes of passive relaxation.

Preliminary results indicate that the BWM-T group exhibited significantly higher HRV during the stress task, suggesting improved autonomic regulation. Additionally, BWM-T participants reported lower perceived stress and better coping abilities than controls.

This study highlights that a single BWM-T session can effectively reduce physiological and psychological stress responses in amateur athletes, underscoring its potential for enhancing performance and well-being in sports settings.

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**QUALITY OF LIFE, TIME USE AND PERCEIVED SOCIAL PRESSURE AMONG STUDENT-ATHLETES AND GENERAL POPULATION STUDENTS: A COMPARISON OF NORWEGIAN LOWER SECONDARY SCHOOLS**

BJØRNDAL, C., BAKKEN, A., AUNE, L.S., SAARINEN, M.

*NORWEGIAN SCHOOL OF SPORT SCIENCES*

This study assesses differences in quality of life, time use, and perceived social pressure between student-athletes in lower secondary sport schools and general population students in ordinary lower secondary schools. We conducted our analysis using a sample of 1,353 students from 16 sport schools, along with data from the national Ungdata Survey. The Ungdata Survey is a national data collection system in Norway designed to provide a representative sample for cross-sectional surveys of adolescents aged 13 to 19. We analysed responses from both student-athletes and general population students from non-sport schools using general linear models, controlling for age, gender, and socioeconomic status. Our findings indicate that student-athletes experience a higher overall quality of life compared to general population students. This trend was reflected in higher reported satisfaction levels in multiple life domains, including relationships with parents and friends, school environment, and overall health. Despite these positive indicators, our analysis also revealed that student-athletes faced increased pressures specifically related to their sports performance. Conversely, they reported experiencing less pressure regarding their academic performance and physical appearance compared to their peers in general population schools. Differences in time use between the two groups were relatively small. General population students were more engaged in non-sporting organised activities, while student-athletes allocated significantly more time to sports and exercise activities. Despite the rigorous demands of their athletic commitments, student-athletes did not report lower levels of social interaction compared to general population students. In fact, male student-athletes reported spending more time with friends than their male peers in non-sport schools, whereas female student-athletes reported slightly less time with friends compared to female general population students. Notable gender differences emerged throughout our analysis. Female student-athletes reported lower levels of appearance-related and academic pressure compared to female general population students, suggesting that sport school environments may provide a protective buffer against certain societal pressures. Additionally, the benefits of sport school attendance in terms of overall life satisfaction appeared to be greater for female student-athletes than for their male counterparts. Our findings highlight the potential role of sport schools as a complementary component of the broader secondary education system. However, given that access to sport schools is often influenced by socioeconomic background, further research is needed to examine the long-term impact of these schools on different social groups. Addressing barriers to access, particularly for students from lower socioeconomic backgrounds, should be a priority for policymakers and educational institutions.

## Oral Presentations

### OP-SH09 Sociology IV - Ageing

**THE ROLE OF SPORT IN EMBODIED SOCIALIZATION OF YOUTH IN A DEPOPULATION-AFFECTED RURAL ENVIRONMENT**

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Background

The development of youths physical activity practices occurs through a complex interplay of social, cultural, and geographical factors. Previous research highlights the dual role of sport in rural communities, where it fosters social belonging and identity but also reinforces exclusion and traditional ideals.

Aim

This study examines how embodied socialization occurs among youth in a depopulation-affected rural environment in Sweden. Research questions were: What type of sporting body is shaped by growing up in a rural environment? Which activities contribute to the creation of this body?

Method:

This study draws on Elders socialization theory, where a places physical and sociocultural traits, along with parents, institutions, and socio-historical events, shape life trajectories. Embodied socialization was, thus, examined in relation to the areas social environment as well as rural culture, traditions, and economic decline.

A qualitative approach was used, employing retrospective biographical interviews with six young individuals (girls=3). Each participant was interviewed individually on two occasions to allow for in-depth analysis. Data were analyzed using reflexive thematic analysis.

RESULTS: Three themes were produced from the analysis: 'Physical activities run in the family' highlights how generationally transmitted activities shape young peoples understanding of desirable physical activity and bodies. The theme "Traditions in social institutions" illustrates how schools and local community organizations reproduce preferences for nature-based activities such as hunting, fishing, cross-country skiing, biathlon, alpine skiing, and running. The third theme, "New sports – same ideals", reveals how modern fitness activities, such as gym training, becoming more popular, align with traditional ideals of a healthy, strong, and resilient body, making them accepted within the local community.

Discussion: The results illustrate how family and community institutions reinforce traditional bodily ideals, with the rural environment and nature playing a central role. This particular rural area is oriented towards forestry, hunting, and fishing rather than farming, which is reflected in the types of bodily ideals that emerge in the narratives of young people. Nostalgia is also evident in the older generation's efforts to encourage youth to continue with traditional sports such as biathlon, ski jumping, and cross-country skiing. This nostalgia, which sustains traditional values in the shaping of bodies, can be understood as a response to societal restructuring and the decline of rural communities. A potential consequence is the limitation of opportunities for youth to explore new movement identities beyond traditionally valued physical activities.

**CHARTING PHYSICAL ACTIVITY ACROSS DEVELOPMENT WITH TRAJECTORIES OF SPORT AND ACTIVE LEISURE FROM TODDLERHOOD TO EMERGING ADULTHOOD**

HARANDIAN, K., PRIVITERA, M., CORREALE, L., PAGANI, L.S.

*UNIVERSITY OF MONTREAL*

Background. Technology is increasingly omnipresent in our lives. Consequently, youth is currently challenged by sedentariness. Physical activity may counter today's effortlessness lifestyle. This is particularly important for development from early childhood to adolescence. Active leisure guided by parents, coaches, and instructors likely contributes to cognitive, social, emotional, and motor skill development and active lifestyle habits. This is reinforced through social modeling and structured activities. To date, there is no documentation that examines distinct pathways of active leisure and sport participation from toddlerhood to emerging adulthood. Using a longitudinal birth cohort of millennial boys and girls, we generate trajectories of sport and physical activity participation in early childhood, middle childhood, and adolescence.

Methods. Participants from the Quebec Longitudinal Study of Child Development (QLSCD) with complete participation data at trajectory start-point ages (2.5, 6, and 12 years) resulted 1995 early childhood participants (50.4% boys), 1492 middle childhood participants (49.2% boys), and 1344 participants in adolescence (47.8% boys). Parents reported on the frequency at which they participated in sport, active hobbies/games with their child from ages 2.5 to 5 years as well as the frequency at which their child participated in organized sport from ages 6 to 10 years. Youth self-reported their level of leisure physical activity (frequency, duration, and perceived intensity) from ages 12 to 17 years. Sex-stratified growth mixture modelling analyses identified series of trajectories: active family leisure in early childhood, extracurricular sport in middle childhood, and active leisure in adolescence.

Results. Longitudinal latent class growth analyses identified trajectories at three childhood periods from early childhood to emerging adulthood. Two early childhood trajectories: low-decreasing trajectory (70% boys, 72% girls) and high-decreasing trajectory (30% boys, 28% girls). Two middle childhood trajectories: for boys, low trajectory (64%) and moderate-increasing trajectory (36%) and for girls, low-increasing trajectory (33%) and high-increasing trajectory (67%). Several trajectories were distinguished in adolescence. For boys, three trajectories were identified: consistently-low (44%), high-decreasing (14%), and high-increasing (42%). For girls, two trajectories were identified: low-decreasing (68.5%) and high-increasing (31.5%).

Conclusion. Throughout childhood and adolescence, active leisure takes many forms and changes over time. Adults provide guidance and opportunities for enriched development and lifestyle habits. As a first, this study highlights the distinct trajectories of sport and physical activity participation of boys and girls at important developmental periods. The findings inform parents, educators, and policy-makers about trends and critical turning points for physical activity participation.

**RESEARCH ON THE DEVELOPMENT OF CHINAS**

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INTRODUCTION: As the global aging society becomes the norm, a potential market foundation is laid for the silver economy. "Sports, Health, and Wellness" (SHW), as an important component driving the development of the silver economy, plays a significant role in enhancing the physical fitness and improving the quality of life of the elderly. However, the development of the SHW pattern in China currently faces such as insufficient demand, homogeneous supply and low efficiency of industrial integration, making it difficult to meet the increasingly diversified needs of the elderly population in China. This study aims to explore the optimization paths of the SHW pattern under the silver economy, enrich the theoretical framework of the SHW pattern.

METHODS: Employed mixed-methods approach. (1) By collecting and analyzing literature, policy documents, and expert interpretations from international sources, summarized China's current status and future development paths of the SHW

pattern. (2) Fifteen elderly individuals from Anhui and Shanghai were interviewed to investigate their awareness and needs regarding the SHW pattern across different provinces and cities. (3) Two sports towns in Anhui and Shanghai were examined on-site to understand the actual operation, service content, and satisfaction levels of the elderly with the SHW pattern. Through quantitative data analysis, the study compares the health data, participation frequency in SHW activities, and consumption patterns of the elderly in the two regions, revealing the developmental differences of the SHW model in different areas and the actual needs of the elderly.

RESULTS: (1) Opportunities: In recent years, driven by improved economic and social conditions, policy dividends, and a shift in social attitudes, the awareness of fitness for all has been increasingly awakened in China, unleashing the potential for the development of the SHW pattern. (2) Challenges: Due to the relatively late development of the SHW pattern in China, there are still issues to be addressed, such as incomplete policy formulation, homogeneous service products, and insufficient public awareness. Additionally, the SHW pattern has not yet been widely promoted in China, and the demand from the public, especially the elderly, needs to be further stimulated. (3) Pathways: The development of the SHW pattern in China requires a multi-dimensional approach, starting from the top-level design, market cultivation, technological innovation, and talent supply. Strengthening health education for the elderly is also essential to fundamentally address these issues and unleash the potential of the SHW pattern in the silver economy to cope with aging.

CONCLUSION: The development of the SHW pattern in China should adhere to the people-centered development philosophy. By constructing a new model and pattern for SHW, creating a more fulfilling and happy life for the elderly.

**REBUILDING DEMOGRAPHIC DIVIDEND : A STUDY ON SPORTS PARTICIPATING SOCIAL GOVERNANCE OF POPULATION ISSUES IN CHINA**

SUN, Z., XIA, M.

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INTRODUCTION: China's population issues encompass not only problems related to population size but also challenges in population structure. This demographic shift affects resource allocation, the environment, the economy, migration, and other areas, while also exerting significant pressure on the development of sports.

METHODS: To conduct an in-depth analysis of the impact of Chinas population issues on sports, this study analyzes authoritative statistical data released by the National Bureau of Statistics and the Ministry of Education.

RESULTS: 1. Combined with changes in population structure, the heavy pressures of elderly care and child-rearing will lead to a decrease in regular sports participation, a reduction in the frequency of sports activities, a decline in sports consumption, and lower levels of participation in sports activities. This, in turn, will affect the development of the sports industry.

2. In a society with a declining birthrate and an aging population, educational resources, including sports education, will face new distribution challenges. On one hand, due to the reduction in the child population, some regions or schools may struggle to fully utilize their sports education resources due to insufficient student numbers. On the other hand, in order to address the challenges posed by an aging society, educational resources will increasingly be directed toward elder care, healthcare, and other related fields.

3. The declining birthrate and aging society also indirectly impact sports education and talent development. The reduction in the youth population may make it more difficult for sports education institutions to recruit students, affecting the cultivation and selection of sports talent.

Discussion: 1. Regular physical activities can enhance the physical condition and immunity of the elderly, thus reducing the risk of illness and dependence on medical and care resources. The popularization and promotion of sports can "flatten" the sharp increase in medical service demand caused by aging.

2. Population dividends are usually linked to an abundant supply of young labor, but as China transitions into an aging society, the advantage of this demographic dividend is gradually weakening. The popularization and deepening of sports education and activities have become key ways to optimize labor quality, enhance productivity, and improve labor efficiency. By improving the physical fitness of the elderly and extending their healthy life expectancy, sports can, in effect, create a "new demographic dividend" for society.

Therefore, Sports is not just a means to promote individual health; it also plays an important role in social governance. As the modernization of sports governance systems continues to improve, the "shock-response model" needs to be restructured into a new development mindset, which actively participates in population governance models.

## 11:00 - 12:00

Conventional Print Poster Presentations

CP-AP07 Sports Technology - Mixed

**IMPROVEMENT OF ACCURACY OF POSE ESTIMATION USING RGBD IMAGES WITH ICP IN SPORT CLIMBING**

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INTRODUCTION: Sport climbing is a sport in which players climb various artificial walls with climbing holds. There is still no uniform performance indicator for evaluating climbing skills, since climbers climb walls of various angles in complex postures. Therefore, researches have been conducted on motion measurement and analysis of sport climbing movements. As in other sports, optical motion capture is mainly used for motion measurement in sport climbing [1], and it provides highly accurate posture measurement. However, there are environmental constraints, such as the need to install multiple cameras for measurement. In contrast, several pose estimation methods using RGBD images have been proposed [2]. However, the accuracy of pose estimation is highly dependent on the climbers posture. We propose a new method for highly accurate human pose estimation using the ICP algorithm with RGBD images. This method applies model fitting based on a three-dimensional ICP algorithm to the two-dimensional pose estimation results obtained from OpenPose [3].

METHODS: The proposed method improves the accuracy of 2D pose estimation results using OpenPose by model fitting with ICP to achieve pose estimation for various postures. The proposed method uses model fitting based on the ICP. The system estimates the climber's posture by fitting a predefined human body model to depth images. First, the 2D position of each joint obtained by OpenPose from the RGB image is projected onto the depth image and converted to a 3D position. These positions are used as the initial positions in each frame of the human body shape model in ICP. Next, the human shape model is fitted to the depth image by ICP for 3D pose estimation. The body model, divided into parts, is prepared in advance. Then, robust 3D pose estimation can be achieved by referring to the model positions in the previous frame when the 2D pose estimation by OpenPose fails.

RESULTS: To evaluate the accuracy of the proposed method, an experiment was conducted in an indoor climbing gym. The subjects were two advanced climbers and one intermediate climber.

The posture measurement results from the optical motion capture system were used as the true values for accuracy evaluation. Compared with the conventional methods, the accuracy of the proposed method was improved. From the experiment, it was qualitatively confirmed that the ICP works effectively. It was also shown that the proposed method estimates 3D position of each joint accurately even when OpenPose failed to estimate 2D position of each joint.

CONCLUSION: In this study, we proposed the method for highly accurate human pose estimation using the ICP with RGBD images. From the experiment conducted in an actual climbing gym, it was confirmed that the proposed method can estimate climbers posture with higher accuracy than conventional methods. As a future work, we aim to generate body models from RGBD images as well.

[1] Iguma,et al., SII,2020

[2] D. Pandurevic ,et al.,icSPROTS,2020

[3] Z. Cao, et al., TPAMI,2019

**EFFECTS OF ARM MOVEMENT AND SUPPORT SURFACE IN YOUNG ADULTS PERFORMING A DYNAMIC BALANCE TASK IN A POSTURE THREATENING VIRTUAL ENVIRONMENT**

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*UNIVERSITY OF DUISBURG-ESSEN*

INTRODUCTION: Previous studies have shown that in young adults balance performance is affected by arm movements, especially during challenging, posture threatening conditions (e.g., balancing at height) [1] as well as by support surface [2]. Additionally, it has been shown that virtual reality (VR) is a suitable tool to expose individuals to posture threatening situations using simulated height scenarios [3]. However, little is known about the effects of free versus restricted arm movements and using (in-)congruent support surfaces during a dynamic balance task performed in a posture threatening virtual environment (VE) provided through a head-mounted display (HMD).

METHODS: Thirty healthy, non-acrophobic young adults (16 f, 14 m; age: 22.3 ± 2.2 years) were exposed to a posture threatening VE using a HMD (Oculus Quest 2, Meta Inc. USA). Participants were instructed to balance forward across a 3-m long and 0.1-m wide virtual wooden beam extending from the 80th floor of a skyscraper and then return while walking backward. Each participant performed two trials (i.e., one with and one without arm movement) on incongruent (i.e., even ground) and congruent (i.e., physical wooden beam) support surface, respectively. The position and dimensions of the physical beam matched those of the virtual beam and the order of test conditions was randomized. Balancing times were recorded and analysed using a 2 (arm condition: free, restricted) × 2 (support surface: ground, beam) repeated measures

ANOVA. Additionally, the iGroup Presence Questionnaire was administered after balancing on congruent and incongruent surface, respectively in order to analyse how present individuals experienced themselves in the VE.

RESULTS: The ANOVA revealed a significant main effect for arm condition ($F = 13.132$, $p < .01$, $\eta 2p = .31$) as well as for support surface ($F = 40.817$, $p < .01$, $\eta 2p = .59$), but there was no significant interaction effect ($p = .08$) between these factors. Balancing times were significantly larger when participants walked with restricted compared to free arm movements and when walking across the beam compared to walking on the ground. Further analysis revealed that perceived presence in the VE was significantly larger ($t = 2.952$, $p < .01$, Cohen's $d = .54$) when participants balanced on the physical beam compared to even ground.

CONCLUSION: Similar to the real environment, restricting arm movements and/or changing the support surface seem to be effective means to modulate task difficulty during balance testing and/or training with healthy young individuals in VR. Larger balancing times during the trials using the physical beam may be explained by increases in participants perceived presence. This highlights the need to align visual and somatosensory input when a posture threatening environment is used in VR.

References

[1] Hill MW et al., Gait & Posture, 2023.

[2] Dault MC et al., Gait & Posture, 2001.

[3] Cleworth TW et al., Gait & Posture, 2012.

Contact

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**USING A PRE-TRAINED MACHINE LEARNING MODEL TO ESTIMATE THE 3D-GROUND REACTION FORCES DURING RUGBY SCRUMMAGING WITH INSTRUMENTED INSOLES**

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*LAAS-CNRS, ICA, STADE TOULOUSAIN*

INTRODUCTION: Rugby scrummaging represents a crucial phase of the game, characterized by high-intensity physical efforts and a significant impact on match outcomes [1]. The horizontal force generated by the entire pack is a key determinant of scrum success. However, existing measurement systems are unable to provide 3D, individual, and on-field assessments of ground reaction forces (GRF). A previous study developed a Machine Learning (ML) model to predict the 3D-GRF with instrumented insoles during scrummaging but this was conducted on recreationally active subjects without specific scrummaging experience [2]. Thus, this study aimed to investigate to what extent this model can be used to predict the 3D-GRF for elite rugby players.

METHODS: Twelve elite rugby players (12 males; age: 20+/-1 ans; height: 191+/-7 cm; weight: 116+/-13 kg) performed three pushing trials of 15 seconds, against a fixed scrum machine. They wore commercial instrumented insoles (Loadsol Pro®, Novel, Germany, 200Hz) inside their shoes with each foot on a force plate (Sensix, 1000Hz) covered with artificial turf. The force plate data served as the reference for 3D-GRF measurements. For each subject, one trial was used to infer data from the pre-trained ML model, while the remaining two trials were utilized to personalize the model for each subject. The model's performance was assessed by computing the Root Mean Square Error (RMSE) between the prediction and the reference, the correlation coefficient (r), and the percentage of RMSE compared to the mean resultant force.

RESULTS: The initial model inference yielded mean RMSE values of 42±9N on the Medio-Lateral (ML) axis, 168±87N on the Antero-Posterior (AP) axis, and 180±49N on the Vertical (V) axis, with correlation coefficients r of 0.708±0.110 (ML), 0.825±0.102 (AP), and 0.571±0.123 (V). RMSE percentages relative to the mean resultant force were 4.2±0.7% (ML), 15.8±5.0% (AP), and 18.0±4.8% (V). After personalization, RMSE were 32±10N (ML), 99±41N (AP), and 135±38N (V), and correlation coefficients r were

0.838±0.062 (ML), 0.911±0.044 (AP), and 0.680±0.168 (V). The mean percentages of RMSE compared to the average resultant force were 3.1±0.6% (ML), 9.7±2.8% (AP), and 14.0±5.5% (V).

CONCLUSION: The findings of this study indicate that an ML model pre-trained on data from recreationally active individuals without specific rugby scrummaging experience is not optimal for accurately estimating 3D-GRF in elite rugby players. Model personalization for each participant improved performance, suggesting that personalization is a promising approach for enhancing ML model performance when the model is trained on a non-specific dataset. However, further improvement in model performance could be achieved by pre-training the model on a dataset more closely aligned with the data used for personalization, to ensure reliable predictions.

References

[1] Scott et al., J. Sci. Med. Sport, 2023

[2] Pomarat et al., IEEE Xplore, 2025

**INFLUENCE OF GRIP POSITION AND HANDLE SHAPE ON FORCE PRODUCTION AND MUSCLE ACTIVATION OF THE UPPER LIMB DURING HORIZONTAL SEATED ROWS**

ERTEL, G., SIMON, F.R., MORNIEUX, G., GAUCHARD, G.C.

*UNIVERSITÉ DE LORRAINE*

INTRODUCTION: The horizontal pull pattern is highly represented in sports such as rowing, or during training with exercises such as seated rows. This pattern is executed through handles which serves as human/device interface. Variations in grip position or handle shape are available to adapt this movement. The impact of grip position on shoulder and back muscles activation and pulling force has been tested, showing increased strength with a neutral grip and reduced shoulder abduction1. Nevertheless, to the authors knowledge, the influence of handle shape on a pulling pattern has only been tested in rowing2. The purpose of this study was to evaluate the impact of different grip positions and handles on performance and neuromuscular activity of upper limb muscles during seated rows.

METHODS: Thirty-six healthy adults were included and tested three grip positions: pronation, semi-pronation and neutral with three individualized handle pairs: circular, elliptic and irregular hexagon. Each of these nine conditions consisted of five maximal concentric seated rows at 40% bodyweight and a maximal isometric pull on a pulling machine equipped with a strain gauge at the handle (150Hz). Subjects were equipped with EMG electrodes (Delsys, USA, 2000Hz) on Flexor Digitorum Superficialis (FDS), Flexor Carpi Ulnaris (FCU), Flexor Carpi Radialis (FCR), Brachioradialis (BRA), Extensor Digitorum (EXD), Extensor Carpi Radialis (ECR), Extensor Carpi Ulnaris (ECU), Biceps Brachii (BIB), Triceps Brachii Longus (TBL), Deltoideus Anterior (DTA), Deltoideus Lateralis (DTL), Deltoideus Posterior (DTP), Trapezius Medialis (TRM) and Latissimus Dorsi (LAD). Force production and EMG recruitment between the conditions were compared using repeated measures ANOVAs.

RESULTS: EMG recruitment was significantly increased for FCU ($p<0.01$) with pronation grip compared to other grip positions. EMG recruitment of EXD, ECU, ECR, BIB, TRM and LAD ($p<0.05$) was significantly higher with semi-pronation and neutral grips compared to pronation grip. No significant difference was found in force production.

CONCLUSION: Changing grip position or handle shape influenced wrist and finger muscles activation. Higher FCU activity and lower EXD, ECR and ECU activity with pronation grip may be linked to the impact of having both palms not facing each other. Thus, needing less extensors contribution to maintain the hand equilibrium3. Hence, pulling in a pronation grip may be better when having extensor tendinitis. Semi-pronation and neutral grips, which induced higher muscular activity of the pulling effectors, could be a better setting when performing seated rows with a hypertrophy focus. Nevertheless, no influence was found for performance regarding force production during dynamic or isometric conditions.

1. Vasconcelos et al., International Journal of Strength and Conditioning, 2023

2. Ertel et al., Applied Ergonomics, 2023

3. Goislard de Monstabert et al., Annals of Biomedical Engineering, 2023

**VALIDATION OF CENTER OF MASS ESTIMATION: COMPARING MARKER-BASED AND 2D AI-BASED MARKERLESS MOTION CAPTURE SYSTEMS DURING COUNTERMOVEMENT JUMPS – A PILOT STUDY**

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INTRODUCTION: Artificial Intelligence (AI) is driving innovation in biomechanics by offering cost-efficient, accessible, practical, and scalable alternatives to traditional, highly accurate, marker-based 3D motion capture (MoCap) systems like Vicon. AI-based markerless MoCap addresses the limitations of conventional systems (e.g., high costs, complexity, and feasibility restricted to laboratory settings), provided it demonstrates comparable measurement accuracy. Center of mass (CoM) estimation is crucial in kinematic analyses (e.g., jump tests) and may be more robust to tracking errors than single-marker analysis since it integrates data from multiple landmarks. Assessing CoM accuracy during countermovement jumps (CMJ) is particularly valuable as CMJ is widely used tests to evaluate jump performance and lower limb muscular power across various sports and clinical settings. This pilot study aimed to assess the accuracy of CoM estimation from a 2D AI-based MoCap system compared to a gold-standard marker-based system during CMJ.

METHODS: A healthy male participant (age: 32 years, body height: 1.69 m, mass: 80.0 kg) performed a CMJ while being simultaneously recorded by two smartphones (30 Hz) from frontal and sagittal angles and eight Vicon Vero v2.2 cameras (200 Hz). Marker-based MoCap involved a full-body PlugIn-Gait marker set, with CoM estimated via Visual3D software. The AI approach employed a publicly available pose detection tool (MediaPipe Pose) to derive skeletal landmarks comparable to the Visual3D model. A self-developed script calculated CoM using the same equation applied in Visual3D. Time-normalized, instantaneous vertical CoM was analyzed over the entire time-series from the start of the countermovement until CoM stabilized after landing. Absolute and relative root mean square errors (RMSE), Lin's concordance correlation coefficient (CCC) with 95% confidence intervals (CI), and Bland-Altman's 95% limits of agreement (LoA) were computed to assess concurrent validity.

RESULTS: The absolute vertical CoM location (Vicon) ranged from 695 to 1547 mm throughout the time-series. AI-derived CoM showed an RMSE of 28 mm (2.8%) in the frontal view and 29 mm (2.9%) in the sagittal view. CCC was 0.986 (95% CI: 0.978–0.991, $p<0.001$) for both views. Bland-Altman analysis revealed biases of -3 mm (LoA: −59 to 52 mm) in the frontal view and 1 mm (LoA: −56 to 59 mm) in the sagittal view.

CONCLUSION: The AI method demonstrated excellent agreement with traditional MoCap in estimating vertical CoM throughout the entire time-series. The promising findings suggest that smartphone-based AI MoCap provides accurate CoM estimation, supporting its potential for biomechanical research, clinical applications, and real-world use outside laboratory settings. Future studies should validate these findings across diverse participants, movements tasks, and specific CoM parameters (e.g., peak velocity and acceleration).

**INFLUENCE OF DETRAINING ON ARTERIAL STIFFNESS IN BODYBUILDERS**

LIAO, H., LEE, I., YU, C., LI, Y., FU, S.
*UNIVERSITY OF TAIPEI*

INTRODUCTION: Arterial stiffness, commonly assessed via brachial–ankle pulse wave velocity (baPWV), is a major cardiovascular risk factor [1]. Although high-intensity resistance training may raise arterial stiffness, moderate- or low-intensity training can maintain or lower it [2]. Limited research examines how detraining affects arterial stiffness in bodybuilders. This study explored whether a 4-week detraining phase post-competition influences arterial stiffness and body composition.

METHODS: Ten male bodybuilders (age 20–35 y) underwent their usual pre-competition protocol—including 1-day dehydration—and were then randomized post-competition into either a detraining group (DeTr, n = 5) or a continued-training group (Tr, n = 5). Arterial stiffness was assessed via baPWV and ankle-brachial index (ABI) using a VP-2000 device (Omron Colin Co., Japan). Body composition was measured by InBody 270 (Biospace Inc., CA, USA) and GE Lunar iDXA (GE Healthcare, Madison, WI, USA). Assessments took place at 1 week before competition (baseline), 1 day before competition (dehydration phase), 1 day post-competition, and at 1 and 4 weeks post-competition.

RESULTS: At 1 day before competition, left-side PWV significantly increased from baseline (1198.8 ± 56.7 vs. 1258.3 ± 64.2 cm/s, $p < .05$). One day post-competition, left PWV declined (1159.2 ± 59.8 cm/s, $p < .05$ compared to dehydration phase), whereas left ABI remained elevated (1.03 ± 0.12 vs. 1.10 ± 0.09, $p < .05$). Over the 4-week period, the DeTr group showed no significant change in PWV or ABI, but in the Tr group, ABI significantly decreased (1.03 ± 0.12 to 0.95 ± 0.08, $p < .05$), and body fat percentage was lower than in DeTr (Tr: 12.1 ± 4.0% vs. DeTr: 16.5 ± 4.2%, $p < .05$).

CONCLUSION: Our results show that short-term dehydration can acutely raise arterial stiffness. Resuming moderate-intensity training mitigated vascular strain and preserved body composition. This aligns with findings that low- to moderate-intensity resistance training may offer vascular benefits [3]. In contrast, high-intensity resistance exercise has been linked to increased arterial stiffness due to heightened blood pressure responses [4]. In the current study, the detraining group did not show further stiffening but also failed to improve vascular indices or maintain low body fat—underscoring the importance of ongoing training. Coaches and athletes should consider gradual retraining strategies post-competition to promote cardiovascular health and optimal physique. Future studies with larger cohorts and extended follow-up should clarify how different intensities, volumes, and recovery approaches affect arterial stiffness in strength-trained populations.

References

1. Zuo, et al., J Cardiovasc Dev Dis., 2022
2. Okamoto, et al., Eur J Appl Physiol., 2011
3. Luo, et al., Front Cardiovasc Med., 2024
4. García-Mateo, et al., Human Movement, 2023

## Conventional Print Poster Presentations

### CP-AP08 Statistics and Analyses III - Performance

**MATCH PERFORMANCE ANALYSIS OF ELITE MENS SABER IN THE 2021-2024 WORLD CUPS**

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INTRODUCTION: Saber is the fastest weapon among the three fencing disciplines. Literature has shown that male players score most frequently using attacks, but there is no consensus regarding specific scoring target areas (1). Moreover, there is little understanding about the impact of score status (leading, even or trailing) and winning the 1st round on the outcome.

METHODS: This study analyzed 120 men's saber matches from the Budapest World Cup (Hungary), Orléans Grand Prix (France), and Seoul Grand Prix (South Korea) from 2021 and 2024, using notational analysis. We examined the relationship between techniques (used and scored) and match outcomes (in winners and losers), and further in different score status and target areas.

RESULTS: Winners were ahead in the 1st round nearly 80% of the matches. Both winners and losers used attacks most frequently, followed by counter-attacks. However, winners had a higher proportion of attack compared to losers, while losers counterattacked more. In terms of techniques scored, both winners and losers scored most often with attacks,

followed by ripostes. Both winners and losers demonstrated association between techniques, both used and scored, with score status, with both expanding their proportion of techniques scored compared to techniques used in leading status. However, winners exhibited a significantly higher proportion of leading status, contributing to the difference in win/loss outcomes. Notably, only winners could effectively perform ripostes while leading, highlighting their superior defensive capabilities. Both groups predominantly targeted the head and the non-dominant side's outer area. For attacks, the dominant-side inner area and non-dominant-side outer area were targeted. Ripostes targeted the dominant-side upper arm and non-dominant-side arm, while counterattacks targeted the dominant-side forearm. Losers exhibited a more dispersed distribution in ripostes and counterattacks, showing a lack of optimal adjustment.

CONCLUSION: The results of this study reveal that world-class saber fencers adjust their techniques based on score status and preferring specific target areas. These findings provide valuable insights for coaches to design situational training and offer tactical guidance during competitions.

**NETWORK ANALYSIS OF TACTICAL INTERACTIONS BETWEEN ELITE UNIVERSITY SOCCER TEAMS IN JAPAN.**

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INTRODUCTION: In recent years, the integration of Artificial Intelligence (AI), Internet of Things (IoT), and sensor technologies has significantly advanced sports analytics. For instance, in team sports like soccer, players often wear sensors equipped with GPS and accelerometers to comprehensively measure movement metrics, such as distance covered and overall exercise intensity during practices and games. By analyzing tracking data from soccer matches, new insights have been uncovered, particularly in predicting injury prevention. This study focuses on visualizing the offensive and defensive tactics and team strategies of Japanese university elite soccer teams using network analysis. This approach is effective in identifying the characteristics of a teams strategic planning and quantifying the contributions and interactions of individual players.

METHODS: We analyzed a top league match of domestic university soccer using an acceleration sensor 1, and applied the results to a unique algorithm to analyze and evaluate the network (player coordination). We investigated the changes in the acceleration of the players, derived random variables, and evaluated the entropy of the movement through statistical processing. This index is an index of synchronization between players, and sheds light on the characteristics of team performance (offense and defense) during a match.

[1] Magome, T. et.al. The development of automatic training analysis using 3D accelerometer in male young elite soccer team, In Proceedings of the 12th (icSPORTS 2024), pp. 160–167.

RESULTS: We analyzed official matches between university teams of comparable skill levels, obtained acceleration data, and performed network analysis. We statistically analyzed the coordination between each player using phase shift entropy. We found that in matches where team tactics were more effective, players coordination was better, and there was a significant difference in players coordination between periods when organized attacks were successful and periods when they were less effective ($p>0.05$). Furthermore, our results suggest that network assessment may be able to assess the performance and injury risk of individuals within a team structure.

CONCLUSION: In this study, we were able to evaluate match performance based on the cooperation between players, visualize the quality of tactics, and obtain insights that can lead to injury prediction. These, combined with the data of individual players, can lead to an understanding of team performance. However, it is difficult to analyze all tactics in detail. Therefore, we aim to work with teams and players to visualize specific data that is key to offense and defense, and provide feedback to the entire team. In the future, we will explore the value of quantifying team performance to confirm and optimize high-quality movements. These are likely to have a ripple effect throughout the sports world and are useful.

**DIFFERENTIATING WORLD-BEST FROM NATIONAL-LEVEL 100M FREESTYLE SWIMMERS: A RACE VIDEO ANALYSIS AND MACHINE LEARNING APPROACH**

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INTRODUCTION: Elite swimming performance is determined by a complex interplay of anthropometric, physiological, biomechanical and technical factors. While previous research emphasises the role of explosive power, physiological conditioning and technical precision in 100m Freestyle, 'in-race' factors discriminating World-class from international and national-level swimmers has not been examined. This study uniquely examined race-phase metrics associated with World-National level performance.

METHODS: High-definition race-analysis software examined race performances of 204 male swimmers recorded at World-National level competitions (2019–2024). Race indices including stroke rate, stroke length, turn efficiency, underwater durations, and 5m interval velocities were extracted. Random forest models and feature importance methods distinguishing World- (0–2.5%), International- (2.5–5%), and National-level (5–10%) swimmers based on proximity to world record performance.

RESULTS: Random forest modelling = 89.5% classification accuracy. Swimmer velocities at 65-70m, 70-75m & 60-65m were the most discriminatory features (relative importance = 0.086, 0.081, 0.053). Shapley Additive exPlanations (SHAP) and Partial Dependence Plots validated mid-race velocity importance as distinguishing factors across performance levels.

CONCLUSION: Given the unique analysis approach, results overall identified how mid-race speed maintenance differentiated World-National level 100m. Findings offer practical implications for performance analysts and coaches, suggesting benefit from assessing race-phase velocity profiles and for targeted training within the 100m event.

**EFFECT OF CONSECUTIVE JUMPING TRIALS ON ANKLE AND KNEE BIOMECHANICS DURING TAKE-OFF AND LANDING: A REPLICATION STUDY.**

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INTRODUCTION: Replication involves testing a claim with new data to confirm its validity. The Sports Science Replication Centre was established to assess the replicability of research in sports and exercise science. As part of this initiative, we replicated Lam et al. 2021 (1), which examined the effects of single vs. consecutive countermovement jumps on lower limb biomechanics. Hence, the objective was to closely replicate this study, investigating the differences of both conditions on ground reaction forces (GRF), ankle and knee joint kinematics and kinetics.

METHODS: Forty basketball players, recruited from French university teams and clubs, performed six countermovement jump trials in single and consecutive conditions. Motion capture and force plates recorded biomechanical data, with 22 markers on the pelvis and dominant leg. The experimental design and methods were similar to the original study. Performance variables (i.e. jump heights, takeoff velocity, GRF) as well as ankle and knee biomechanics (i.e. peak angle, velocity and power) were computed during takeoff and landing. Paired t-tests assessed jump condition effects on performance and biomechanics, while a z-test was used to evaluate the compatibility of the replication and original effect sizes.

RESULTS: Single jumps resulted in greater height, takeoff velocity, and peak GRF at landing ($p<0.001$). Ankle dorsiflexion was larger in consecutive jumps while angular velocity and power were greater for single jumps during landing. Knee extension velocity and power were lower in consecutive jump takeoff and the extension moment was higher. During landing, peak knee flexion angle was larger in consecutive jumps and power was greater in single jump condition ($p<0.001$). Regarding the replicability of the original study, only 4 variables were successfully replicated, 3 considered as practical failure to replicate, 7 as inconclusive and 6 as informative failure to replicate (2).

CONCLUSION: During takeoff, consecutive jumps induced lower jump height and takeoff velocity, which is consistent with lower knee extension velocity and power. In contrast, the original study showed higher joint power during consecutive jump. During landing, consecutive jumps led to greater ankle and knee flexion angles but lower joint power and peak GRF, indicating stiffer landing in single jumps. However, our findings differed from the original study regarding ankle and knee mechanics as only 4 out of the 20 variables investigated were replicated. The differences in participant's athletic performance and in shoe model between the two studies could potentially explain these discrepancies, as they can impact joint kinematics and kinetics. Therefore, we are confident to state that overall, the results of the original study were not replicable and couldn't be generalized to the basketball male population.

REFERENCES:

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2. Brandt et al (2014) Journal of Experimental Social Psychology

**PARADIGM INNOVATION IN ATHLETIC TRAINING DRIVEN BY ARTIFICIAL INTELLIGENCE AND BIG DATA ANALYTICS: CONVERGENCE OF TRAINING OPTIMIZATION, TECHNICAL AND TACTICAL ANALYSIS, AND HEALTH MANAGEMENT**

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INTRODUCTION: Scientific training in competitive sports is shifting from experience-driven to data-driven methods. Traditional models often rely on subjective judgment, leading to biased decisions and inefficiencies. AI and big data offer solutions through multimodal data collection, dynamic modeling, intelligent decision-making, and training optimization. This study explores AIs impact on training, tactics, and health management while addressing ethical and scientific challenges.

METHODS: This study used experimental, data analysis, and video analysis techniques:

•Data Acquisition: Sensors (IMUs, myoelectric sensors), computer vision (motion capture), and environmental devices (GPS trackers, pressure sensors) collected real-time biomechanical, tactical, and environmental data.

•Algorithm Model Construction:

oTraining Optimization: Personalized action recognition using LSTM and reinforcement learning, enhanced by K-means++ clustering.

oTactical Analysis: A team dynamic model with Graph Convolutional Networks (GCN) and spatio-temporal attention, plus VR simulations for adversarial training.

oHealth Management: A Temporal Convolutional Network (TCN) predicted muscle fatigue and injury risk, incorporating metabolomics and genetic data for personalized plans.

•Validation Design: A double-blind study with 120 athletes compared AI-driven and traditional training methods in terms of performance, tactical accuracy, and injury rates.

RESULTS: The AI group showed a 23.6% improvement in movement standardization ($p < 0.01$) and a 17.4% shorter training cycle. The GCN model predicted opponent tactics with 82.3% accuracy, and VR simulations improved tactical response

times by 31.5%. The TCN model predicted muscle injury risk 48 hours in advance with an AUC of 0.91. Genetically tailored nutrition reduced recovery time by 29%.

Ethical concerns arose, with 30% of athletes concerned about data privacy, and only 64.2% of coaches adopting AI recommendations due to the "black-box" nature of algorithms.

CONCLUSION: AI enhances training precision, shifting from "trial-and-error" to individualized methods. It improves tactical decision-making and creates a "prediction-intervention-feedback" cycle in sports medicine, transitioning from treatment to prevention. However, three challenges remain:

1.Human intuition vs. data-driven insights: AI should complement, not replace, coaches' decisions.

2.Ethical risks vs. technological benefits: Clear standards for biometric data use and algorithm transparency are crucial.

3.Sport-specific suitability: AI's adaptability varies, and sports should develop domain-specific models rather than using generalized ones.

Future research should focus on multimodal models, metaverse training ecosystems, and sports biomarker mapping. International organizations must establish ethical governance standards for AI in competitive sports.

**PACING PROFILES AMONG ELITE 800M ATHLETES: K-SHAPE CLUSTERING AND MACHINE LEARNING CASE STUDY FROM THE 2024 DIAMOND LEAGUE**

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INTRODUCTION: Pacing behavior is a key determinant of 800 m performance, reflecting an athlete's energy distribution, and physiological and psychological regulation across the race. While positive pacing is mostly adopted, little is known about variability in pacing approaches among elite athletes. This study applied time-series clustering and Random Forest to (1) identify pacing profiles, (2) determine their impact on performance, and (3) quantify performance sensitivity to pacing strategy changes.

METHODS: Race split data from 135 elite 800 m performances (68 males, 67 females) of the 2024 Diamond League were standardized and analyzed. K-shape clustering identified pacing profiles based on split-time patterns, with the optimal cluster number determined via Elbow Method and Silhouette Index approaches. Performance differences were assessed using Wilcoxon tests, while a Random Forest model predicted finishing time using pacing profile, power law-derived speed and endurance parameters, and 400 m and 1500 m performances. From this model, a sensitivity analysis was conducted by randomly reassigning pacing clusters and measuring the impact on predicted performance.

RESULTS: Six distinct pacing profiles were identified: Fast start & end, Aggressive positive, Aggressive & even, Reverse J-shaped, Aggressive U-shaped, and Prudent positive. Wilcoxon tests revealed significant associations between pacing strategies and performance, with Aggressive U-shaped and Prudent positive pacing producing faster times than Reverse J-shaped for males, and Aggressive U-shaped also outperforming Aggressive & even. Among females, Aggressive U-shaped yielded the fastest performances, while Fast start & end and Reverse J-shaped were significantly faster than Aggressive positive. The Random Forest model ($R2 = 95.6$ %, RMSE = 1.87 s) reinforced these findings, confirming the role of pacing profiles in performances. Sensitivity analysis demonstrated that switching to Aggressive U-shaped (1.4 s) or Prudent positive (0.45 s) pacing improved predicted times for males, while Reverse J-shaped (-1.14 s) and Aggressive positive (-0.8 s) pacing led to slower performances. For females, Fast start & end (1.08 s) and Reverse J-shaped (1.38 s) pacing was advantageous, whereas Aggressive positive pacing resulted in slower predicted times (-0.9 s).

CONCLUSION: This study confirms that pacing strategy significantly influences elite 800 m performance. Male athletes benefit from Aggressive U-shaped and Prudent positive pacing, while female athletes perform better with Fast start & end and Reversed J-shaped pacing profiles. In contrast, Reverse J-shaped and Aggressive positive pacing may not be very effective in males and females, respectively. These findings underscore the importance of optimizing mid-race pace regulation and race strategy development.

**THE IMPACT OF DISTANCE AND ALTITUDE ON SEX DIFFERENCES IN ULTRA-TRAIL PERFORMANCE**

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INTRODUCTION: Despite the growing participation of female athletes in recent years, there is a lack of data on female-specific responses to endurance sports, including trail running. It has been hypothesized that women may gain a relative competitive advantage in ultra-trail events as the distance increases [1]. Mountain ultra-trails present unique environmental challenges, such as altitude and large elevation gain (D+), which may influence sex differences in performance [2-3]. Therefore, this study explores the impact of distance, altitude, and D+ on sex differences in DNF rates and performance in ultra-trail running.

METHODS: This study included 56 trail running races from the 2024 UTMB World Series circuit, covering all European events classified as 50 km (50K, n = 20), 100 km (100K, n = 19), and 170 km (100M, n = 14). For each race, the mean altitude, distance, and D+ were extracted from GPS traces. The study examines the relationship between race characteristics and sex differences (women vs. men) in DNF rates and median race times, using Pearson correlation coefficients for statistical analysis.

RESULTS: Mean DNF rates increased with race distance in both females (50K: 7%; 100K: 20%; 100M: 36%) and males (50K: 6%; 100K: 19%; 100M: 33%), with similar trends observed in both sexes. Sex differences in median race time decreased as distance increased (50K: 9%; 100K: 7%; 100M: 5%). Sex differences in DNF rates were not correlated with race distance or D+, but were positively correlated with mean altitude in the 100K ($r = 0.51$, $p = 0.02$) and 100M ($r = 0.58$, $p = 0.02$) races, indicating a larger altitude effect on females DNF rates compared to males. In contrast, sex differences in median race time were negatively correlated with both race distance ($r = -0.37$, $p = 0.005$) and D+ ($r = -0.47$, $p < 0.001$), but not with mean altitude.

CONCLUSION: The mean altitude amplifies sex differences in DNF rates in trail running, particularly in longer races, while it does not affect sex differences in median race times. Females are known to face greater altitude-related challenges, such as exacerbated pulmonary limitations or hypoxemia [3]. Additionally, sex differences in uphill velocity are more pronounced (18-22%) compared to endurance sports on flat terrain (9-12%) [2]. These findings raise questions about the appropriateness of applying the same time barriers for both females and males in ultra-trail races, regardless of the race profile, and may help explain the higher DNF rates and slower median times observed in females. Further research is needed to explore the causes of DNF in women, considering race characteristics (distance, elevation gain and loss, etc.) and environmental factors (altitude, temperature, etc.), as well as to determine whether cutoff times are too stringent for female athletes.

**FEMALE AND MALE PERFORMANCES IN THE VERTICAL KILOMETER RACE OF THE YOUTH SKYRUNNING WORLD CHAMPIONSHIP 2023**

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INTRODUCTION: Skyrunning is a mountain running sport reaching an altitude of at least 2000 meters above sea level, where symptoms of acute mountain sickness can appear. This sport has recently gained significant popularity, with an increasing number of participants from youth age. In this study we analyze youth performances in the Vertical Kilometer (VK) race of the Skyrunning World Championship 2023, a competition through a path of 1,000 m of uphill vertical climb, with an average slope of 26%.

METHODS: The time trial race, starting every 30 s, took place on August 2023, from Fonte Cerreto (Italy) to Campo Imperatore at 2,150 m of altitude. Female (F) and male (M) participants, representing 28 countries, were divided into four age categories: YA, YB, YC, and U23. They wear a sensor to record the time performance. Blood lactate concentration from a microsample taken from the earlobe (Lactate Scout, EKF Diagnostic, UK) was measured within 5 minutes after crossing the finish line.

Data were analyzed by descriptive statistics. Differences between means were assessed by unpaired Student's t-test, with $P<0.05$ significance. Relationships between age and time performance was assessed by least-squares method.

RESULTS: A total of 233 athletes (74 F, 32%; 159 M, 68%) participated in the VK race. The mean (±DS) ages were: YAF (n=13) 15.7±0.5 yrs; YAM (n=28) 15.9±0.5; YBF (n=21) 17.8±0.5; YBM (n=37) 17.6±0.6; YCF (n=18) 19.5±0.5; YCM (n=38) 19.7±0.5; U23F (n=22) 22.2±0.9; U23M (n=56) 22.4±0.9 ($P>0.05$ between F and M).

All the categories showed significant differences of weight and height ($P<0.05$) between F and M; no significant differences were found on body mass index (BMI; $P>0.05$). No significant differences in weight and height were found between U23 and YC ($P>0.05$); YB and YA tend to have lower weight, height and BMI than U23 and YC. The differences are significant for YA ($P<0.05$), indicating that in this category participants have not yet completed their somatic growth.

M winners report significantly lower race times than F ones in their respective age categories. The average performance difference was 19.8±3.9%, with the smallest difference in the YA category (F=00:46:39 vs M=00:40:03; 14%).

The average time taken tend to decrease with increasing age in F ($R2=0.985$) and M ($R2=0.671$). However, the coefficient of variation was 19% and 11% in F and M respectively.

Blood lactate at the end of the race showed mean values of 9.9±3.8 and 12.0±4.3 mM in F and M, without significant differences between age categories and without relationships with race time.

CONCLUSION: F participants are only 32% of participants. Their performances were about 20% lower than those of M, with a significant contribution of anaerobic metabolism regardless of age. Inter-participant variability of performance depends on genetic, growth and training characteristics of the athletes selected to represent their country in the World Championship, that need further research.

**DROPOUT PREVALENCE AND DEMOGRAPHICS IN BIG CITY MARATHONS**

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INTRODUCTION: Not all runners who start a marathon finish, and those who do not are classified as Did Not Finish (DNF). DNFs can result from factors such as dehydration, musculoskeletal injuries, or cutaneous wounds (1). In elite marathon events, the DNF rate has been reported at 25% for men and 41% for women, as seen in the 2019 Doha World Athletics Championships (2). However, DNF prevalence and demographics in mass-start marathons remain largely unexplored. Understanding these factors is essential for race organisers to provide optimal medical support and race-day logistics.

METHODS: DNF prevalence and demographics were analysed across six marathons (Boston, Chicago, London, Hamburg, Houston, and Stockholm) from 2013 to 2023. Data were collected via web scraping, yielding 1,246,144 records, with 17% removed due to missing values, anomalies, and DNS cases. Binary coding was applied for statistical analysis, and the direct method of standardisation was used to adjust for confounding factors such as age and gender. Statistical analyses, conducted in SPSS, included chi-squared tests for categorical comparisons and binary logistic regression to assess associations between DNFs and key demographic variables.

RESULTS: The overall DNF rate across all marathons was 2.52% (20.52 per 1,000 runners), with significant differences between the six events ($\chi^2(5, N = 1{,}030{,}603) = 5296.5$, $p < 0.001$). Men had a significantly lower crude DNF rate (2.01%) compared to women (2.12%) ($\chi^2(1, N = 1{,}030{,}603) = 15.0$, $p < 0.001$). A significant association was found between DNF rate and age category ($\chi^2(7, N = 1{,}030{,}603) = 1767.7$, $p < 0.001$), with runners aged 70+ years exhibiting the highest DNF rate (8.0%), while those aged 40–44 years had the lowest (1.65%). Multivariate analysis showed that women had 13.5% lower odds of dropping out than men (OR = 0.865, 95% CI: 0.839–0.993), while runners aged 70+ had the highest odds of DNF compared to all other demographics (OR = 2.576, 95% CI: 2.344–2.831).

CONCLUSION: This study is the first to establish that the DNF rate in mass-start marathons is lower than in elite events. Findings suggest that gender and age significantly influence the likelihood of dropping out, with male runners aged 70+ being at the highest risk. These results emphasise the need for targeted medical and logistical support for high-risk groups. Future research should investigate the underlying causes of DNFs to improve race planning and runner support strategies.

1. Tang, N. et al. 2008 2. Racinais, S. et al. 2022

## Conventional Print Poster Presentations

### CP-AP09 Statistics and Analyses IV - Mixed

**IS EXPLORATORY RESEARCH MISUNDERSTOOD IN SPORT AND EXERCISE SCIENCE?**

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INTRODUCTION: Exploratory research is well established in the literature (Kimmelman et al 2014). It involves exploring a dataset, freely and without existing hypotheses or research questions in mind, to detect patterns and associations that may look interesting and even unexpected, with the aim of generating new hypotheses. A confirmatory study should then support or question these hypotheses using a new dataset. This implies a logical sequence of events, with an exploratory study occurring first, i.e. the background work that enables a researcher to properly plan their hypothesis testing analyses in a subsequent confirmatory study (Ditroilo et al 2024). It is however important to emphasise that in exploratory studies the error rate of statistical tests is not controlled, therefore no scientific claims should be made, as the probability that these claims are misleading cannot be controlled. Yet in the sport and exercise sciences we contend that many exploratory studies are passed off as being confirmatory. Accordingly, the aim of this study was to review the literature to examine if sport and exercise science studies described as exploratory are truly exploratory.

METHODS: PubMed was searched for sport and exercise science papers that described their study as exploratory (Jan 2025) using: "exploratory stud*" or "exploratory research" or "exploratory anal*" and ("sport science*" or "exercise science"). Inclusion criteria: quantitative original studies; studies published in one of the 127 Sport Sciences journals (Clarivate Journal Citation Reports); studies stating somewhere in the paper that it is an exploratory study or that used methods of exploratory research or that used exploratory analyses. Exclusion criteria: non original studies (e.g. review papers); unable to source full text.

A study to be exploratory must: 1) have no pre-specified hypothesis to be tested; 2) have no a-priori power analysis and sample size calculation; 3) make no claims about their results. A study with a mix of confirmatory and exploratory analyses would still be selected if the exploratory section met the criteria (Ditroilo et al 2024).

RESULTS: A total of 247 papers were retrieved and 43 were selected based on inclusion/exclusion criteria (sample size: 9-1139). While 20 studies had no pre-specified hypotheses and 38 studies had no sample size calculation and power analysis, only 3 studies were classified as exploratory as they made no claims and highlighted their hypothesis generation role.

CONCLUSION: Although several studies reported as exploratory did have some elements of exploratory research, most of them made claims as if they were confirmatory studies.

Often the word 'exploratory' is used as a synonym of preliminary, first attempt at investigating a topic, pilot, feasibility, study with small sample size, etc.

It appears most researchers do not know how to properly carry out and present this type of research.

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Kimmelman et al (2014). PLoS biology, 12(5), e10018

**SPORT AND EXERCISE SCIENCE EXCELLENCE THROUGH DATA SCIENCE (SPEEDS) – AN ONLINE REPOSITORY OF STATISTICS EDUCATION MATERIALS IN SPORT AND EXERCISE SCIENCE**

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INTRODUCTION: Wearable devices, GPS and other technologies have led to an explosion in the volume of data available to Sports Scientists. But there is now a mismatch between the amount of data available and the skills required to make sense of it.

METHODS: The Australian Institute of Sport (AIS) has identified enhancing data science literacy in sport scientists as a strategic priority area. In collaboration with the AIS, La Trobe University have developed an online learning platform written in the R statistical programming language to improve data exploration and visualisation skills within sport and exercise scientists called the SPEEDS (Sport and Exercise Science Excellence Through Data Science) project. This project aims to enhance data exploratory data analysis, data visualisation, and statistical modelling skills within sport and exercise scientists.

RESULTS: We hope the SPEEDS project can help address the lack of specificity of existing data science resources with sport and exercise science, which tend to focus on and provide examples from other disciplines which practitioners often find difficult to apply to the high-performance sports arena.

CONCLUSION: We aim to expand the resources over the next few years and encourage contributions from sport and exercise scientists and data scientists, which will then be reviewed by our team for quality and then published on the website. Quantitative and qualitative data about the reach and significance of the impact of the site will be gathered towards the end of 2025.

The SPEEDS Project: https://speeds.quarto.pub/speeds/about.html

**EFFECTS OF EXERCISE-RELATED ENHANCEMENT OF TRICEPS SURAE CAPACITIES ON MUSCLE-TENDON KINETICS DURING HORIZONTAL JUMPS**

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INTRODUCTION: Muscle and tendon respond differently to mechano-metabolic stimuli, with tendons requiring high-strain loading (4.5–6.5%) for optimal adaptation, while muscles increase force and mechanical power-generating capacity even at moderate mechanical loads when exposed to high metabolic stress [1]. Given that tendon stiffness influences contractile dynamics during locomotion [2], we aimed to assess whether a mechano-metabolic exercise-induced increase in triceps surae (TS) strength, with and without changes in Achilles tendon (AT) stiffness, result in distinct muscle-tendon unit (MTU) kinetics during maximal unilateral forward jumps.

METHODS: Nine healthy males completed 12 weeks of resistance training with cyclic fatiguing isometric isometric plantarflexion contractions (3 sets at 80% MVC) to induce high metabolic stress. One leg trained in dorsiflexion (DF: high mechanical loading), the other in plantarflexion (PF: moderate loading). Pre- and post-exercise TS biomechanical properties were assessed via MRI, dynamometry, and ultrasonography. Motion capture and ultrasonography analyzed TS MTU kinetics during unilateral forward jumps. AT strain was measured from the curved displacement between the gastrocnemius medialis (GM) myotendinous junction and calcaneal tuberosity [3], and AT force was estimated using pre-calibrated force-strain relationships during MVC.

RESULTS: After training, both legs showed comparable increases in TS muscle volume (~6%) and strength (~20%). However, AT stiffness increased only in DF ($p<.05$), while muscle fascicle length remained unchanged in both legs. During the ground contact phase of horizontal jumps, the DF leg exhibited higher average AT velocity, leading to greater mechanical AT power during push-off (on average, -133 vs. -227 W). There were no exercise-related effects on MTU kinetics in the PF leg, while the relative change (post/pre) in GM mechanical power during push-off was 20% greater in DF compared to PF.

CONCLUSION: Our data confirm that an exercise-related increase in TS muscle strength and AT stiffness in the DF leg led to altered MTU kinetics during horizontal jumps, increasing AT mechanical power during ankle push-off. However, an exercise-induced enhancement in TS muscle force and maximal mechanical power generation capacity in the PF leg, without changes in AT stiffness, did not affect MTU kinetics during jumping. Given that our analysis showed that the GM belly exhibited a stretch-isometric-shortening cycle during ground contact, with up to ~8cm/s shortening velocities and ~800°/s joint angular velocities, we might suggest that the adaptive changes in TS muscle biomechanical properties (higher muscle volume without any changes in fascicle length) were insufficient to improve MTU kinetics during maximal unilateral horizontal jumps. This highlights the relevance of tendon mechanical properties for plyometric tasks.

References:

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2)Kubo et al., J Appl Physiol,2010

3)Kharazi et al., Sci Rep,2021

**CAN VISUAL CHANGES IN RIDER POSITION WITHIN THE CROSS-COUNTRY PHASE OF EVENTING INFLUENCE HORSE PERFORMANCE?**

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INTRODUCTION: Horse welfare in Eventing is being increasingly questioned by the public. Research to date has focused on risk factors in the cross country (XC) associated with falls, and physiological demands of riders. During competition officials can eliminate combinations if their safety appears compromised. This study explored whether visual assessment of rider position during XC can provide an indication of rider fatigue and inform decision-making to promote safety.

METHODS: Notational analysis using an ethogram was developed by 3 researchers after watching videos of XC footage taken from a flat section on course between jumps during a UK Novice Event. Videos (~5s duration) taken near the start, middle and end of the course (n=285 video clips) of horse and rider combinations were analysed by a trained observer, at 0.25 speed in a random order. Positional factors including, trunk position: forwards/neutral/backwards, hand position: forwards/backwards, hand stability: stable/unstable, hand height: consistent/ varying, leg stability: still/swinging, leg position: in front of girth/ on girth/ behind girth, knee motion: bent absorbing force/ locked out resisting force, seat variation: sat down/ off horses back/ rising with light saddle contact/ rising with hard saddle contact and centre of mass movement: stable/ unstable. Differences in the frequency of behaviours across the course were examined using Friedmans analyses with post-hoc Wilcoxon Signed-rank tests (Significance: $p \leq 0.05$).

RESULTS: Five factors: hand stability, hand height, leg position, knee motion and seat variation differed significantly across the course ($p \leq 0.05$); post-hoc tests found no differences between the start-middle-end for hand stability, leg position, and knee motion. Decreased hand height stability ($p<0.001$) and seat variation changes were seen from the start to the middle of the XC, with a decrease in riders rising with light saddle contact off the horse's back position to more rising with hard saddle contact ($p=0.04$).

CONCLUSION: Changes in rider seat variation and hand height were observed in the middle of the course; these observations warrant further exploration as potential visible indicators of fatigue in riders. Identification of repeatable and objective signs of fatigue can help inform rider training to ensure rider fitness supports horses' performance and could provide objective measures to inform competition official decision-making when judging if combinations should be eliminated supporting Eventing's social licence to operate.

**THE SIGNIFICANCE OF HORSE BEHAVIOURS IN IDENTIFYING FATIGUE IN ELITE EVENTING**

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INTRODUCTION: Eventing is an equestrian discipline where horse and rider combinations are tested physically and mentally. The potential impact on horse welfare has placed the sport in a position to be scrutinised by the public. Research to-date has focused on risks associated with jumping during the cross-country phase of the sport to develop ways to increase safety. Fatigue is an overlooked factor that can contribute to these risks as an unfit horse will not meet the demands of the competition risking injury and serious falls. During competition officials can eliminate combinations if their safety appears compromised. This study By explored if identifying early onset fatigue could decrease risks and inform official decision-making.

METHODS: Horse and rider combinations were purposively sampled from Burghley Horse Trials 5* 2023 (n=137 videos). Using ~5 second videos (viewed 0.5x speed) from flat sections at the beginning, middle, end of the course, a trained, blinded observer used an ethogram to score behaviours identified by experienced equine researchers, who also assigned a fatigue score. Data met non-parametric assumptions; therefore, behaviour frequencies were analysed using Friedmans analysis and post-hoc Wilcoxon Signed-rank tests to evaluate fatigue changes across the course.

RESULTS: Nine factors reported significant ($p \leq 0.05$) differences across the course. Five factors: rider balance ($p=0.023$), varied rider balance ($p=0.046$), tail carriage ($p=0.024$), tail swishing ($p=0.004$) and fatigue ($p=0.001$) showed no difference in post-hoc testing. Horse and rider harmony decreased from the beginning to the end of the course ($p=0.011$). Varied tail carriages were observed from the beginning to the end but with no distinct trends ($p=0.011$). Ear position also varied from the beginning to the end of the XC ($p<0.001$) and from the middle to the end ($p=0.017$); horses started out with forward and alert ears and progressively this position changed to a more loose and slightly back position.

CONCLUSION: Behavioural changes can precede physical signs of fatigue and could be used to inform riders, trainer's and stewards with evidence-based reasons to manage horse welfare during competition. Measurable markers of fatigue are more difficult to identity within elite horses; however these observations may help progress research into these behaviours to aid safeguarding of the sport.

**COMPARATIVE ANALYSIS OF TECHNICAL AND ARTISTIC TENDENCIES IN ELITE WOMENS AND MEN'S PAIRS IN ACROBATIC GYMNASTICS.**

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INTRODUCTION: Acrobatic Gymnastics (ACRO) is an official discipline of the Gymnastics International Federation. It is performed in pairs or groups and requires great collaboration between partners to perform elements of difficulty and efficient

use of space and time during the competitive routine [1]. Teams perform three exercises (Balance, Dynamic, and Combined) in competition. The scoring criteria fosters teams' creativity, challenging performance assessment [2]. This study aimed to compare the technical and artistic performance of top-level Women's (W) and Men's (M) Pairs.

METHODS: Data were collected from 47 exercises, including Balance, Dynamic, and Combined (26 W; 21 M) from the Acrobatic Gymnastics World Championship 2022. A single observer (sports scientist, national ACRO judge and coach) collected all data from official videos supported by previous reliability assessment (Cohen's Kappa: 0.90). Techniques were categorized according to ACRO official classes. Balance: mount (M0-1), grip (G1-6), support (SU1-4), top position (TP1-8), base support (B1-2), and motion (MT0-6). Dynamic: top's initial position (TI1-6), top's final position (TF1-4), salto direction (SA0-2), rotation quarters (Q0-8), element category (C1-4), twist (TW0-1). Spatial analysis considered the execution of elements within a grid of nine zones on the competition floor (bottom, center, top; left, middle, right). Temporal analysis compared time spent performing either techniques or choreography. The comparison of technical elements was only descriptive due to the great dispersion of frequencies among techniques. A chi-square test was applied to analyse the usage of floor zones. Generalized Estimating Equations were applied to analyze the time spent with techniques and choreography (alpha = 0.05).

RESULTS: Technical elements: i) Balance: grip - W: G1 (40%); M: G6 (57%); support - W: SU1 (91%); M: SU4 (57%); top position - W: TP5 (47%); M: TP4 (30%); ii) Dynamic: quarters - W: Q8 (39%); M: Q4 (54%); twist - W: TW0 (55%); M: TW1 (64%); iii) Combined: grip - W: G1 (50%); M: G6 (92%); support - W: SU1 (96%); M: SU4 (92%); top position - W: TP5 (56%); M: TP4 (33%); quarters - W: Q8 (53%); M: Q4 (53%); twist - W: TW0 (60%); M: TW1 (73%). Spatial analysis - Balance: W and M performed more elements, respectively, on the top and on the center of the floor ($p<0.05$); Combined: W performed more elements on the center. W and M similarly allocated time for techniques and choreography.

CONCLUSION: Top-level ACRO Women's and Men's Pairs exhibited different patterns of technique execution and floor zones utilization. However, both groups allocated similar amounts of time to techniques and choreography. These findings offer valuable benchmarks for high-performance preparation and provide broad technical references for coaching at all levels of practice.

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**ESTABLISHING THE MINIMAL IMPORTANT DIFFERENCE OF THE VISUAL ANALOG SCALE FOR ASSESSING EXERCISE-INDUCED FATIGUE**

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INTRODUCTION: Exercise-induced fatigue is a physiological state characterized by performance decline. The Visual Analog Scale (VAS) is one of the most commonly used subjective methods for evaluating exercise-induced fatigue. However, there is a limited interpretation of how much a change in this method indicates a fatigue status that matters to the exercise performance due to the lack of a well-established minimal important difference (MID).

METHODS: This study is a secondary analysis of data from three trials. We analyzed individual participant data before and after exercise-induced fatigue. Anchor-based methods were used to determine the MID of the VAS for fatigue, using Countermovement Jump (CMJ) height as an anchor. Specifically, the MID was calculated using mean change, receiver operating characteristic (ROC) curve analysis, and linear regression methods.

RESULTS: Data from 71 participants (80.28% male, 22.85 ± 2.51 years), corresponding to 230 person-time measurements, were included in this analysis. The CMJ height fulfilled the requirements to be used as an anchor. MIDs for mean change, ROC curve, and linear regression analysis were 48.51, 44.13, and 43.08, respectively. The Youden's Index indicated that the MID calculated by the mean change method was the most relevant and reliable in distinguishing between fatigued and non-fatigued states.

CONCLUSION: When assessing exercise-induced fatigue in trained adults using the VAS, it is crucial to evaluate whether changes exceed the MID threshold of 48.51, ensuring accurate identification of its actual impact.

**QUANTIFYING TRAINING LOADS OF COMPETITIVE SOUTH AFRICAN OPTIMIST SAILORS IN DIFFERENT WIND INTENSITIES**

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INTRODUCTION: More effort is required from a sailor during stronger wind intensities (WI(s)). The extent to which WIs influences the amount of stress (training load; TL) imposed on the sailor is unclear. Therefore, the primary aim of this study was to describe and compare TLs of Optimist sailors in different WI conditions during on-water training sessions. Secondary aims were to use estimated energy expenditure (EE) as a criterion to compare different TL measures within the different WIs.

METHODS: Twelve competitive Optimist sailors (n = 8 boys, 4 girls) were monitored during 21 sailing training sessions in light, medium and strong WI exposures. The coaches determined all training sessions beforehand, and the researchers did not make any changes to the planned training. The sailors were familiarised with the subjective Category Ratio scale (CR-10 RPE) [1] and the session-RPE protocol. Heart rate (HR) was monitored via a chest-based HR monitor (H10, Polar Electro®, Kempele, Finland), where HR was recorded at one second intervals. The CR-10 RPE were recorded within 30

minutes after returning to shore. For all data, Kruskal-Wallis and Mann-Whitney tests were used to compare any differences between WI categories within the TL methods. All the TL measures were additionally compared to EE by assessing the level of correlation.

RESULTS: Sailors' EE were higher during strong compared to light and moderate WIs ($p < 0.01$). Median TL (IQR) for all sessions was calculated at 95 (59-128) AU, 222 (1501-306) AU and 438 (292-598) AU for TRIMP, SHRZ and session-RPE, respectively. TRIMP (Median: 104 vs. 99 AU) and session-RPE (Median: 479 vs. 328 AU) ($p < 0.05$) TLs were higher in strong compared to light WIs. Conversely, the HR-based methods were highest in medium WI (Median: TRIMP=120 AU; SHRZ=246 AU). More time was spent in SHRZ zones 4 and 5 during stronger compared to lighter WIs ($p < 0.05$). Correlations between EE and TL variables were between rho = -0.36 and 0.61 ($p < 0.01$).

CONCLUSION: Wind intensities apply an external stimulus to the sailor, thereby contributing to internal loads (physiological and psychological response) imposed on the sailor, especially when comparing strong and light WIs. These findings demonstrate that an increased effort is required to sail an Optimist dinghy in increasing WIs. It is, therefore, necessary to monitor the TLs of Optimist sailors in different WIs to be sure the athlete is optimally adapting to the training stimulus, as well as not becoming overloaded. Furthermore, TLs in different WIs suggest the need for specific training programs for competitive Optimist sailors. Where adjustments when expecting certain conditions in future regattas, i.e. a session with a prescribed training intensity, can be manipulated by either sailing in lighter/stronger wind intensities or by decreasing/increasing the session duration.

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## Conventional Print Poster Presentations

### CP-AP12 Coaching IV - Elite Athletes

**THE PHYSICAL DEMANDS OF ELITE FEMALE FILED HOCKEY ATHLETES DURING MATCHES AND THE ENLIGHTENMENTS OF FIELD HOCKEY TRAINING**

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INTRODUCTION: Field hockey is a team sport that requires a lot of technical, tactical and physical activity. Players need to use the hockey stick to control the hockey, and cooperate with teammates to complete a variety of technical and tactical actions [1]. The 2015 new FIH rules increased the requirements of physical activities of athletes in the matches [2]. In addition, the application of GPS and inertial motion analysis (IMA) in the field of hockey matches further improved the match-analysis level of field hockey games [3,4]. Thus, using the latest GPS and IMA technology to reveal the physical demands of elite female hockey players under the 2015 new FIH rules is very important.

METHODS: 21 high level matches' data of 22 elite Chinese females field hockey athletes [Age: (23.5±4.9) years old; Height: (168.5±4.6) cm; Weight: (62.4±5.3) kg; BMI: (22.0±1.7) kg/m2] were recorded by IMA units (Optimeye S5, Catapult Sports, Australia, 10Hz). The paired sample T-test was used to compare the differences between different positions and different quarters, significant difference was set at $P < 0.05$, and very significant difference was set at $P < 0.01$.

RESULTS: The elite female field hockey athletes covered 45.5±15.5 min average playing time, 5021.5±1535.0 m average total running distance (544.0±210.8 m in high-speed running, 11.2%±3.8% of total running distance), 52.6±24.0 times medium and high (M&H) IMA movements and 112.9±14.0 m/min average running speed per game. Regarding the sprint performance, the elite female field hockey athletes performed 167.9±85.3 m total sprint distance, 11.2±5.5 times sprint times and 15.2±3.8 m average sprint distance per game. Compared with the strikers and midfielders, defenders performed significant lower high-speed running (HSR) distance percentage, average running speed, HSR distance percentage per minute ( $P<0.01$), and significant higher total M&H IMA movement, M&H acceleration movements, M&H deceleration movements, M&H change of direction left, M&H change of direction right ( $P<0.05$).

CONCLUSION: The elite female field hockey athletes should have more substitutions, lower playing time in future competitions; the high-speed running distance percentage should above 20% in the future high intensity training sessions; should focus on intermit running and recovery sessions, to improve the ability of intermit running and recovery; should have specific training schedule to develop the high-speed running capacity of strikers and midfielders, and the explosive capacity of defenders.

1. Reilly et al., (1992) 2. McMahon and Kennedy, (2019) 3. Kapteijns et al., (2021) 4. Cai, (2017)

**WEEKLY WORKLOAD DISTRIBUTION IMPACT IN ELITE FOOTBALL PERFORMANCE - SCIENTIFIC HYPOTHESIS OR EMPIRICAL EVIDENCE: A SYSTEMATIC REVIEW**

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INTRODUCTION: In elite soccer, weekly workload management is commonly used with the aim objective of enhancing performance and reducing fatigue. Despite the widespread implementation of weekly workload monitoring in professional clubs, the relationship between load distribution and performance remains unclear.

METHODS: A systematic search was conducted using PubMed and ScienceDirect databases until December 2024. The analysis was performed in two steps: first, characterizing weekly workload distribution patterns within microcycles, and second, examining their effects on performance outcomes. The Newcastle-Ottawa Scale was used to assess methodological quality.

RESULTS: Thirty-six studies met the inclusion criteria, with a moderate methodological quality score (5 ± 0.84/9). Analysis revealed a consistent weekly periodization model characterized by three phases: post-match recovery (MD+1/MD+2), peak load distribution (MD-4/MD-3), and pre-match tapering (MD-2/MD-1). While this general framework was common across teams, variations were observed in its practical implementation across all phases of the microcycle. Regarding performance outcomes, only two studies (5.4%) examined the direct impact of load distribution through specific performance tests, with limited evidence to establish clear impacts of weekly training load patterns on physical performance.

CONCLUSION: Despite a common weekly periodization framework across elite football teams, substantial variations exist in its practical implementation throughout each phase of the microcycle. Most importantly, there is a critical lack of evidence regarding the impact of these different load distribution strategies on performance outcomes. Future research should prioritize examining this impact to establish evidence-based recommendations for practitioners.

**COORDINATIVE WARM-UP AND ITS INFLUENCE ON TECHNICAL PERFORMANCE AND STRESS BIOMARKERS IN ELITE SOCCER PLAYERS**

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INTRODUCTION: Coordination training in soccer plays a crucial role in the integrated development of players' technical, physical, and tactical skills. Several studies have highlighted the close correlation between high levels of physical fitness and specific coordination skills, demonstrating how these factors improve cognitive functions related to the game [1, 2]. Another key element in soccer is the role of cortisol—the stress hormone—which is released in response to motivational and goal-relevant tasks in competition [3]. This study evaluated the effectiveness of an experimental warm-up protocol designed to improve motor coordination and optimize biomarker levels in elite soccer players.

METHODS: Thirty-two male soccer players (age: 24.7 ± 3.1 years) from two elite regional teams were randomly assigned to either an experimental group (EG; n = 18) or a control group (CG; n = 14). Over 12 weeks, the EG performed a specialized warm-up consisting of four progressive coordination exercises for the upper and lower limbs using various balls, four times per week (including game days), while the CG maintained their usual routine focusing on joint mobility and muscle activation. Technical and coordination abilities were assessed pre- and post-intervention using the Y Pre-Planned Agility Test, the Y Reactive Agility Test, the Illinois Change of Direction Test (ICODT) with and without the ball, and the Loughborough Soccer Shooting Test (SHOT). Urine samples were collected before and after the intervention to measure levels of cortisol, dopamine, adrenaline, and noradrenaline.

RESULTS: RM-ANOVA revealed significant improvements in the Illinois Ball Test and Technical Index, with the experimental group showing significant progression from pre- to post-assessment ($p < 0.001$) and performing significantly better than the control group ($p = 0.017$). Significant improvements were also found in the Unplanned Y Test and Reaction Index, with the experimental group demonstrating marked gains from pre- to post-assessment ($p < 0.001$) and performing significantly better than the control group ($p < 0.05$). In addition, significant differences were observed in shooting accuracy, with the experimental group showing marked improvement from pre- to post-assessment ($p < 0.001$) and performing significantly better than the control group ($p < 0.05$). The experimental group also exhibited a significant reduction in cortisol levels ($p = 0.0007$); post-intervention comparisons between groups ($p = 0.003$) and delta analysis ($p = 0.036$) further confirmed a more pronounced reduction in cortisol levels in the experimental group.

CONCLUSION: The study highlights that the adoption of a coordinative warm-up protocol not only enhances technical performance and change of direction ability but also promotes a more favourable regulation of cortisol level in elite soccer players.

1.Baccouch (2024) 2. Buchel (2022) 3. Page et al. (2024)

**VASTUS LATERALIS MUSCLE VOLUME AND BODY MASS INDEX AS KEY DETERMINANTS OF STRENGTH AND POWER PERFORMANCE IN YOUNG FEMALE ACROBATIC GYMNASTS.**

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INTRODUCTION: In acrobatic gymnastics, the interplay between force production and movement velocity (F-V) is fundamental for performance optimization (1,2). Furthermore, gymnasts' lower limb muscle characteristics have been shown to influence both isometric force production and the efficiency of the stretch-shortening cycle, which are essential for executing complex gymnastic movements (3). This study aimed to assess the relationship between muscle size, muscle architecture, body mass index and strength and power performance in young elite acrobatic gymnasts (ACRO).

METHODS: Eighteen elite females base ACRO participated (13.83±1.62 years; body mass index (BMI): 21.03±2.39 kg/m2). Maximal dynamic strength was measured by the one-repetition maximum test in the squat exercise (1RM-SQ). F-V relationship was evaluated in the squat exercise (Selection MED, Technogym, Italy) using a lineal encoder (ADR System, Toledo, Spain). From the F-V regression equation, several variables were derived, including maximum isometric force (F0), maximum unloaded velocity (V0), optimal force (Fopt), optimal velocity (Vopt), and maximum muscle power (Pmax). Jumping ability was measured by the countermovement jump height (CMJmax) using a force plate (Hawkin Dynamics Inc., USA) and the modified reactive strength index (mRSI) was measured. Body composition was determined via bioelectrical impedance (Tanita BC-601). Ultrasonography (MyLab 25, Esaote Biomedica, Italy) was used to assess vastus lateralis anatomical cross-sectional area at 35, 50, and 65% of femur length and muscle volume was estimated, while muscle architecture was assessed at 50% of femur length. Images were analyzed using Fiji and SMA software. Pearson correlations and multivariate regression models adjusted for maturation status (Tanner scale) were used (SPSS v26.0, IBM, USA).

RESULTS: Model 1 predicted 1RM-SQ and included BMI, vastus lateralis muscle volume, F0, Fopt and Tanner Scale as predictors (p=0.017, $R^2$=0.496). Model 2 predicted Pmax-SQ and included BMI, vastus lateralis muscle volume, and Tanner Scale as predictors (p=0.006, $R^2$=0.485). Model 3 predicted CMJmax and included vastus lateralis muscle volume, mRSI and Tanner Scale as predictors (p=0.107, $R^2$=0.203).

CONCLUSION: Vastus lateralis muscle volume and BMI were significant predictors of strength and power performance, indicating their role for base acrobatic gymnasts. Thus, the vastus lateralis muscle emerges as a key muscle to prioritize training for this population. Muscle volume and mRSI alone did not predict jump height, suggesting that other biomechanical and neuromuscular factors may affect explosive performance. Future research should use larger groups and more performance variables to better understand how muscular architecture affects gymnastics performance.

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**OVERALL ANALYSIS OF PERFORMANCE PARAMETERS IN ELITE ARCHERS: FOCUS ON THE AIMING PHASE**

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INTRODUCTION: Archery is an Olympic sport where archers aim at a 122 cm target placed 70 m away, scoring points based on the concentric rings hit. Performance depends on multiple phases of movement, with aiming and follow-through phases being essential for accuracy and control. Factors like neuromuscular activation, postural stability, kinematic of drawing arm, and temporal strategy vary with performance level, highlighting distinct strategies between elite and novice archers (Vendrame et al., 2022). While most studies focus on analyzing each type of performance determinant separately, our approach stands out by simultaneously assessing these factors. The aim is to provide a comprehensive view of their overall contribution to success at the elite level.

METHODS: Eight high-level French archers (4 men, 4 women; 19.1 ± 2.7 y.o.), ranked in the national top 20 in 2024, participated in this study with informed consent. They shot eight rounds of nine arrows at a 70 m target using their own equipment. The five highest scores (HS) and five lowest scores (LS) for each participant were analyzed. During the aiming phase, measurements includes temporal strategies (aiming duration and clicker reaction time), muscle activity (mean %EMG on MVC for 14 upper body and core muscles), drawing arm kinematics (elbow flexion, shoulder abduction), postural control (center of pressure displacement), and breathing patterns (breathing amplitude). HS and LS were compared using paired t-tests for all the variables measured.

RESULTS: All HS (10.6 ± 0.1) were higher than LS (7.4 ± 0.5). Among the performance parameters measured, only muscle activity appeared to be a discriminating factor. Higher activity in the drawing-side flexor digitorum superficialis (FDS), the drawing-side deltoid posterior (DP), and the drawing-side external oblique (EO) was significantly associated with poorer performance ($p < 0.05$). Additionally, a tendency was observed for the chord-side deltoid middle, the chord-side upper trapezius, and both multifidus muscles ($p < 0.08$), suggesting that increased activity in these muscles may also be linked to poorer performance. The other parameters measured, including postural control, kinematics of the drawing arm, temporal strategy, and respiratory movement, did not significantly contribute to explaining elite-level performance.

CONCLUSION: Results for the FDS and EO align with those of another study, but the DP result contrasts (Simsek et al., 2018), likely due to our focus on elite athletes versus their mixed-level study. Comparing groups of different skill levels could offer valuable insights. The tendency for three trunk muscles suggests the need for further research on their role in elite archery. Advanced methods like partial least squares regression could also clarify the contribution of each parameter to performance

**ANXIETY LEVELS IN ELITE ARCHERS IN COMPETITION AND ITS EFFECTS ON ATHLETES' PERFORMANCE**

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INTRODUCTION: In precision sports, it is important for athletes to manage their anxiety levels as it can affect their motor performance. Competitive anxiety can have a significant impact on an athletes performance. It triggers emotional, behavioral, cognitive, and physiological responses such as the release of cortisol.

METHODS: This cross-sectional study evaluated 40 elite archers, all male and with at least 5 years of archery experience, who volunteered to be monitored during a national archery championship. The Sport Competition Anxiety Test (SCAT), salivary cortisol (s-cortisol), and salivary IgA (s-IgA) were measured 30 minutes before free practice (day 1) and 30 minutes before the official competition (day 2). A sub-sample of eight participants was also monitored for four weeks prior to the competition.

RESULTS: A t-test analysis indicated that s-cortisol ($p<0.001$, Cohens $d=1.20$), s-IgA ($p<0.01$, Cohens $d=0.5$) and SCAT ($p<0.001$, Cohens $d=1.20$) levels were statistically different when compared between competition and free training, with an increase in competition. One-way repeated measures ANOVA showed a significant increase in anxiety (SCAT) from training to competition [$F(1.46) = 15.54$, $p<0.001$]. The increase was significant over time (four ($p<0.05$), three and two ($p<0.01$) weeks prior to competition). Finally, the rate of increase in anxiety was moderately negatively correlated with competition performance ($r= -0.7$; $p<0.01$).

CONCLUSION: This study highlights how competitive anxiety affects elite archers. The increase in cortisol, IgA, and SCAT scores during competition suggests higher stress levels. Anxiety gradually increases leading up to competitions, impacting performance negatively. Interventions like relaxation training and cognitive-behavioral techniques may help improve performance by managing anxiety.

The psychophysiological anxiety and stress responses of professional archers increase significantly in competition, and this process develops gradually during the archers training process up to four weeks before official competition. This condition can negatively impact the accuracy of shots, impairing the performance of precision's athletes during a competition.

**WHAT MAKES AN ATHLETE READY FOR TEAM SELECTION IN PROFESSIONAL AUSTRALIAN FOOTBALL? PERSPECTIVES FROM COACHING AND SUPPORT STAFF.**

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INTRODUCTION: The transition from sub-elite to elite Australian Football is a significant milestone for athletes striving for a professional career. To achieve this, athletes need to be drafted by one of the 18 clubs in the Australian Football League (AFL) [1]; however, that does not guarantee success as only 22 (of 44 athletes) are selected each week. This study aimed to describe the perceptions of key club personnel on what attributes make an athlete ready for selection into the team each week. Findings will provide athletes a clear and comprehensive understanding of what is required to be ready for weekly AFL team selection.

METHODS: Participants were recruited using a purposive sampling procedure. Twelve current staff members from one AFL club participated in individual 30–60-minute semi-structured interviews. Staff members were involved in the men's team selection and/or preparation of athletes (coaches ($n = 4$), physical preparation staff ($n = 3$) and other football department staff ($n = 5$)). Interviews were transcribed verbatim prior to analysis. Data analysis followed the six-phase framework for reflexive thematic analysis.

RESULTS: A total of thirteen lower-order themes and four higher-order themes were identified that related to the individual athlete attributes as described by staff in this context. The four higher order themes were Physical and Physiological, Technical and Tactical, Psychological, and Performance. Staff generally agreed on the importance of physical and physiological, and performance attributes, with less consensus observed within the technical and tactical, and psychological attributes. However, the specific attributes required by an athlete depend on what position they are being considered for. Findings suggest that two categories of attributes may exist in the assessment of readiness, the first consisting of attrib-

utes considered essential and possessed by a larger portion of athletes (e.g., health or running capabilities), while the second consists of attributes seen as less essential but more critical to performance (e.g., speed or football IQ).

CONCLUSION: These findings provide novel insights within a football department about what determines player readiness, which could lead to an aligned interdisciplinary approach to developing athletes. Findings also have the potential to benefit playing groups across the league, giving athletes greater clarity of what is expected of them to be considered ready for selection into an AFL team.

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**THE SCIENCE OF CHAMPIONS: CASE STUDY INSIGHTS INTO LONG-TERM DEVELOPMENT OF WORLD-CLASS ATHLETES' TRAINING AND PHYSIOLOGY**

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INTRODUCTION: Sports science typically relies on group designs comparing experimental and control groups or pre- and post-intervention results. However, in elite sports, the focus shifts to individual adaptation rather than group averages. Single-subject or case-study designs offer valuable insights into long-term development of training and physiology that larger sample sizes cannot capture [1]. Therefore, this narrative review aims to provide a comprehensive overview of case studies on the long-term development of world-class and elite athletes in Olympic and Paralympic sports, advancing the field by identifying trends, highlighting knowledge gaps, and guiding methodological improvements.

METHODS: A systematic search of ScienceDirect, PubMed, and SPORTDiscus identified case studies on world-class or elite athletes (Tier 5 or 4, McKay et al., [2]) that provided long-term data (>2 years) on training characteristics or physiological performance factors in Olympic or Paralympic sports.

RESULTS: Twenty-six peer-reviewed studies met the inclusion criteria, covering nine sports including running (6 studies), triathlon (5), rowing (3), biathlon (2), swimming (2), tennis (2), cross-country skiing (2), cycling (1), and Nordic combined (1). Athletes from 8 countries were included, with the majority from Norway (9), Spain (6), and the United Kingdom (4). The studies included 29 athletes, with limited data on female (31%), Paralympic (14%), and non-endurance athletes (8%). The mean study duration was 7.1 ± 4.6 years.

Of the included studies, 23 reported long-term training data, showing a 10-438% increase in annual training volume over 2-17 years, with varying trends in training intensity distribution. Fourteen studies examined physiological performance, with eight reporting $VO_2$max increases of 4-42% over 2-11 years, while three documented declines of 4-17% post-retirement. Twelve studies analyzed submaximal performance indicators, showing power output or velocity at threshold values (VT2, LT, or 4 mmol) increased by 13-101% over 2-11 years. The percentage of $VO_2$peak at different threshold values remained stable or increased by up to 13 %-points. Only two studies reported data on efficiency/economy, showing a decline of 9% and 14% in $VO_2$ at similar submaximal speeds over 4-11 years, respectively.

CONCLUSION: This review summarizes available evidence on long-term development of training and physiology in world-class or elite athletes. Detected knowledge gaps include long-term data on female and para-athletes, as well as training in specialized environments like heat and altitude. Developing better frameworks for reporting long-term training data on world-class and elite athletes (e.g., intensity distribution and exercise modes) represent key areas for methodological improvement.

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## Conventional Print Poster Presentations

### CP-AP20 Power and Strength III

**THE RELIABILITY OF HORIZONTAL REACTIVE STRENGTH INDEX**

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INTRODUCTION: The Reactive Strength Index (RSI), defined as the ratio between jump height and ground contact time, is used to assess vertical reactive strength and has been shown to be reliable both during (1) and between training intervals (2). A possible limitation of the RSI is that they only assess reactive strength in the vertical direction, whereas horizontal movements, such as sprinting and CoD in many sports are critical. For example, research has shown that horizontal force generation is a major determinant of sprint acceleration. It is critical to assess the horizontal RSI of horizontal sport athletes. However, the reliability of horizontal RSI derived from different horizontal jumps is unclear. Therefore, the aim of this study was to determine the reliability of sprint bounding and single-leg hopping.

METHODS: Thirty-six male college players (21.29 ± 2.16 yr, 180.73 ± 4.02 cm, 79.32 ± 15.27 kg) with well-trained background were recruited in this study. All subjects randomly performed three sprint bounding and single-leg hopping trials in random order. The 2-3 min rest interval was allowed between trials and 5 m interval between tests. For the sprint bounding and single-leg hopping test, participants started with a 5 meter sprint and completed a 5-step forward jump, the contact time and distance was recorded using 10 pair Optojump. The average contact time and jump distance of each jump was used for further analysis. Horizontal DSI was define as the ratio of jump distance and contact time. For the assessment of reliability, and given our repeated measures design, a two-way mixed effects intraclass correlation model was used, where both the reliability of a single (best) trial (ICC [3,1]) and the average of three trials (ICC [3,k]) were assessed. Furthermore, the coefficient of variation (CV %) was also calculated, thus providing us with a measure of relative and absolute reliability. The combination of the ICC and CV% enabled the interpretation of overall reliability as follows: excellent (ICC > 0.9 and CV% < 5), good (0.75 < ICC ≤ 0.9 and CV% < 10), fair (ICC ≤ 0.75 or CV% > 10) and poor (ICC ≤ 0.75 and CV% < 10) (3).

RESULTS: For the sprint bounding, good reliability was observed in contact time (ICC = 0.78, CV% = 9.4%), jump distance (ICC = 0.82, CV% = 8.3%), and horizontal RSI (ICC = 0.81, CV% = 3.4%). For the single-leg hopping, contact time (ICC = 0.89, CV% = 9.2%) and jump distance (ICC = 0.89, CV% = 9.2%) exhibited good reliability, excellent reliability was observed in horizontal RSI (ICC = 0.91, CV% = 2.4%).

CONCLUSION: Both sprint bounding and single-leg hopping showed accepted reliability, the horizontal RSI derived from single-leg hopping exhibited excellent reliability. Therefore, practitioners can choose sprint bounding or single-leg hopping to assess player's horizontal RSI.

**COMPARING LINEAR ENCODERS AND INERTIAL MEASUREMENT UNITS IN NEUROMUSCULAR PROFILING: A PRELIMINARY STUDY**

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INTRODUCTION: The functional assessment of sports performance is fundamental throughout an athlete's season. In various sports such as kayaking, water polo, soccer, and swimming, linear encoders are widely used to monitor the neuromuscular profile (1-4). The linear encoder (MuscleLabTM system, Norway), introduced and validated by Bosco et al., (1995) is a mechanical device capable of measuring time and displacement to estimate respectively the force-velocity and power-velocity ratio.

Recently, new encoders and inertial measurement units (IMUs) (e.g., Vitruve, Movella Xsens) have been employed to assess kinematic and dynamic performance in land exercises such as bench press, squat, and prone bench pull. Given these advancements, this study aims to investigate whether these new devices provide data as reliable as the gold-standard MuscleLab system.

METHODS: All devices involved in the study (MuscleLab, Vitruve, Xsens) were fixed and calibrated on the barbell. The sample acquisition rate was 100Hz for Vitruve and MuscleLab and 120Hz for Xsens. The test protocol provided six repetitions for each load (from 20,30,40,50 and 60kg) performed by the same athlete (Semi-Pro water polo athlete, Male, 32 years, 1.87m height, 83.5 weight) at maximum velocity, on the bench press (Smith machine). Between each series, an optimal recovery of 4 minutes was considered. The data provided for each device were respectively range of motion [ROM] (m), time (s), mean propulsive velocity [MPV] (m/s), and power (W). Repeated measures analysis of variances (ANOVA) has been used to compare the similar parameters measured by different devices on the same subject.

RESULTS: The results showed no significant differences between MuscleLab and Xsens ($p > 0.05$). However, Vitruve exhibited statistically significant differences with MuscleLab and Xsens specifically for MVP, power, ROM, and time ($p < 0.01$). Instead, the MVP showed no significant differences between the devices, only at 60kg.

CONCLUSION: This preliminary study showed that the parameters measured with Vitruve are different from the MuscleLab linear encoder and Xsens for light loads. Thus, to focus on the velocity and power in the power-based exercises it could be suggested to implement MuscleLab or Xsens.

**VALIDITY AND RELIABILITY OF FLYWHEEL RESISTANCE TECHNOLOGY AS AN ASSESSMENT METHOD AND ITS ASSOCIATION WITH SPORTS PERFORMANCE AND ASYMMETRY: A SYSTEMATIC REVIEW**

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INTRODUCTION: Flywheel technology is commonly used in training but remains underutilized for monitoring and testing. Flywheel devices can provide valuable data from mechanical outputs during both concentric and eccentric movements. This systematic review assesses its validity and reliability for evaluating sports performance and limb asymmetry.

METHODS: Searches were conducted in PubMed, SPORT-Discus, Google Scholar, and Web of Science following PRISMA DTA guidelines, focusing on keywords related to flywheel testing.

RESULTS: The initial search yielded a total of 310 articles (figure 1). The data were imported to the ZoteroTM reference manager software version 6.0.30 (Vienna, Virginia, USA). Duplicates (30 titles) were subsequently removed, either automatically or manually. The remaining 280 articles were screened for their relevance based on their titles and abstracts. Of those,

260 articles were removed, and the full texts of the remaining studies were then inspected. After the automatic search, 20 articles remained for data extraction and further analysis. Following the citation of the list of 20 articles, 7 more eligible titles were suggested, reviewed, and integrated. Consequently, a total of 27 articles were included in the final systematic review.

CONCLUSION: Results show that flywheel testing is reliable and valid for the athletic population who when subjects undergo two familiarization sessions and perform with 1-2 pre-repetitions followed by 5-10 recording repetitions with 1-4 sets and 2-3 minutes of rest between sets and with proper equipment (e.g., rotary encoders, force plates, linear encoders, and inertial measurement units) are used (ICC=0.66-0.99, r=0.69-0.97, α=0.85-0.98). Moment of inertia can be customized based on the athletes experience and the type of flywheel device used. Key metrics for assessment encompass speed, force, and power, with peak power being the most commonly employed parameter. Few samples of evidence showed that increased asymmetry in concentric power may negatively affect change of direction performance, emphasizing the need for more high-quality studies. In conclusion, flywheel technology offers valuable insights across various movements, providing strength and power assessment while potentially improving athletic performance and injury prevention. Continued research is vital to explore its effectiveness in diverse athletic contexts.

**RELIABILITY OF A NOVEL ISOMETRIC MAXIMAL STRENGTH TEST FOR HIP THRUSTS: A STUDY WITH ELITE ATHLETES**

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INTRODUCTION: Hip Thrusts are widely used in elite athletes training to increase maximal strength of the posterior chain muscles in the lower limbs, to enhance performance, provide hip, knee, and core stability and to reduce injury risks.

Therefore, we aimed to calculate reliability of a novel isometric maximal strength test for the Hip Thrusts under different conditions, compare muscle activity and assess maximal strength differences across these conditions.

METHODS: Eleven elite athletes from seven different sports (age: 22.4 ± 2.6 years) participated at two testing sessions. The protocol included bilateral and unilateral isometric maximal strength measurements (force plate) in a horizontal Hip Thrust position against a barbell fixed at knee height. Testing was conducted at two knee angles (90° and 150°) and under two conditions: stable and unstable (feet on an independently moving cart system). To evaluate differences between these conditions, muscle activity (EMG) of the biceps femoris (BF), gluteus maximus (GM), rectus femoris (RF), and erector spinae (ES) and relative maximal isometric strength (Fmax_rel) was measured.

RESULTS: Results showed high reliability for Fmax_rel across all conditions (ICC: 0.90–0.99). Coefficient of variation (CV%) values were acceptable for bilateral conditions (90° stable: 5.9%, unstable: 5.0%; 150° stable: 6.0%, unstable: 3.2%) and unilateral conditions at 90° (stable: 4.4%, unstable: 4.6%), though variability was higher at 150° (stable: 11.3%).

Comparisons of EMG measurements at 90° knee angle revealed a significant decrease in muscle activity of RF under the unstable condition (-57.1% ± 22.0, $p < 0.001$). Conversely, a non-significant increase in muscle activity was observed for BF (+29.8% ± 75.4, $p > 0.05$).

Comparing stable conditions at 90° and 150° showed significantly higher muscle activity for BF (+163.8% ± 149.2, $p < 0.01$) and significantly lower activity for RF (-60.5 ± 25.6%, $p < 0.001$) and GM (-37.4% ± 25.1, $p < 0.001$) at 150° knee angle.

Analysis of Fmax_rel at 90° knee angle showed a reduction in isometric strength of 21.1% ± 8.9 when performed under unstable compared to stable conditions ($p < 0.001$). Comparing Fmax_rel under stable conditions at 90° and 150° demonstrated a 50.0% ± 9.2 lower maximum strength at 150° ($p < 0.001$).

CONCLUSION: The results demonstrated sufficient reliability under most tested conditions (except unilateral 150°). Further research is required to validate the test and establish its relevance to elite sports performance. The findings suggest that posterior chain muscles fulfill distinct roles depending on foot stability and knee angles during the execution of Hip Thrusts. Accordingly, targeted training regimens could optimize training stimuli, enhance performance and reduce the risk of injury. Finally, implementing an unstable variation of hip thrusts appears to be a highly effective strategy for promoting correct activation patterns in posterior chain muscles.

**APPLYING MULTIPLE-SPRINT FATIGUE INDICES TO FLYWHEEL SQUAT: A RELIABILITY STUDY**

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INTRODUCTION: Fatigue indices have been employed to assess athletic performance decrements in repeated sprint ability tests (RSA) where short resting periods are allowed between repetitions [1]. Flywheel devices (FD) are widely used in resistance training for their adaptive resistance, enabling maximal exertion per repetition [2]. FD are ideal for assessing fatigue since, unlike RSA, there is no rest between repetitions. Therefore, performance can decline within the set, in spite of being stable between sets. Despite numerous studies focused on fatigue with FD, there is a gap regarding the best formulae to quantify the drop-off in performance. This study aims to explore the reliability of eight established fatigue indices, typically used in RSA tests, applied to the squat exercise on a FD.

METHODS: Seven males and 11 females performed 2 sets of 6 half-squat repetitions at maximal velocity at an inertial load of 0.13 kg·m2 with 3 minutes of rest in between.

Fatigue during each set was calculated from mean power of the concentric phase using eight formulae [3]. A paired T-test was conducted to evaluate differences between sets in repetition one and mean value of each set. Reliability was presented as intraclass correlation coefficient (ICC) and coefficient of variation (CV).

RESULTS: Sixty one percent of highest mean power values occurred in repetition one in set 1, compared with 50% in set 2. There were no significant differences between sets neither in repetition 1 ($p=0.897$) nor in the mean value of the set ($p=0.765$). The ICC values ranged from 0.718 to 0.833, showing good relative reliability across the different formulas [4]. In contrast, absolute reliability (CV) was ≥ 20% in all formulas except in those which consider the highest and lowest mean power values of the set.

CONCLUSION: While most methods demonstrated good reliability, some exhibited considerable variability as previously reported [3]. Although the usefulness of these measures is questioned to calculate fatigue during RSA due to the lack of reliability [5], we found

that methods considering the highest and lowest mean power values exhibited lower variability while maintaining good reliability. However, these indices only represent the percentage of change, without considering whether performance declines or increases from the beginning of the set. For FD squat exercise, where it is important to determine the time-course of fatigue throughout the set, we suggest as the most appropriate indexes, those that consider the percentage difference between the beginning and the end of the set, particularly the first and last repetition.

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**STATISTICALLY SIGNIFICANT BUT PRACTICALLY IRRELEVANT CHANGES IN JUMP HEIGHT AFTER REPEATED BOUTS OF COUNTER-MOVEMENT-JUMPS: A NON-INFERIORITY STUDY**

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INTRODUCTION: The counter-movement-jump (CMJ) is commonly used to estimate training readiness and neuromuscular fatigue [1]. Typically, multiple jumps (sets of 3 – 5) are performed to enhance test sensitivity and reduce variability. However, repeatedly performing maximal jumps in a short period of time may itself induce fatigue, complicating the interpretation of results. This non-inferiority study aimed to determine the maximum number of CMJ sets that can be performed in a single session without inducing statistically significant and practically relevant decreases in jump height.

METHODS: Therefore, 97 young active (female & male) adults attended the lab twice. The first visit consisted of anthropometric evaluations and CMJ familiarization. The second visit started with a standardized cycling warm-up (10 min; 100 W; 80 rpm) and three submaximal CMJ. After 2 min of rest, participants completed sets of 3 maximal CMJ (15 s rest between jumps) at Baseline (T0) and every subsequent three minutes (T3–T24; 9 sets in total). Jump height was estimated using two distinct methods: (i) the flight time method and (ii) the impulse–momentum method. For both methods, performance was analyzed as the mean of all three jumps, the two highest jumps, the highest jump, and the median jump. To determine equivalence between timepoints, the maximal difference between the jump heights at T0 (DmaxT0; highest – lowest jump) was determined. Jump height at T3–T24 were deemed equivalent to T0, if their mean difference and corresponding 95% confidence intervals were entirely within the 'irrelevant margin', defined as $T0 \pm 0.5 \times DmaxT0$.

RESULTS: An ANOVA revealed statically significant time-effects for all four data handling methods in both the impulse–momentum ($F(8, 760) \geq 34.50$, $p < 0.001$, $\omega p2 \leq 0.26$) and the flight-time method ($F(8, 760) \geq 19.71$, $p < 0.001$, $\omega p2 \leq 0.16$). For the impulse–momentum method, post-hoc testing revealed a statistically significant reduction from T9 (median, two highest, and highest) and T12 (mean) onwards compared to T0. For the flight-time method, post-hoc testing revealed a statically significant reduction from T9 (highest), T12 (median, two highest) or T15 (mean) onwards compared to T0. However, all changes from baseline across all time points and analysis methods remained within the irrelevant margin.

CONCLUSION: To improve the accuracy and sensitivity of jump height estimation, practitioners and researchers should assess multiple jumps at each time point and use an average of at least two jumps. While jump height declined significantly after only 4 to 5 sets of 3 jumps, the decrease was smaller than the baseline noise and thus likely too small to be considered a practically relevant fatigue-related performance decline.

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**THE RELATIONSHIP BETWEEN INTENSITY AND NUMBER OF REPETITIONS FOR CMJS**

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INTRODUCTION: The countermovement jump (CMJ) is widely used in sports as a diagnostic tool and as an exercise to assess lower-limb function and enhance neuromuscular jump performance. CMJ-based training regimen typically follow best-practice guidelines, emphasizing maximal intensity and predefined volumes. However, submaximal CMJs may impose similar loads on the ankle and knee while reducing hip joint demand, indicating unexplored potential by varying the intensity of jumps during training (Lees et al., 2004). Moreover, jumps have been used recently to create a high intensity interval training (Kramer et al., 2019), requiring a high number of jumps throughout one training session. In order to individualise submaximal jump-training, the relationship between jump height (intensity) and number of repetitions (volume) must be known. At present, this relationship has not been studied and is unknown. Thus, the aim of the present study was to assess the relationship between jump height and number of repetitions until failure for CMJs.

METHODS: In a within-subject design, 16 young, healthy adults (7 female, 9 male) performed randomized trials of repetitive CMJs until exhaustion at target intensities of 55%, 70%, 85% and 100% of their maximal baseline CMJ height. Participants received visual feedback on their jump intensity after every jump. Break time was standardized with an auditory signal 1 s after ground contact, and trials stopped when participants fell below their target range (target intensity -7.5%) for three consecutive jumps.

RESULTS: Results showed progressively more repetitions until failure at lower intensities with an average of 11 (SD = 7) repetitions at 100%, 55 (SD = 42) repetitions at 85%, 134 (SD = 75) repetitions at 70% and 424 (SD = 334) repetitions at 55%.

CONCLUSION: These results create baseline values for intensity-dependent standardizations of CMJ-based training protocols and training interventions. The observed relationship between intensity and repetitions until failure appears to follow a hyperbolic curve, resembling common power-duration relationships. The present study paves the way for future research to explore whether CMJs adhere to established power-duration models and how this relationship might inform training prescriptions and fatigue management strategies for jump-training.

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**JUMPING FOR EFFICIENCY: EXPLORING COUNTERMOVEMENT JUMP PROFILES IN SHANGHAIS SUB-ELITE YOUTH ATHLETES**

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INTRODUCTION: The measurement of vertical ground reaction force (GRF) during countermovement jumps (CMJ) is the most used assessment for lower extremity power in athletes. Previous studies have shown that CMJ profile characteristics, such as curve shape and peak force timing, can distinguish movement patterns in adult athletes[1,2]. This study aimed to validate the ability of CMJ profiles to differentiate movement efficiency in youth athletes.

METHODS: GRF data from CMJs performed by Shanghai city-level sub-elite youth athletes were analyzed. Jumps were conducted with arms akimbo on dual force plates (VALD, ForceDeck Lite) as part of routine monitoring, following standardized procedures. A single best jump per athlete (243 total trials: 143 males, 105 females; aged 14.7 ± 1.3 years) was included. Sports represented included track and field, baseball, swimming, and others. Jumps were categorized based on (1) peak force timing, specifically whether peak force occurred at the lowest center of mass (COM) position, and (2) GRF curve shape (unimodal or bimodal) using predefined criteria[2,3]. Performance metrics (jump height, modified reactive strength index), movement pattern metrics (e.g., phase times, countermovement depth), and phase-specific force and power metrics were analyzed. Data normality was assessed using the Shapiro-Wilk test. T-tests or Mann-Whitney U tests were applied for group comparisons, with effect sizes reported. Profiles were further classified into four groups for additional analysis. ANOVA or Kruskal-Wallis tests were used for multi-group comparisons. The significance threshold was set at $p < 0.05$.

RESULTS: In males, jumps where peak force coincided with the lowest COM position showed superior performance (9% higher jump height, 12% greater reactive strength index) and braking phase metrics (12%–36% higher outputs). Unimodal profiles demonstrated faster movement patterns (7%–15% shorter phase durations) and deeper countermovement (21% greater depth) compared to bimodal profiles, though jump height was similar. Further classification revealed that among four categories, unimodal profiles, where peak force coincided with the lowest COM position, demonstrated superior outputs across most metrics, indicating that this may represent the optimal movement strategy. Among females, significant differences were observed only with GRF curve shape, with shorter phase durations, deeper countermovements, and higher braking phase outputs, while no significant differences were associated with peak force timing.

CONCLUSION: GRF profiles can differentiate CMJ efficiency in male youth athletes, with jumps exhibiting peak force at the lowest COM position and unimodal curve shapes showing superior efficiency. These findings suggest that this combina-

tion represents the most effective jump strategy, producing higher outputs in shorter durations. However, differences were less evident in female athletes, warranting further study.

1. Kennedy (2018) 2. McHugh (2020) 3. Bayne (2021)

## Conventional Print Poster Presentations

### CP-AP23 Cycling

**RELIABILITY, CONCORDANCE AND AGREEMENT OF A STEP-RAMP-STEP CYCLING PROTOCOL TO EVALUATE ENDURANCE PERFORMANCE VARIABLES IN TRAINED TRIATHLETES.**

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INTRODUCTION: Ramp-incremental (RI) cycling protocols may allow to determine the constant work rate (CWR) oxygen uptake (VO2)-Power Output (PO) relationship(1) and hence the full spectrum of exercise intensity prescription(2). Endurance performance variables like the Gas Exchange Threshold (GET), the Respiratory Compensation Point (RCP), the maximal VO2 (VO2peak) and the energy depleted above RCP (Wramp) can be derived from a Step-Ramp-Step (SRS) protocol(2,3). However, reliability of these variables determined with the SRS protocol has not been reported and the agreement of the corrected PO at RCP (PORCP) and Wramp with gold-standards is equivocal(2,4,5). Also, recent research has focused on moderately active populations (Tier 0 and 1(6)) and studies with fitter individuals are lacking. Therefore, the goals of this study were to: 1) study the reliability of endurance performance variables from a modified SRS protocol in trained triathletes and 2) evaluate the agreement between PORCP and Wramp derived from the SRS protocols with the critical power (CP) and the quantity of energy depleted above CP (W) computed from 4 CWR exercise trials to failure.

METHODS: Twelve trained triathletes (Tier 2(6), 31 ± 6 yr, 72.2 ± 4.3 kg, VO2peak = 67.9 mL.min-1.kg-1) attended the laboratory 8 times to conduct a SRS protocol (visit 1), multiple CWR trials to failure (visits 2-5), a modified SRS protocol (twice, visits 6 and 7) and a CWR into the heavy-intensity domain (visit 8). PORCP was corrected similarly to recent studies(2,3) and W'ramp>CP or W'ramp>RCP were computed as the energy depleted above CP and PORCP respectively.

RESULTS: Coefficients of variation for VO2 variables were within a range of 2.1 to 3.7 % (CI95% : [1.5, 3.6] to [2.6, 6.3] %), for corrected PO at GET and RCP 3.0 % and 2.9 % (CI95% : [2.1, 5.1] % and [2.0, 5.9] %) and for Wramp>CP and Wramp>RCP 11.3 % and 11.6 % (CI95% : [8.0, 19.3] % and [8.2, 19.9] %). CP was higher than PORCP (bias 17 to 20 W, bias CI95% : [4, 29] to [6, 35] W, CCC = 0.52 to 0.67) and W' was higher than Wramp>CP (bias 1.5 to 6.2 kJ, bias CI95% : [-1.2, 4.3] to [4.2, 8.1] kJ, CCC = 0.48 to 0.74). Wramp>CP derived from the second modified SRS was higher than Wramp>CP derived from the SRS (+4.6 kJ, CI95% : [1, 8.2] kJ).

CONCLUSION: In trained triathletes, the modified SRS protocol provides good test-retest reliability for GET, RCP and VO2peak. Using the existing corrections strategies, CP was higher than PORCP and W' was higher than Wramp>CP. Although the variability associated with W'ramp>CP is important, the modified SRS protocol may provide closer estimates for W'ramp>CP than the classical SRS protocol.

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**OPTIMAL CADENCE FOR OPTIMAL ENDURANCE CYCLING PERFORMANCE**

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INTRODUCTION: The concept of optimal cadence in cycling performance can be examined from both a metabolic and a biomechanical standpoint. Metabolic Optimal Cadence (MOC) refers to the cadence that minimizes metabolic demands, such as oxygen consumption (VO2), thereby improving endurance performance. Biomechanical Optimal Cadence (BOC) can be assessed as improved neuromuscular efficiency measured via electromyograph (EMG), where total muscle excitation is minimized. The primary objective of this study was to investigate the possibility of predicting MOC from BOC.

METHODS: Each participant visited the lab twice. Visit 1 included a graded exercise test to determine maximal O2 uptake (VO2max) and the first ventilatory threshold (VT1). During visit 2, participants completed 35 minutes of cycling at a constant power output equivalent to 110% of VT1, where every five minutes cadence (60, 70, 80, 90, 100, 110, 120 rpm) was randomly changed. Participants were equipped with 13 EMG sensors on the quadriceps and hamstrings muscles, tibialis anterior, gastrocnemius, gluteus max and multifidi of the right side of the body. Additionally, they were connected to a metabolic system to allow continuous monitoring of metabolic variables. One minimum point was extracted from fitted parabolic

curves for VO2 (i.e., MOC) and for muscles excitation and co-contraction (i.e., BOC) for each participant. Model II linear regression and Bland-Altman plots were performed to assess the relationship between MOC and BOC.

RESULTS: Fifteen highly trained triathletes and cyclists participated in this study (14 males; mean±SD.; age: 24±5 years, height: 1.76±0.05 m, body mass: 66.8±5.1 kg, VO2max: 65.9±8.3 mL/kg/min, training volume: 18±7 hours per week). They came from the fields of triathlon, road, cross country and track cycling (n=9,3,2,1 respectively). The preferred cadence reported by the participants was 88±9 rpm. As analysed from VO2 data, MOC was 60±14 rpm. Conversely, EMGs provided greater BOC values (95±13 rpm for KE, 84±14 rpm for KF). The mean BOC leading to minimal KE-KF co-contraction was 91±7 rpm. For plantar flexors and for ankle co-contraction, BOC values were respectively 85±18 rpm 87±18 rpm. The relationship between MOC and KE showed fixed bias (35 rpm) with confidence interval (CI) for the intercept between 1.8-64.6 rpm. The relationship between MOC and KE-KF co-contraction showed both proportional bias (CI intercept: 38.2-73.7 rpm) and fixed bias (CI slope: 0.3-0.9). According to the Bland-Altman analysis, difference MOC and BOC were highly variable (CI: 1–71 rpm).

CONCLUSION: BOC values were on average greater than MOC values. Notwithstanding the fixed bias observed for KE, suggesting MOC may be predicted from KE EMGs (i.e., MOC = BOC – 35 rpm), the somewhat high variability observed in the Bland-Altman plots between MOC and BOC KE warrants further investigation.

**SIMILAR PERFORMANCE AND MUSCLE ADAPTATIONS BETWEEN INTERVALS WITH AND WITHOUT BLOOD FLOW RESTRICTION IN WELL-TRAINED CYCLISTS**

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INTRODUCTION: Blood flow restriction (BFR) allows exercise at lower absolute intensity yet, showing similar or greater results compared with traditional training in non-trained individuals. However, since the effects in well-trained competitive athletes are unclear, the current study aims to compare the effect of an effort matched short HIIT microcycle performed with or without BFR, on indicators of endurance performance in well-trained cyclists.

METHODS: 17 well-trained cyclists (aged 31 ± 9 years, maximal oxygen uptake (VO2max: 67±6mL/min/kg) were randomised in two groups performing a microcycle of five HIIT sessions (6 x 5 min intervals with 2.5 min of recovery) with (BFR group) or without (HIIT group) a cuff over the thighs occluding the limbs. An exercise cycling test was used to assess VO2max, mean power output at 4 mmoL/L blood lactate (LT4), and mean power output during 5-min maximal cycling (MPO5) and the percentage of maximal oxygen consumption used at LT4 (%VO2max @LT4). Haemoglobin mass (HB) and blood volume (BV) were measured by CO rebreathing. Moreover, muscle biopsies on the vastus lateralis were used to evaluate muscle cross-sectional area (CSA), capillaries around fibre area (CAFA), citrate synthase (CS), Hydroxyacyl-Coenzyme A dehydrogenase (HADH), cytochrome c oxidase 4 (COX4), and αβ-Crystallin (CRYAB)

RESULTS: The BFR group trained at a lower power output compared to the HIIT group (177±3 W vs 307±8 W, respectively, $p<0.01$), but with no group differences in heart rate or rate of perceived exertion. Both groups significantly improved MPO5, with no significant changes in LT4, VO2max, HB and BV. However, only HIIT improved significantly %VO2max@LT4. Moreover, HIIT showed a significant reduction in CSA for type 2 muscle fibres compared with BFR whereas no significant changes were found in the other biomolecular indexes.

CONCLUSION: BFR applied during a 6-day microcycle provides similar but not greater physiological adaptations than traditional HIIT linked to exercise performance in well-trained cyclists. BFR achieved similar performance gains as the HIIT group with similar perceived effort and heart rate, but with 40% lower average power output during the training sessions. Moreover, despite HIIT having a significant reduction in CSA type 2 compared to BFR, no group differences were observed in capillarisation, CS, HADH, COX4, αβ-Crystalline (CRYAB) content. These results might be important for athletes who are seeking to promote positive adaptation in a relatively short period of time, or athletes who are recovering from injuries and want to obtain similar adaptation as HIIT with reduced mechanical stress. Future studies will be needed to ascertain if these adaptations can be maximized following consecutive intensified blocks and be of benefit to elite athletes with higher cardiorespiratory fitness and performance.

**FAMILIARIZATION IS CRUCIAL FOR TESTING THE MAXIMAL RATE OF LACTATE ACCUMULATION**

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INTRODUCTION: Recently, the testing procedure for the maximal rate of capillary blood lactate accumulation following an all-out sprint test of 10 - 30 s has gained popularity. The metabolic implications of this parameter are based on simulations of human muscle energy metabolism described by the mathematical equations of Mader. While there is still a scarcity in the literature on this matter, the reliability of the testing procedure has been well studied.

Most of the studies describing good to excellent reliability in many modalities of the procedure include 2 or 3 trials. In studies involving 2 trials, reliability of subsequent trials is unknown as only one exists. Meanhile, studies involving 3 trials have analyzed all three trials together. However, it is unknown if familiarization changes the results (i.e., what changes are caused by learning effects) and therefore the possible metabolic implications.

Therefore, the aim of this study was to determine differences in relevant variables (peak and mean power output, capillary lactate accumulation) between familiarization and subsequent trials.

METHODS: 50 cyclists performed a 15-s all-out sprint test in isokinetic mode at 130RPM on a Cyclus2 ergometer on three separate (T1, T2, T3) occasions. Capillary blood was sampled twice before and every minute (for 8 minutes) after the sprint to determine the difference between resting and peak post-exercise lactate values as maximal lactate accumulation.

Glycolytic contribution was calculated as the product of lactate accumulation, fat-free mass and the mechanical energy equivalent of lactate of 12J/kg FFM (Meixner et al. 2024). The fraction of glycolytic contribution to total work was also calculated. The One-way ANOVA was performed to determine differences in trials in peak and mean power output, capillary lactate accumulation, glycolytic contribution (Wgly) and percent of glycolytic contribution (%Wgly).

RESULTS: Peak and mean power output was significantly lower in T1 compared to T2 and T3. Capillary blood lactate accumulation was significantly higher in T1 compared to T2 and T3. Accordingly, Wgly and %Wgly also significantly decreased in T2 and T3. No differences were found between T2 and T3.

CONCLUSION: Several studies have shown that increased lactate accumulation and power output are intricately linked. Our results display a paradoxical behavior between T1 and subsequent trials: while lactate accumulation decreases, power output increases.

This is noteworthy as two relevant output components change in opposite directions and potentially obfuscate the relationship between power output and lactate accumulation. These findings highlight familiarization as a crucial element in this diagnostic procedure and we urge practitioners to include a familiarization trial in their practice.

Meixner B et al (2024) Relationship of peak capillary blood lactate accumulation and body composition in determining the mechanical energy equivalent of lactate during sprint cycling. Eur J Appl Physiol

**HIGH CADENCE IN CYCLING – PHYSIOLOGICALLY OPTIMAL OR JUST A TREND?**

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INTRODUCTION: There is a wide spread notion among coaches and athletes that cycling at a high cadence is advantageous for athletic performance. However, scientific data indicates that - at least metabolically - the "optimal" cadence is lower. Specifically, various physiological variables (e.g., heart rate (HR), O2 uptake (VO2), blood lactate concentration (BLa-)) have been shown to be lowest (i.e., physiologically advantageous) at cadences of 50-60 rpm, while cycling on a stationary ergometer – a condition that does not reflect real life cycling. Thus, this study aimed to comprehensively examine the effects of different cadences on metabolic, ventilatory and perceptual variables while riding on a motorized treadmill.

METHODS: Fifteen highly trained cyclists and triathletes (f=1; Mean±SD: age: 24±6 years; height: 1.76±0.05 m; weight: 66.9±5.1 kg) completed two exercise sessions: 1) maximal graded exercise test from which maximal O2 uptake (VO2max) and power output at the first ventilatory threshold (VT1), and 2) a 30-min submaximal bout at constant power output equivalent to 110% VT1. Every 5 minutes during the submaximal effort, subjects were instructed to change gears to match the target cadence (60, 70, 80, 90, 100 or 110 rpm, in a random order). HR and metabolic variables were continuously recorded, while rating of perceived exertion (RPE; 0-10 scale) and BLa- were obtained at the end of every stage. Mixed linear models were used to assess differences in physiological variables between cadences.

RESULTS: On Average, VO2max was 65.9±8.3 ml/kg/min and power output at 110%VT1 was 235±46 watts. VO2 was significantly ($p<0.01$) lower at 60 rpm (3127±546 l/min), and CO2 production (VCO2) was significantly ($p<0.01$) lower at both 60 and 70 rpm (2862±503 and 2878±503 l/min, respectively), compared to 90 rpm (VO2: 3218±546; VCO2: 2960±503 l/min). No other variables were different between 90 rpm and lower cadences. VO2 and VCO2 were significantly ($p<0.01$) higher at 100 rpm (3319±546 and 3085±503 l/min, respectively) and 110 rpm (3410±546 and 3226±503 l/min, respectively) compared to 90 rpm. At 110 rpm, minute ventilation (VE; 101.0±18.6 l/min), respiratory exchange ratio (RER; 0.95±0.02), %carbohydrates (CHO) oxidation (81.3±7.5 %), HR (155.9±15.6 beats/min), BLa- (2.9±1.2 mmol) and RPE (5.3±1.4) were significantly ($p<0.01$) higher than 90 rpm (VE: 88.6±18.6 l/min; RER: 0.92±0.02; CHO oxidation: 72.9±7.5 %; HR: 147.7±15.6 beats/min; BLa-: 2.0±1.2 mmol; RPE: 3.8±1.4).

CONCLUSION: This study is the first to examine physiological responses at different cadences while riding on a motorized treadmill, which more closely mimics real world cycling than a stationary ergometer. Our findings indicate that while riding at cadences >100 rpm is more taxing from a physiological and perceptual standpoint than lower cadences, these responses are similar at 60-90 rpm. Thus, using high cadences should be reconsidered as lower ones might be more beneficial, especially for endurance and metabolic efficiency.

**COMPARISON OF MUSCLE ACTIVITY AND ENERGY EFFICIENCY IN CYCLING TRAINING WITH THREE-ROLLER SYSTEMS, FIXED-ROLLER TRAINERS, AND ON-ROAD TRAINING**

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INTRODUCTION: The lateral tilt of the bicycle optimizes the direction of force on the pedals (1). This study aims to clarify which training device, fixed roller trainers (Fix) or three-roller systems (Rol), is closer to on-road training in terms of muscle activity, respiratory gas exchange, and kinematic analysis.

METHODS: A pilot study was conducted with one male athlete from the university triathlon team. The experiment involved three conditions: fixed roller (Fix), three-roller (Rol), and treadmill (Tre) simulating actual riding. The athlete pedaled at 75% of their maximal oxygen uptake (VO2 max) for 15 minutes in each condition. During the last 5 minutes of each exercise, external work, electromyography (EMG), respiratory gas, and bicycle and body tilt were measured. The work rate was measured using a power meter (Shimano, FC-R9200-P) attached to the athletes own bicycle. Respiratory gas exchange was measured continuously during exercise. Kinematic data on bicycle and body tilt were collected using a Motion Capture System (BTS Bioengineering, Italy) and analyzed using specialized software. EMG was recorded using BTS FREEEMG (BTS Bioengineering, Italy) for eight muscles: latissimus dorsi (LD), upper rectus abdominis (RA), gluteus maximus (GMax), long head of the biceps femoris (BF), rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), and medial gastrocnemius (Gas).

RESULTS: The work rates for each exercise ranged from 207 W to 221 W, with Fix showing the highest ventilation volume (VE) [Fix: 98.9±5.1 L/min, Rol: 90.0±5.2 L/min, Tre: 92.9±5.0 L/min]. VO2 per body weight was lowest with Fix [Fix: 0.33±0.02 Rol: 0.35±0.03, Tre: 0.36±0.03 ml/min/kg]. Regarding body and bicycle tilt angles, Fix exhibited the least bicycle sway compared to the other two conditions, with the greatest body sway. The angle A (the angle between the floor and the normal vector of the bicycle) for Fix was 93.6±0.4°, while Rol and Tre were 90.9±0.9° and 90.9±1.1°, respectively. The angle F (the angle formed when the unit vectors of the sacrum and 7th cervical vertebra, and the bicycles top tube unit vector are projected onto the floor) was smallest for Fix [Fix: 1.30±3.09°, Rol: -0.19±1.27°, Tre: 2.12±1.62°].

In terms of muscle activity, GMax showed the highest activity during Tre [0.037mV], followed by Rol [0.026mV] and Fix [0.023mV]. For biceps femoris (BF), both Rol [0.134mV] and Tre [0.135mV] showed greater activity than Fix [0.127mV]. For RF, VM, and VL, Fix exhibited the highest muscle activity: [RF: 0.065mV (Fix), 0.056mV (Rol), 0.058mV (Tre)]; [VM: 0.106mV (Fix), 0.087mV (Rol), 0.082mV (Tre)]; [VL: 0.127mV (Fix), 0.102mV (Rol), 0.102mV (Tre)].

CONCLUSION: The results indicated that muscle activity and bicycle and body tilt differed among the three conditions, suggesting that energy efficiency may vary due to these differences.

1. (Duc, et al., 2008)

**IMPACT OF CYCLING STRATEGIES ON MUSCLE ACTIVITY AND ENERGY METABOLISM IN COMPETITIVE CYCLING**

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INTRODUCTION: The superiority of variable-load intensity, in which the load intensity is changed during cycling exercise, over constant-load intensity has been pointed out (1). This study aimed to evaluate the effects of two different conditions—variable-load intensity, where the exercise intensity fluctuates, and constant-load intensity, where a steady intensity is maintained—on muscle activity and cardiorespiratory function.

METHODS: This study was positioned as a pilot study, with a single male university triathlete (maximum oxygen uptake: 58.5 ml/min/kg) as the participant. A cycling ergometer (Monark LC4) was used, and two different 30-minute cycling trials with different load conditions were conducted. The first condition was variable-load intensity, in which the exercise intensity was calculated based on an incremental exercise test performed beforehand, with alternating intensity levels at 95% and 105% of the OBLA threshold every five minutes. The second condition was constant-load intensity, where the participant cycled at the OBLA intensity. The total workload over the 30 minutes was set to be identical for both conditions. The pedaling cadence was set to match the participants competition cadence.

RESULTS: During exercise, respiratory gas exchange parameters (AE-310s, Minato, Japan) were continuously monitored, blood lactate concentration (Lactate Pro2, Arkray, Japan) was measured every 2.5 minutes, and RPE was recorded every 5 minutes. Electromyography (EMG) (BTS EMG sensors, 1000 Hz) was continuously recorded throughout the entire cycling session. Muscle activity was measured in five muscles of one leg: the rectus femoris, vastus lateralis, biceps femoris long head, medial gastrocnemius, and tibialis anterior. The average oxygen uptake during the 30-minute cycling session was higher for the variable-load condition than for the constant-load condition (45.6 vs. 45.1 ml/min/kg). In the first five minutes, as well as between 10–15 minutes and 20–25 minutes, oxygen uptake was higher in the variable-load condition (39.8 vs. 38.9, 48.0 vs. 45.6, 49.6 vs. 47.4 ml/min/kg). However, in the intervals of 5–10 minutes, 15–20 minutes, and 25-30 minutes, oxygen uptake was lower in the variable-load condition (44.8 vs. 44.9, 44.7 vs. 45.6, 48.0 vs. 45.6, 47.0 vs. 48.2 ml/min/kg).

Regarding muscle activity, the average RMS value of the rectus femoris increased over time from 0.040 mV in the first five minutes after the start of exercise. In the final five minutes before exercise completion, the RMS value was higher in the variable-load condition (0.069 mV) than in the constant-load condition (0.053 mV).

CONCLUSION: These results suggest that the fluctuating intensity of variable-load cycling may induce physiological adaptations, allowing muscles to adapt to various intensities and maintain high muscle activity while minimizing oxygen consumption. In other words, variable-load intensity may lead to higher energy efficiency during cycling.

1. Suriano et al. (2007)

**PHYSIOLOGICAL RESPONSES AND RESPIRATORY MUSCLE FATIGUE TO SUPRAMAXIMAL CYCLING EXERCISE ON POST-WARM-UP BREATHING THROUGH ADDITIONAL RESPIRATORY DEAD SPACE VOLUME MASK.**

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INTRODUCTION: In endurance sports, the frequent interval between the end of the warm-up and the start of the race leads to a loss of cardiorespiratory effects by, among other things, increasing the oxygen deficit during the initial stages of exercise. Therefore, it is worth looking for methods to sustain the effects of the warm-up. The factor that influences vasodilatation of vessels and increases vascular blood flow is carbon dioxide, among others. A simple method to increase the arterialized blood CO2 partial pressure (pCO2) is to breathe through the additional respiratory dead space volume mask (POOPM). Therefore, it is possible that breathing through the POOPM during the interval between warm-up and intense exercise may increase oxygen uptake during exercise. We hypothesized that breathing through the POOPM during the interval between warm-up and 3-minute 110%Pmax exercise would achieve, among other things, higher oxygen uptake (VO2) during exercise. The purpose of this study was to compare acute physiological, biochemical and perceptual responses during supramaximal cycling exercise on post-warm-up breathing through by POOPM and without the device.

METHODS: Twelve cyclists (VO2max: 57.5±6.1ml/kg/min) participated in the study. During 3 visits to the laboratory with a minimum break of 48 h, they participated in (1) an incremental test (IET) on a cycloergometer with respiratory gas analysis; (2) and (3) crossover sessions of a 110% of maximal power of IET (110%Pmax), each lasting 3-min. Each of the 110%Pmax tests was followed by a15-min warm-up and an 8-min passive break. In the experimental condition (EC), immediately after the warm-up, a mask was used for 7-min with an increased tidal dead space volume of 1000ml (POOPM). In the control condition (CC), participants passive waiting for a test without POOPM. After a break, each performed a 3-min of 110%Pmax test on a cycloergometer. During the entire test procedure, respiratory parameters were measured (excluding the POOPM breathing phase) in the same procedure as in the IET.

RESULTS: After a 3-min 110%Pmax test preceded by POOPM mask breathing after warm-up, we observed a 6% increase in peak oxygen uptake (VO2peak) ($p<0.05$) compared to CC (60.9 versus 57.8 ml/kg/min). VO2mean was not significantly different between conditions. No differences were observed in the change in peak heart rate (HRpeak) where in EC was 195 u/min and in CC it was 193 u/min. There were also no statistically significant differences in lactate concentration after the 3-minute test, with 11.65 and 11.55 mmol/L in EC and CC, respectively. Rate of perceived exertion (RPE) did not significantly difference between conditions, while a statistically significant 4% higher inspiratory muscle strength was observed after the test in the EC condition ($p<0.05$).

CONCLUSION: Breathing through POOPM during the post-warm-up phase leads to higher peak oxygen uptake in 3-min supramaximal cycling exercise (100%Pmax), with greater inspiratory muscle engagement and lower RPE.

**ACUTE PHYSIOLOGICAL RESPONSES TO HEART RATE- AND CRITICAL POWER-BASED HIGH INTENSITY INTERVAL TRAINING**

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INTRODUCTION: High intensity interval training (HIIT) is characterized by repeated bouts of relatively hard work interspersed with recovery periods, with bouts commonly prescribed at an intensity that elicits ≥80% of maximal heart rate (HRmax) [1, 2]. Exercise prescription based on "traditional" anchors such as HRmax can be associated with large interindividual response variability [3]. An alternative approach is to characterize intensity using metabolic thresholds, which demarcate intensity "domains" that reflect distinct profiles of physiological stress [4]. The application of metabolic thresholds such as critical power (CP) to prescribe HIIT, as commonly done in the training prescription for athletes, could reduce variability in physiological responses. We therefore examined whether an acute session of HIIT in which intensity was anchored to CP elicited lower variability in blood lactate (BLa-) accumulation as compared to a %HRmax-based approach.

METHODS: Healthy active adults (9 males and 10 females; 23±4 years) with a peak oxygen uptake (VO2peak) of 46±7 ml·kg-1·min-1 were recruited. CP was initially determined based on three to five maximal, constant load tests [5]. Participants performed two familiarization visits before completing two experimental trials in a randomized, crossover, single-blind manner. Each trial involved a 5-min warmup followed by a 4x4-min HIIT session performed at a workload corresponding to CP+10% of work prime (CPHIIT) or one that elicited 80-90% HRmax (HRHIIT). Capillary BLa- samples were obtained at rest before exercise and immediately after the fourth bout. HR and rating of perceived exertion (RPE) were measured during each bout and expired gases were measured during the first and fourth bouts.

RESULTS: There was no difference in the variability in [BLa-] accumulation between CPHIIT and HRHIIT (1.33±1.13 vs 1.44±0.86 mM; $p=0.75$). Net [BLa-] accumulation was also not different (6.72±1.78 vs 6.13±1.71 mM, respectively, $p=0.10$). Workload was higher in CPHIIT vs HRHIIT (192±39 W vs 180±43 W; $p=0.001$). Mean exercise VO2 was higher in CPHIIT vs HRHIIT (2.86±0.61 vs 2.72±0.65 L/min, $p=0.002$). CPHIIT elicited a higher mean (156±13 vs 153±10 beats/min, $p<0.0001$) and peak exercise HR (169±12 vs 166±9 beats/min, $p<0.0001$). RPE was also higher in CPHIIT vs HRHIIT (14±2 vs 13±2, $p=0.003$).

CONCLUSION: Anchoring exercise intensity to CP did not reduce variability in BLa- accumulation compared to a traditional, %HRmax-based approach. Participants, however, achieved a higher workload that elicited a greater cardiorespiratory and perceived stress during the CP- vs %HRmax-based trial, which could translate to divergent training-induced responses.

1) Fox et al. (1973) PMID: 4721844. 2) Weston et al. (2014) PMID: 24144531. 3) Iannetta et al. (2020) PMID: 31479001. 4) Black et al. (2016) PMID: 28008101. 5) Jones et al. (2008) PMID: 18056980.

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**BIOMECHANICAL AND METABOLIC RESPONSES TO PEDALING CADENCE AND ROAD GRADIENT VARIATIONS DURING SUBMAXIMAL CYCLING: A 2×2 FACTORIAL STUDY**

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INTRODUCTION: In cycling, different pedaling cadences elicit distinct metabolic, neuromuscular, and biomechanical responses (Ahlquist et al., 1992; Broxterman et al., 2015). Pedaling cadence can vary considerably due to multiple factors, with road gradient playing a key role. However, research on the influence of road gradient on metabolic and biomechanical responses remains limited. To address this gap in the literature, we conducted a 2×2 factorial study to investigate the combined effects of pedaling cadence and road gradient on cyclists biomechanical and metabolic parameters during submaximal cycling.

METHODS: Twelve well-trained male cyclists (age: 29.2 ± 10.1 years, VO2max: 60.3 ± 9.1 ml/kg/min) visited the laboratory on two separate occasions. During the first visit, they performed a ramp incremental exercise test (30 W/min) to determine power output at the first (WGET) and second (WRCP) ventilatory thresholds. On the second visit, participants completed, in a random order, four 5-min bouts at 100% WRCP in different conditions: flat low-cadence (0%, 55-60 rpm), flat high-cadence (0%, 90-95 rpm), uphill low-cadence (6.5%, 55-60 rpm), uphill high-cadence (6.5%, 90-95 rpm). Power, torque, cadence, heart rate, pulmonary gas exchange and ventilation data, biomechanical variables (i.e., crank-torque profile), and perceived exertion were recorded. A linear mixed-model analysis was used to compare conditions (high vs. low cadence; flat vs. uphill).

RESULTS: Pedaling cadence significantly influenced all measured biomechanical parameters. Specifically, in the low-cadence conditions, higher torque efficiency ($p<0.001$) and pedaling smoothness ($p<0.001$) were observed, along with a wider angular range of positive torque ($p=0.001$). Additionally, the angle at which peak torque (Tpeak) was expressed occurred earlier in both low-cadence ($p=0.001$) and uphill ($p=0.001$) conditions. Lower oxygen uptake ($VO_2$; $p=0.027$), respiratory frequency ($p=0.006$), and perceived exertion ($p=0.025$) were also reported in low-cadence conditions compared to high cadence, irrespective of road gradient.

CONCLUSION: Our results confirm that pedaling cadence influences metabolic responses, with higher $VO_2$ and respiratory frequency observed in high-cadence conditions, irrespective of road gradient. Both cadence and road gradient affected the crank-torque profile, particularly the angle of Tpeak, thereby influencing torque distribution throughout the pedal cycle. Our findings align with the assumption that training under specific conditions (uphill and level ground, low and high cadences) may induce distinct adaptations in cyclists (Bertucci et al., 2005). Moreover, since the work rate associated with intensity boundaries varies, this raises the question of whether training zones, commonly used for prescriptions in training programs, should be adapted for different cadences.

## Conventional Print Poster Presentations

### CP-AP27 Body Composition and Ageing

**PHYSIOLOGICAL ADAPTATIONS AND TRAINING STRATEGIES IN THE TRANSITION FROM LIGHTWEIGHT TO HEAVYWEIGHT ROWING: A MULTI-YEAR CASE STUDY OF AN OLYMPIC FINALIST.**

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INTRODUCTION: Paris 2024 marked the final Olympic Games featuring lightweight rowing as a competitive category. In preparation for Los Angeles 2028, many elite lightweight rowers worldwide must transition to the heavyweight class to remain eligible for Olympic competition. This transition requires optimized training strategies and efficient body composition adjustments to maximize performance. This study reports the physiological adaptations and training practices over three years in a Belgian rower who successfully transitioned to the heavyweight category and placed fourth at the Paris 2024 Olympics after reaching the final in the lightweight event at Tokyo 2020.

METHODS: Physical testing was conducted at least once per year from April 2021 to June 2024 to monitor changes in physical and physiological variables during the weight transition. Assessments included anthropometric measurements, an incremental rowing test, power profiling, and maximal strength testing.

The training program over 145 weeks was analyzed to provide insight into training characteristics, including total volume, the relative contributions of rowing, alternative training, and strength training, as well as training intensity distribution (TID). The training period was divided into four phases corresponding to the years 2021, 2022, 2023, and 2024, and training characteristics were compared using a one-way analysis of variance (ANOVA) with post-hoc Tukey tests.

RESULTS: Body weight increased from 74.6 kg (fat-free mass: 72.1 kg) on April 21, 2021, to 81.8 kg (fat-free mass: 74.4 kg) on June 21, 2024, with the majority of changes occurring in the first year (2022: body weight 81.4 kg, fat-free mass 74.6 kg).

$VO_2$peak increased from 5.65 $L \cdot min^{-1}$ (75.74 $mL \cdot min^{-1} \cdot kg^{-1}$) to 6.06 $L \cdot min^{-1}$ (74.08 $mL \cdot min^{-1} \cdot kg^{-1}$), while peak power output increased from 489 W to 508 W. Strength values for the squat and bench pull changed from 110 kg and 100 kg (2021) to 128 kg and 97 kg (2024), respectively.

The mean weekly training volume was 15 ± 4 hours, consisting of 53.3 ± 26.6% rowing, 26.4 ± 6.6% strength training, and 20.3 ± 12.6% alternative training. The training intensity distribution (TID) for rowing, based on heart rate zones, was 83.2% zone 1, 9.9% zone 2, and 6.7% zone 3. The proportion of zone 1 training increased significantly ($p < 0.05$) from 72.6% in 2021 to 89.3% in 2024, while the contributions of zones 2 and 3 decreased progressively each year ($p < 0.05$) up to Paris 2024.

CONCLUSION: This multi-year case study provides insights into the transition from lightweight to heavyweight rowing in an athlete who reached the Olympic finals in both Tokyo 2020 and Paris 2024. The data suggest that early-phase physical preparation is critical for a successful transition and can serve as a reference for coaches and sports scientists supporting athletes preparing for Los Angeles 2028.

**ANTHROPOMETRIC PROFILES AND BODY COMPOSITION ASSESSMENT IN BULGARIAN BODYBUILDERS**

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INTRODUCTION: Bodybuilding places a strong emphasis on achieving a balanced and aesthetically pleasing physique. This involves developing both size and proportion. Achieving a very low body fat percentage (BF%) is crucial to minimize the subcutaneous fat obscuring the underlying muscle definition, allowing for a more pronounced and impressive display of muscle volume and separation. The aim of this study was to compare anthropometric profiles of Bulgarian bodybuilders with classic bodybuilding parameters.

METHODS: This study included 11 bodybuilders with a mean age of 24.3 ± 4.3 years, who were practising bodybuilding for at least 6 years with a mean sport experience 8.19 ± 2.55 years, and an average of 10 hours per week. The height and body mass were measured preciously, and BMI was calculated. Arm, thigh, and calf circumferences were measured with the LufkinW606PM tape and compared to the 'ideal' standards for male bodybuilders developed by David Willoughby. The following skinfolds were measured: pectoral, triceps, axilla, suprailiac, abdomen, subscapular, thigh, and calf by using the Lange Skinfold Calliper. BF% was calculated based on the measured skinfolds by using Jackson & Pollock's 1976 and Katch & McArdle's 1973 equations for men. The percent muscle mass (MM%) was calculated by using the equations of Lee et al. Additionally, body fat percentage (BF%BIA) and muscle mass percentage (MM%BIA) were also measured by using BIA method with the Omron BF-511. The descriptive statistics test of distribution normality (Shapiro–Wilk), paired Student's t-test, and correlation and regression analyses were conducted with SPSS 19 (IBM, USA).

RESULTS: The average BF% (Katch & McArdle) was 8.2% ± 2.0, which was within the reported BF% in the literature for male bodybuilders before competitions (6-10%). Height was 175.4 ± 6.2 cm, body mass was 81.3 ± 9.3, and BMI of 26.4 ± 1.7 kg/m2. Regression equations with high correlation coefficient (0.997-1.000) for 'ideal' body circumference were obtained. Body mass, BMI, as well as the measured circumferences, except neck, did not differ significantly from the calculated 'ideal' measures for male bodybuilders. The individual BMI of some of the bodybuilders was above the normal limits provided by WHO due to the large MM% (47.2 ± 2.9%).

CONCLUSION: The anthropometric profiles of the bodybuilders in our study did not differ significantly from the 'ideal' standards published by Willoughby. Bodybuilders can apply the 'ideal' standards to compare and assess their body sizes. Our regression equations can be utilised to precisely calculate the published 'ideal' body circumferences for each individual. Although on a small number of participants, we also concluded that using the 3-skinfold equation of Katch & McArdle for calculating BF% provided the most consistent results compared to Jackson & Pollock's 7-skinfold and BIA Omron BF-511.

**A MULTI-SPORT COMPARISON OF MUSCLE-TO-BONE RATIOS IN FEMALE COLLEGIATE ATHLETES**

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INTRODUCTION: The purpose of the present study was to compare the muscle-to-bone ratio (MBR) in National Collegiate Athletic Association (NCAA) Division I female athletes (n=338) to healthy, age-matched controls (n=205). In addition, to examine MBR in weight bearing and non-weight bearing sports.

METHODS: Total and regional lean mass (LM), fat mass (FM), and bone mineral content (BMC) were determined by dual X-ray absorptiometry (DXA). MBR was calculated by dividing LM by BMC. Female athletes were categorized by sport: basketball (n=66), diving (n=17), soccer (n=69), softball (n=71), swimming (n=93), and volleyball (n=22).

RESULTS: The controls were significantly (P<0.001) shorter (163.9±6.6 vs. 171.4±8.9 cm) and weighed less (61.7±9.4 vs. 69.2±10.3 kg) than female athletes. There were significant (P<0.01) differences between controls and female athletes for total LM (40.6±5.5 vs. 48.8±6.0 kg), FM (18.9±5.6 vs. 17.7±5.2 kg), and BMC (2.3±0.3 vs. 2.9±0.5 kg). Although there were significant differences in body composition between controls and female athletes, there was no difference in total MBR

between controls and female athletes (17.3±1.4 vs. 17.2±1.9, P=0.38). Regionally, controls had significantly higher trunk (27.9±2.9 vs. 26.8±4.3, P<0.001) and leg MBR (16.7±1.7 vs. 15.8±2.0, P<0.001) than female athletes but lower arm MBR (13.8±1.7 vs. 14.5±1.5, P<0.001). Sport differences were noted as total MBR being significantly higher in swimming (19.0±1.4) than basketball (15.4±1.9), soccer (16.7±1.2), softball (17.1±1.2), and volleyball (16.5±1.1). Total MBR was similar in swimming and diving (17.9±1.3). The total MBR in basketball players was lower than the other sports examined. Arm MBR showed a similar trend with swimmers (15.4±1.4) having a higher arm MBR than basketball (14.5±1.5), soccer (13.8±1.4), softball (14.0±1.3), and volleyball (13.8±1.4). Arm MBR was similar in swimming and diving (14.7±1.7). Leg MBR was also higher in swimmers (17.6±1.7) than basketball (14.2±1.6), soccer (14.6±1.2), softball (16.1±1.5), and volleyball (14.7±1.2). Leg MBR was similar in swimming and diving (17.0±2.0).

CONCLUSION: When total MBRs in female athletes was compared to healthy controls there were no significant differences, however there were significant differences in regional MBRs. When female athletes were compared to each other by sport there were significant differences in both total and regional MBRs. Non-weight bearing sports such as diving and swimming had significantly higher total as well as regional MBRs than weight being sports such as basketball, volleyball, softball and soccer. The differences identified between sports in total as well as regional MBR may be a result of sport-specific training impacting the balance between muscle and bone. Findings of this study are important as they may provide insight into how training-induced body composition impacts the balance between the tissues which could inform strategies to mitigate discrepancies and prevent injury and optimize performance.

**BODY COMPOSITION IN PROMISING YOUTH TENNIS PLAYERS - A PREDICTOR TO SUCCES?**

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INTRODUCTION: In recent years, physical fitness and athletic anthropometrics are gaining relevance for elite tennis performance in men and women. Consequently, respective measurements should be taken at close intervals in childhood and adolescence. Bioelectrical impedance analysis (BIA) offers a practicable method for recording body composition. However, there is currently no evidence as to which body composition characteristics are associated with performance advantages in junior tennis. Therefore, the aim of the present study was (1.) to analyse body composition characteristics in a large sample of elite nationally ranked pre- and post-matured male and female tennis players and (2.) to calculate correlations between body composition and tennis performance (e.g. ranking position).

METHODS: In the present study, body mass (BM) and composition (percentage body fat [BF%] and skeletal muscle mass [SMM]) of 234 young squad tennis players were examined using BIA (InBody 770; InBody Co, Ltd. Seoul, Korea). Players were in the age groups u12 (11-12 years, n=27 male, n=16 female), u14 (13-14 years, n=46 male, n=42 female), u16 (15-16 years, n=45 male, n=20 female) or u18 (17-18 years, n=24 male, n=14 female). ANOVA and post-hoc t-tests (with α-correction according to Bonferroni) were used to analyse cross-sectional changes depending on age and gender. Pearson correlation was used to determine correlations between body composition components and tennis performance according to the national ranking position.

RESULTS: In boys, SMM increases significantly between age groups (u12: 18.1±2.4; u14: 25.5±6.6; u16: 33.2±4.6; u18: 37.1±3.9 kg) and was significantly correlated to the ranking position in u12 (r=-0.414, p=0.032) and u14 (r=-0.436, p=0.002). In girls SMM increases were less pronounced (u12: 18.6±3.2; u14: 23.7±3.2; u16: 26.6±3.2; u18: 29.3±2.9 kg) but also correlated to the ranking position in the age of u14 (r=-0.317, p=0.041) and u18 (r=-0.579, p=0.030). In boys, PBF (u12: 10.4±4.2; u14: 10.5±4.0; u16: 8.8±3.2; u18: 8.0±2.2 %) tend to decrease in u16 and u18 compared to u12 and u14 while in girls (u12: 13.2±3.0; u14: 14.9±5.2; u16: 18.1±4.0; u18: 18.7±4.5 %) PBF increased significantly between u14 and u16. In both sexes, no correlation between PBF and the ranking position was found.

CONCLUSION: The study showed that increased skeletal muscle mass positively correlates with the ranking position of elite young tennis players, particularly in pre-matured boys and in post-matured girls, while the percentage of body fat has no negative impact. It shows that skeletal muscle mass and biological age must be considered in talent identification, while in male adolescent tennis players muscle hypertrophy training beyond normal development is not primarily necessary for being successful. In adolescent females, a high fat-free mass is not primarily necessary, as long as there is a sufficient absolute skeletal muscle mass. Strength training instead of diet can be strongly recommended in older girls.

**FROM FAT TO FACTS: NEW SKINFOLD-BASED REFERENCES FOR ASSESSING BODY FAT IN MALE AND FEMALE ADULTS**

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INTRODUCTION: Anthropometric-based body fat assessment is typically performed using predictive equations. However, these equations, that are limited in the literature, provide estimates and can be prone to errors if not appropriately tailored to the target population. Monitoring raw anthropometric data, such as skinfold thicknesses that are directly related to body fat, offers a method to evaluate body fat without relying on predictive equations. The current multicentric, cross-sectional study aimed to provide new centile curves for the sum of skinfold thicknesses, specific to the general adult population, and to identify phases of significant change during adulthood.

METHODS: Stature, body mass, and eight skinfold thicknesses (i.e., triceps, biceps, subscapular, iliac crest, supraspinal, abdominal, thigh, and calf) were measured according to the International Society for the Advancement of Kinanthropome-

try (ISAK) protocol in 1,313 males and 1,194 females, all adults aged 18–65 years. Smoothed age- and sex-specific percentiles (3rd, 10th, 25th, 50th, 75th, 90th, and 97th) for the sum of eight skinfolds were generated. For both sexes, simple linear regressions of the dependent variable (sum of eight skinfolds) versus the explanatory variable (age) were performed to empirically investigate changes in the response variables slope and to test for potential breakpoints.

RESULTS: This study presented new centile curves for the sum of eight skinfolds, highlighting time-point phases of significant change. In males, skinfold thickness increased by 1.0 mm per year (95% confidence interval: 0.7–1.3) between 21.0 and 59.0 years ($p < 0.001$). In females, a pronounced increase of 3.8 mm per year (95% confidence interval: 0.3–7.3) was observed between 38.5 and 47.0 years ($p = 0.035$).

CONCLUSION: New reference values for assessing body fat using the sum of eight skinfold thicknesses are now available. Furthermore, specific age ranges with significant changes in subcutaneous adipose tissue have been identified for both male and female adults.

**THE RELATIONSHIP BETWEEN THE PHYSICAL FITNESS TEST AND MOVEMENT-RELATED MEMORY ABILITY TEST IN ELDERLY WOMEN WITH REGULAR EXERCISE HABITS**

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INTRODUCTION: Movement-related memory ability is important for maintaining independent living as it is related to activities of daily living. Thus, this study investigated the relationship between physical fitness and movement-related memory ability in elderly women in Japan through physical fitness tests and a simple dance-based motion memory ability test.

METHODS: Healthy women aged ≥65 years with regular exercise habits (n=33) were included. The measurements were conducted from September 2024 to February 2025. Physical characteristics such as height, weight, and body fat percentage were measured. Physical fitness tests included handgrip strength, seated forward bend stretch, and knee extension strength evaluations, and a 10-m obstacle walk. The movement-related memory ability test (MMAT) was conducted with a 30-s dance. The participants were asked to learn the dance in 3 min and then promptly tested. Since memory ability tends to decline with age, the participants were divided into the following groups to examine age-related differences: early (65-69 years,n=9), intermediate (70-74 years,n=9), and late (≥75 years,n=15). Data were analyzed using one-way analysis of variance and partial correlation analysis.

RESULTS: Regarding body composition, there were no significant age-related intergroup differences in body fat percentage, fat mass, or body mass index. However, there were significant differences in height, weight, lean body mass, and lean body mass/height ratio, with the early group having significantly higher values for height, weight, lean body mass, and lean body mass/height ratio compared with the late group (height: p=0.012, weight: p=0.007, lean body mass: p=0.003 , lean body mass/height ratio: p=0.012). No significant age-related intergroup differences were found in the physical fitness tests. Significant intergroup differences were observed in MMAT scores, with the early group scoring significantly higher than the other two groups. Significant correlations were found between movement-related memory ability and age (r=-0.408, p=0.018), height (r=0.384, p=0.027), lean body mass (r=0.346, p=0.048), seated forward bend stretch (r = 0.368, p = 0.035), handgrip strength (r = 0.349, p = 0.046), 10-m obstacle walk (r=-0.358, p=0.041), seated forward bend stretch score (r=0.345, p=0.049), and 10-m obstacle walk score (r=0.349, p=0.046). When age was the controlled variable, no significant correlations were found between movement-related memory ability and the other variables.

CONCLUSION: MMAT showed significant positive correlations with height, lean body mass, and seated forward bend stretch, and negative correlations with age and 10-m obstacle walk performance. When controlling for age, no significant correlations were found, suggesting that age may be the primary MMAT-influencing factor. The observed relationships with seated forward bend stretch and the 10-m obstacle walk performance suggest that improving flexibility and walking ability could affect movement-related memory ability.

**THE EFFECT OF E75 MODIFY EXERCISE PROGRAM ON MUSCLE MASS AND FLEXIBILITY IN THE ELDERLY**

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INTRODUCTION: The modified E75 Exercise Program is adapted from the "Elderly Exercise Program For Hale 75 Years (E75)" developed by the Department of Health, Physical Activity for Health Division, Ministry of Public Health, Thailand. It is an exercise program aimed at enhancing muscle strength and brain function for elderly individuals, promoting physical health, an active lifestyle, and improved quality of life. The program strives to help seniors achieve an average life expectancy of 75 years with good health. The research objectives of this study included 1) to study the effects of E75 modify Exercise Program on Muscle mass and Flexibility in the Elderly 2) to compare the effects of E75 modify Exercise Program on body fat percentage and Flexibility in the Elderly within a control group and an experimental group and 3) to compare the effects of E75 modify Exercise Program on Muscle mass and Flexibility in the Elderly between the control group and the experimental group

METHODS: The samples were elderly people living in Nakhon Pathom Province whose age ranged from 60 to 70 years old. The sample of 26 people, which its size was calculated by G*power was divided into two groups, 13 people in the experimental group and 13 people in the control group. with E75 modify exercise program for . The E75 modify exercise programe is an exercise program that uses bodyweight exercises. The exercises are simple and can be performed anywhere without the any equipment. There are a total of 15 exercise poses included in the programThe researcher will de-

termine the appropriate intensity, frequency, and duration of the exercise to ensure it is safe for elderly individuals, incorporating a rhythm of 90-100 beats per minute using a metronome. The experimental group were trained 60 minute per day, 3 days per week, total 12 weeks. The instruments were the E75 modify exercise program, TANITA SC-330P body composition analyzer equipment, Chair Sit-and-Reach test. The statistics used to analyze data were Paired t-test and Independent t-test.

RESULTS: The results were found as follows:1. The results of comparison within the experimental group before training and after training found that the muscle mass were equal to Mean=38.83, SD=6.38 and Mean=38.99, SD=6.49 respectively, revealed no differences, but the Flexibility were equal to Mean=2.22, SD=4.03 and Mean=3.49, SD=3.19 respectively was significantly different at the .05 level.

2. The results of comparison within the control group before training and after training found that, it was found that the muscle mass, flexibility was consciously significant at the .05 level. 3. The results of comparison between the experimental group and the control group after training found that the muscle mass revealed no differences but flexibility was significantly different at the .05 level.

CONCLUSION: This research can be concluded that the muscle mass and flexibiity of the elderly can be improved by E75 exercise programe.

**EXPLORING THE RATING OF PERCEIVED EXERTION OF THE FIRST REPETITION TO INDUCE POST-ACTIVATION PERFORMANCE ENHANCEMENT WITH ELASTIC BANDS: A PILOT STUDY**

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INTRODUCTION: Jump and sprint performance are crucial in sports, however, limited research has investigated post-activation performance enhancement (PAPE) using a single set of a full-body elastic-band exercise. Moreover, the use of the rating of perceived exertion of the first repetition (RPE-1) as a method to quantify intensity remains largely underexplored.

This pilot study aimed to evaluate the PAPE effects of performing a single set of push-press with elastic bands, using the RPE-1 for intensity quantification. Additionally, the study examined the influence of participants' fitness level on PAPE. We hypothesized that the intervention would induce PAPE, regardless of the participants' fitness level.

METHODS: Twenty-four trained, healthy young adults (age 23 ± 3 years; height 178.83 ± 8.57 cm; weight 78.10 ± 12.27 kg) participated. Each participant completed both conditions in a randomized order on two non-consecutive days.

One condition included a conventional control warm-up, consisting of two laps around a basketball court at a light jog, followed by bodyweight and dynamic mobility exercises (10 repetitions of alternating front lunges, side squats in both directions, jumps with one-legged landings, and dynamic hip flexion-extension and abduction-adduction). Additionally, three sets of skipping for 5 seconds, each followed by a maximum-acceleration 5-m sprint, were performed. Finally, participants completed 5 squats, push-ups, and burpees.

The second condition included the same conventional warm-up, followed by a 3-minute rest period, after which participants performed a single set of 6 repetitions of the push-press with elastic bands at an RPE-1 of 6 out of 10 (corresponding approximately to 85% 1RM), executed with an intentionally maximal concentric velocity.

The assessed variables included jump height, measured via countermovement jump using force plates (Forcedecks 4000, Vald Performance, Vic, Australia) and 10- and 20-m sprint times, measured using photocells (Fitlight Trainer, Ontario, Canada).

A two-way mixed repeated-measures ANOVA was conducted with condition (control and push-press) and fitness level (low-strength, high-strength; based on the median jump height) as factors.

RESULTS: Less strong participants significantly improved their jump height by 7.93% ($p < 0.05$) following the push-press, while stronger participants showed no significant jump improvement. Both groups significantly improved in 10-m (5.70–8.07%) and 20-m (5.18–6.23%) sprints after the push-press intervention.

CONCLUSION: The push-press with elastic bands effectively induced PAPE, with greater benefits observed in less strong participants. These findings suggest that RPE-1 is a viable strategy for quantifying elastic-resistance exercise intensity and inducing PAPE.

Conventional Print Poster Presentations

CP-AP29 Youth Football

**THE EFFECTS OF RHYTHM JUMP TRAINING ON AGILITY AND JUMPING ABILITY IN JUNIOR HIGH SCHOOL SOCCER PLAYERS: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Metronome-synchronized training utilizes rhythm perception and is suggested to enhance motor performance [1]. In soccer, precise synchronization of sensory and motor functions is crucial for optimal timing and coordination between the upper and lower limbs. Rhythm Jump Training (RJT) is a training method that incorporates auditory rhythms cues to enhance movement synchronization, potentially improving agility and jumping performance. However, its effectiveness in adolescent athletes remains unclear. This study aimed to clarify the effects of RJT on agility and jumping ability in junior high school soccer players through a randomized controlled trial.

METHODS: A randomized controlled trial was conducted with 25 male junior high school soccer players (age: 13.1 ± 0.2 years) who trained five days per week in their school club. Participants were randomly assigned to either the RJT group, which performed 30-minute rhythm jump training once per week for eight weeks, or the control group, which continued regular warm-up exercises without rhythmic training. To evaluate the effects of RJT on athletic performance, pre- and post-intervention assessments were conducted using the Pro-agility Test (PAT) to measure agility and the Reactive Strength Index (RSI) to assess jumping performance. A mixed-model two-way ANOVA was performed to analyze the effects of RJT, with group (RJT vs. Control) as the between-individual factor and time (pre vs. post) as the within-individual repeated factor. Additionally, age in months was included as a covariate to account for growth-related changes.

RESULTS: A total of 19 participants completed the study. No significant interaction effects were observed for the PAT ($p = 0.97$) or RSI ($p = 0.99$).

CONCLUSION: A previous study conducted with elementary school students demonstrated significant improvements in PAT, but no effect on RSI [2]. However, in this study, no significant improvements were observed in junior high school soccer players. This suggests that the intensity and frequency of RJT may have been insufficient for this age group. Additionally, RSI performance is highly dependent on maximum muscle strength [3], which may not be effectively enhanced through RJT. Future research should explore increased training intensity and frequency, as well as age-specific adaptations, to optimize the benefits of RJT in adolescent athletes.

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**THE IMPACT OF AGE ON PHYSICAL AND TECHNICAL SKILLS IN YOUNG FOOTBALLERS**

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INTRODUCTION: Youth football performance depends on psychophysiological skills, but the relative age effect (RAE) often favors those born earlier in the year (1). While physical fitness contributes significantly to technical performance, some studies (2) find no direct link. On the other hand, motor control has been highlighted as a good predicting factor of football-specific skills, with no regard for chronological age. However, age-based groupings are common, neglecting actual motor skills. Therefore, this study evaluates motor skill differences between adjacent age groups in a youth soccer academy, examining the development of physical and technical parameters.

METHODS: 170 male soccer players (aged 8-12) were divided into five groups based on chronological age. At the beginning of the regular season, participants underwent physical and technical tests, including: Counter Movement Jump with arm swing (CMJA) and without arms (CMJ); 15-meter linear sprint with (LSB) and without the ball (LS); 15-meter agility test with (ATB) and without the ball (ATB); and a sit and reach test for flexibility (SeR). A non-parametric Kruskal-Wallis test was used to identify group differences at T0, with Mann-Whitney tests for post-hoc comparisons between adjacent age categories.

RESULTS: Kruskal-Wallis tests revealed significant differences across all age groups ($p \leq 0.01$). Post-hoc analysis comparing adjacent groups yielded interesting results. For the jump tests (CMJ vs. CMJA), significant differences were only observed between the 10- and 11-year-old groups ($p = 0.032$). However, when arm use was incorporated (CMJA), differences also emerged between the 8- and 9-year-old groups ($p = 0.045$). The linear sprint (LS, LSB) and agility test (AT, ATB) results showed similar trends. For tests without the ball (LS and AT), differences were found between the 8- and 9-year-old groups ($p \leq 0.010$) and the 11- and 12-year-old groups ($p < 0.01$). With the ball, differences were only present between the

10- and 11-year-old ($p < 0.01$) and 11- and 12-year-old groups ($p \leq 0.01$). Finally, the 9- and 10-year-old groups showed no significant differences across any of the tests.

CONCLUSION: For the CMJ tests, the increase between 10- and 11-year-olds likely reflects increased lower limb power, while the difference between 8- and 9-year-olds reveals a significant coordination improvement (CMJA). Differences in LS and AT between 8-9 and 11-12 year olds could be attributed to sensitive periods of speed development. However, with the ball, differences emerge only between 10-11 and 11-12 year olds, likely due to better ball control related to game experience. Finally, the lack of significant differences between 9- and 10-year-olds across all tests suggests similar characteristics, potentially justifying their practical grouping by age.

**ANTHROPOMETRIC, PHYSIOLOGICAL, AND GENETIC DETERMINANTS OF CARDIORESPIRATORY FITNESS IN MALE YOUTH SOCCER PLAYERS: A CROSS-CULTURAL COMPARISON BETWEEN SAUDI ARABIA AND THE UK**

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INTRODUCTION: High cardiorespiratory fitness (CRF) is a key determinant of elite performance in soccer. In Saudi Arabia, the hosts of the FIFA 2034 World Cup, adult and youth soccer players demonstrated consistently lower CRF than international counterparts1,2 which could be attributed to genetic factors. The aim of this study was to compare CRF between elite youth Saudi and maturity-matched UK soccer players, and assess the cumulative genetic influences on CRF phenotype in elite youth Saudi soccer players.

METHODS: Anthropometric and CRF (measured VO2max during Yo-Yo IRL1 using COSMED-K5) phenotypes were compared between post-peak height velocity (PHV) youth male soccer players from Saudi Arabia (n=20) and the UK (n=23). Subsequently, 98 Saudi players were genotyped for 6 SNPs (ACE, BDKRB2, NOS3, PRDM1, GRIN3A, KCNH8), using TaqMan PCR. Associations between genotypes and VO2max from Yo-Yo IRL1 were assessed individually and as part of a total genotype score (TGS). A TGS of 100 represents a 'perfect' polygenic profile, and 0 the 'worst' possible profile for CRF. Independent t-tests were used to determine significant differences in anthropometric and CRF phenotypes of the post-PHV players from Saudi and UK. In the Saudi players, a one-way ANOVA was conducted to determine significant differences in anthropometric and CRF phenotypes between maturity offset groups and genotypes individually and as part of a TGS.

RESULTS: In comparison to post-PHV UK-based players, post-PHV Saudi players were smaller, lighter, younger and had a significantly lower VO2max (0.09±0.01 m; 11.0±2.1 kg; 2±0.3 years, 10.8±3.3 mL·kg·min-1; $P<0.001$ respectively) but there was no difference between groups for age at PHV ($P=1.00$). In the sub-group of Saudi players, age ($P=0.004$), height ($P<0.001$), body mass ($P<0.001$) and maturity offset ($P<0.001$) differed between maturity groups. VO2max was not significantly different ($P=0.183$) between maturity sub-groups for the Saudi players but there was a main effect of PRDM1 rs10499043 genotype on age ($P=0.016$), age at PHV ($P=0.007$) and VO2max ($P=0.003$). TGS was significantly different between maturity groups ($P=0.029$), with the TGS for the pre-PHV group lower than circa-PHV (13±5, $P=0.031$).

CONCLUSION: Saudi elite youth male soccer players are smaller in size and possess inferior CRF compared to UK counterparts matched for maturity status. While this is likely explained by a lower training age of Saudi players, genetic factors are also important to consider. It is possible that PRDM1 TT homozygotes, achieved higher CRF via enhanced mitochondrial efficiency, oxygen transport and/or increased proportion of type I fibres. Interestingly, it appears that existing talent ID processes in Saudi reflect CRF polygenic profiles, as older and more mature players had higher TGS scores than younger players.

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**ANATOMICAL AND FUNCTIONAL CHARACTERISTICS OF ELITE CENTRAL AFRICAN YOUTH FOOTBALL PLAYERS: A COMPARATIVE STUDY WITH INTERNATIONAL PEERS**

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INTRODUCTION: Youth football performance is influenced by several anatomical and functional factors, which vary depending on age, ethnicity, and position played. While many studies have analyzed adult players, limited data exist on young, elite African footballers. This study compared the anthropometric and performance characteristics of elite Central African U15 and U17 football players with international peers.

METHODS: Data were collected during the 2022 International Challenge Cup (Rabat, Morocco) from 162 players (126 Central African; 36 international). Anthropometric measurements included height, weight, and body fat percentage. At the same time, performance tests assessed lower limb power (Squat Jump, Countermovement Jump, Drop Jump), sprint speed (10m and 20m), and aerobic capacity (Yo-Yo IR1 test). ANOVA was used to analyze differences across age groups, ethnicities, and field positions.

RESULTS: International players had higher body weight (66.17±10.25 kg vs. 61.5±8.3 kg, $p=0.041$) and body fat percentage (11.5±2.1% vs. U15=6.8±1.2%, U17=7.1±1.5%, $p<0.001$) compared to Central Africans. U15 Central Africans exhibited superior jump performance (SJ: 42.5±4.3 cm; CMJ: 45.2±4.8 cm) compared to U17 ($p=0.032$) and international players ($p=0.003$). Sprint times showed no significant differences, while U17 Central Africans had a higher VO2max (56.3±5.2 ml/min/kg) than international players (52.8±4.6 ml/min/kg, $p=0.040$).

CONCLUSION: Central African youth players demonstrated superior lower limb power and aerobic capacity than their international peers, with lower body fat percentages observed in the U15 and U17 categories. These findings contribute to the scarce literature on African youth football and may guide training and talent development programs for young athletes in the region.

**COMPARISON OF FUNCTIONAL AND TRADITIONAL STRENGTH AND POWER TRAINING ON U19-TRAINED MALE FOOTBALL PLAYERS**

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INTRODUCTION: Functional strength training is thought to develop the neuromuscular system controlling muscle force and dynamically stabilize the kinetic chain during functional movements in a coordinated sequence, while traditional strength training has its benefits in improving maximum strength in an isolated muscle or specific muscle groups.

METHODS: The current study compared the effects of functional versus traditional strength training on physical and technical parameters in U19-trained male football players. A quantitative randomized controlled trial design was used. Thirty-three participants were recruited and randomly divided into a functional training group [(FTG; n = 11)], a traditional training group [TTG; n = 11)], and a control group [CG; n = 11)]. The intervention groups were trained for eight weeks, with additional off-season football training (two weekly sessions) in the first four weeks of the intervention.

RESULTS: A significant (p = 0.05) decrease in time in the Loughborough soccer shooting test (LSST-time) was observed between the FTG (p = 0.031) and TTG (p = 0.003) compared with the CG, and an increase in body weight was observed between the FTG and CG (p = 0.002).

CONCLUSION: Both training methods improved the LSST-time performance during the off-season period. Furthermore, both training methods can maintain components considered important in football performance during the off-season period, ensuring that players are better prepared for the upcoming pre-season period.

**SMALL-SIDED GAMES WITH STOP-BALL RULE: ANALYSIS OF SOME EXTERNAL LOAD PARAMETERS IN YOUNG SOCCER PLAYERS**

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INTRODUCTION: Small-sided games (SSGs) are currently one of the most common drills used and have been progressively growing in amateur and professional soccer teams [1]. SSGs are used to increase the technical skills and physical abilities of soccer players [2].

During SSGs, the manipulation of pitch size, number of players per team, goalkeeper presence and technical rules modulate the soccer-specific demands depending the aims of each training session [3]. Among these variables pitch size is most frequently used, as larger vs smaller configurations affect soccer players behavior [4].

The purpose of this study is to investigate the effects of two fields of different sizes for SSGs-stop ball (SB) on some parameters of high intensity in Under-15 soccer players.

METHODS: Ten young soccer players (age:13,8±0,42 years; stature:168,8±6,21cm; body mass:55±7,07kg) voluntarily participated in this study. During the training interventions, the SSGs-SB were based on 4-a-side team format, without goalkeeper, and were performed on 20x25 m (62,5 m2 · player) and 30x38 m (142,5 m2 · player) fields. In both exercises the protocol consisted of 4x3 min, followed by 2 min of passive recovery. The training sessions, conducted in two different days, were performed on the same artificial grass field and time (16:30-18:00 pm) with the same outside temperature (22 C°).

During sessions, the players were monitored using global positioning system (GPS) devices at 18.18 Hz (GPEXE® SYSTEM, EXELIO srl, Udine, Italy). Total distance covered (TD), high speed running distance 13-18 km/h (HSRD), sprint running distance >18 km/h (SRD), peak speed, distance in acceleration (ACC) >2,5 m/s2 and deceleration (DEC) <-2,5 m/s2 were measured. The significance level has been set to $p<0.05$ and effect size (ES) was calculated.

RESULTS: Large SSGs-SB (30x38 m) have determined higher significantly values than smaller field for HSRD (317,41±63,82 m vs 248,05±61,56 m; $p<0.05$; ES: 1.10), SRD (84.77±30.28 m vs 54.37±29.17 m; $p<0.05$; ES: 1,02) and peak speed (23.36±0.93 km/h vs 21.64±1.19 km/h; $p<0.001$; ES: 1.62); instead, small SSGs-SB (20x25 m) have produced greater outcomes and statistically significance for distance covered both in ACC >2,5 m/s2 (22.36±7.58 m vs 12.82±3.17 m; $p<0.001$, ES: 1.77) and DEC <-2,5 m/s2 (33.47±6.86 m vs 24.55±6.77 m; $p<0.05$; ES: 1.39). No significant differences haven't been found for TD (1568,14±122,37m vs 1592,81±136,15m).

CONCLUSION: Large SSGs-SB have generated a significant increase on external load monitored, while lower dimensions have affected mechanical variables. Finally, it is recommended implementing high intensity exercises in order to promote lower non-contact muscle injury risk [5]. This results can contribute some methodological advises to practitioners and fitness soccer coach that must schedule SSGs during season.

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**REACTION SPEED PERFORMANCE IN SOCCER PLAYERS: A CROSS-SECTIONAL STUDY FROM U13 TO PROFESSIONAL LEVELS**

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INTRODUCTION: Reaction speed is a key factor in soccer, influencing players' ability to anticipate actions. Its development can be influenced by age, cognitive-motor maturation, training exposure and competitive level. The study aims to investigate the reaction-speed performance across U13 to U17, professional and semi-professional soccer players, using a light training task.

METHODS: A total of 159 soccer players participated in the study, categorized into U13 (n=23), U14 (n=17), U15 (n=26); U16 (n=18), U17 (n=18), semi-professional (n= 23) and professional (n=34) groups. Each player completed a single session of a reaction-speed task using the Speedpad application (Mentis VR Ltd), a Virtual Reality light training task. The task presented an array of nine circular discs and players were required to hit with their hands as fast as possible, each disc whose outline changed to red. The number of correct responses to target discs in a 1-minute session was considered the player's reaction-speed score. One-way ANOVA was used to compare the groups, and Tukey post-hoc to identify significant differences across groups.

RESULTS: Reaction speed performance was lower in U13 (62.7±10.3 points) and U14 (63.5±8.87 points) players compared to the other groups (F=6.90, p<.001). No significant differences were observed among U15 (75.0±7.01 points), U16 (n=72.9±10.0), U17 (74.6±12.6 points), semi-professional (75.3±10.1 points), and professional (74.3±10.3 points) players, indicating that reaction speed stabilizes from U15 forward.

CONCLUSION: This study demonstrated that reaction speed improves up to U13-U14 and stabilizes across older age groups, including semi-professional and professional players. The lower performance in U13 and U14 may reflect ongoing neuromuscular development, maturation and training exposure. The lack of differences from U15 onwards suggests reaction speed plateaus with accumulated experience. These findings emphasize the need for targeted reaction-speed training from childhood to early adolescence to achieve maximum cognitive-motor development. Future research should explore advanced training methods, such as virtual reality-based drills, to further refine reaction speed in elite soccer players.

**CAN INCREASED WEEKLY PLYOMETRIC TRAINING FREQUENCY ENHANCE PERFORMANCE AND MITIGATE MUSCLE SORENESS IN YOUTH SOCCER?**

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INTRODUCTION: Neuromuscular adaptations and performance gains can be achieved across different plyometric training (PT) frequencies assuming the total training volume remains equal (1). However, distributing the training load across more frequent weekly sessions may assist young soccer players in reducing their perceived internal load, thereby fostering recovery, and enhancing training sustainability (2). This study aims to investigate the effects of volume-matched PT with different weekly frequency distributions on physical performance and muscle soreness in adolescent soccer players.

METHODS: Thirty-four sub-elite adolescent soccer players were allocated into two groups: the PLYO-1 group underwent one PT session per week, while the PLYO-3 underwent volume-matched PT distributed over three sessions per week. The 9-week experimental program included nine plyometric exercises, starting with a weekly volume of ~55-foot contacts and increasing by 10% each week. The 7-point Likert scale was employed to assess the perceived muscle soreness before and after each PT session. All players were tested for countermovement horizontal (CMHJ) and vertical (CMVJ) jumps, 10-m sprint and change of direction (COD) performance using the modified 505 test (505mod). A two-way ANOVA for repeated measures analyzed simple and main effects between PLYO-3 and PLYO-1, with Cohen's d (d) effect size to quantify the magnitude of each difference.

RESULTS: After the 9-week experimental period, both groups exhibited significant improvements in CMHJ distance ($p < 0.001$; $d = -0.55$) and CMVJ variables (jump height and modified reactive strength index) ($p < 0.001$; $d = -0.34$ and $d = -0.33$), and 505mod time (COD deficit) performance ($p < 0.001$, $d = 1.09$). However, no improvements were observed in the 10-m sprint time performance for PLYO-1 and PLYO-3 ($p > 0.911$, $d = -0.12$). The changes in perceived muscle soreness were significantly lower for PLYO-3 compared with PLYO-1 ($p < 0.001$, Cohen's $d = 1.04$) throughout the experimental period.

CONCLUSION: Implementing a high-frequency PT regimen (three sessions per week) with a progressive 10% increase in weekly foot contacts can optimize weekly load distribution and enhance overall athletic readiness in youth soccer. Therefore, employing PT interventions with weekly volume-matched but conducted at different frequencies can help maintain or even improve jump and COD performance, while impacting muscle soreness differently.

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**THE RELATIONSHIP BETWEEN FITNESS CAPACITIES AND THE MAXIMAL INTENSITY PERIODS IN YOUTH SOCCER MATCH-PLAY**

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INTRODUCTION: Soccer is a high-intensity intermittent sport that demands a combination of technical skill, tactical awareness, and fitness to compete successfully. During periods of match-play, players are at times required to perform at very high intensities - termed the maximal intensity periods (MIPs), which can significantly impact match outcomes (Weaving et al., 2022). Thus, the development of fitness to perform in these intense periods may underpin the capacity to sustain high output during the MIPs. Till date, most studies examining the relationship between fitness and match-running output have mainly focused on the volume of match outputs (total distance, total high-speed distance etc.). However, studies have shown large variability lies within these volume-based metrics, which is further compounded by variability shown between playing positions (Carling et al., 2016). The use of intensity-based metrics by normalizing to playing minutes may provide a more reliable expression of match intensities with lower variability (<10% CV) between matches and positions (Thoseby et al., 2022). This study seeks to examine the relationship between fitness status and the maximal intensity periods in a cohort of male youth competitive footballers.

METHODS: 32 male youth players (age = 14.1 ± 0.8 years, height = 162.8 ± 8.3 cm, body mass = 50.4 ± 9.6 kg) were observed during the in-season period. Fitness capacities were assessed using the 5-m acceleration time and maximal sprinting speed (MSS) derived from a 40-m sprint test, vertical jump (VJ) test and the Yo-Yo Intermittent Recovery Test Level 1 (YYIRT 1). MIPs were tracked using a moving-average technique applied to the speed, acceleration and PlayerLoad across 10 different durations (1-10 mins) in matches played within four weeks of the fitness tests. Mixed linear models were used to determine the relationship between fitness capacities and the peak-match intensities by converting the t statistics from the models to effect sizes (ES) correlations (r).

RESULTS: There were no clear relationship between 5-m, MSS, VJ or YYIRT 1 with the rolling averages of MIP of total distance (m.min-1), high-speed distance (> 14.4km.h-1), acceleration (m.s-2), and PlayerLoad (au.min-1) (r = 0.02 to 0.16).

CONCLUSION: There is little association between a youth footballer's fitness status and the ability to perform during MIPs in matches. Practitioners should evaluate fitness and match intensities metrics separately and avoid postulating an effect between these two constructs. Both measures can be assessed based on their variability to identify meaningful changes in individual player's fitness and match outputs.

## Conventional Print Poster Presentations

### CP-AP32 Training and Testing IV - Mixed

**THE EFFECTS OF SOFT AND DEEP TISSUE MASSAGE ON LOWER EXTREMITY OXYGENATION RATES ASSESSED USING ISCHAEMIC PRECONDITIONING**

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INTRODUCTION: Soft and deep tissue massage are routine approaches utilised both in the rehabilitation and recovery processes of performance and recreational athletes, with therapeutic benefits purported to be increased blood flow and oxygenation rates. However, the evidence remains contradictory. Therefore, the purpose of this preliminary study was to examine the impact of both soft and deep tissue massage on consequent muscle oxygenation levels.

METHODS: Following local institutional ethics approval, 10 recreationally active participants (7 males, 3 females) volunteered (mean ± SD: age 21 ± 2, body mass 67.8 ± 11.2 kg, height 175.3 ± 9.2 cm). All participants were assessed using the ankle-to-brachial index for suitability to undergo blood flow occlusion. For all conditions, the participant lay supine on a massage bench, where muscle oxygenation was recorded throughout using NIRS sampling at 10 Hz, across the midpoint of rectus-femoris. An occlusion cuff (20 cm width) was placed midway between ASIS and mid-patella. Following 7 min in the rested state (REST), muscle blood flow was regulated using occlusive and reperfusion phases of 7 min using 80% of the individualised limb occlusion pressure. Immediately followed by 7 min of SOFT then DEEP tissue massage, which were proceeded by a second occlusive-reperfusion phase.

RESULTS: There was a significant difference (P< 0.01, effect size (ES) = 2.03; 95% CI 3.01 - 0.88 between minimum (66.43 ± 12.13%) and maximum (88.24 ± 9.12%) tissue saturation index (TSI) values when comparing REST to SOFT following reperfusion. For DEEP, when comparing to REST for minimum to maximum responses (82.34 ± 6.84%), a large ES: 1.51; 95% CI 2.54 - 0.55; (P< 0.01) was also observed. Oxyhaemoglobin (O2Hb) increased from a minimum [baseline value] at REST of

26.63 ± 18.38% to a maximum of 91.53 ± 37.65% following SOFT; ES = 2.19; 95% CI 3.19 – 1.01; (P< 0.01), while for DEEP there was an increase of 201.6% in O2Hb: ES = 3.19; 95% CI 1.77 – 4.35; (P< 0.01).

CONCLUSION: These data tentatively suggest that both soft and deep tissue massage increased O2 availability at the muscle, as reflected in the increases for both TSI and O2Hb. It is probable that vasodilation, possibly linked to the nitric oxide cascade influenced by the pressure applied and thermoregulatory responses are the primary candidates attributable. Caution should be applied to these findings as both procedures occurred subsequent to each other, potentially explaining the mixed results across conditions.

**JOINT PREDICTION OF ENERGY EXPENDITURE DURING INCREMENTAL LOAD EXERCISE IN COLLEGE STUDENTS USING MULTI-SOURCE HETEROGENEOUS DATA AND DYNAMIC TIME SERIES ANALYSIS**

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INTRODUCTION: Energy Expenditure (EE), a key indicator reflecting exercise intensity and volume, has been widely researched in public health and sports training. Accurate monitoring of EE is crucial in physiology, health management, and exercise prescription design. Consequently, accurately predicting or estimating energy expenditure using simple, easy-to-measure indicators combined with artificial intelligence (AI) algorithms has become a critical direction in energy consumption research. Building on previous research, this study integrates heart rate and acceleration data from incremental load exercises, constructing multiple dynamic time series prediction models. The model with the best fit was selected based on performance evaluation metrics, providing a theoretical reference for future energy expenditure prediction studies.

METHODS: Twenty-five college students participated as subjects, undergoing an incremental load exercise test on a treadmill. Data collection comprised exercise load metrics and heart rate readings captured by accelerometers, with energy expenditure predictions made using dynamic time-series models (e.g., LSTM, BiLSTM, TCN, GRU, CNN+LSTM). Model performance was evaluated using metrics such as RMSE, $R^2$, and Bias, with prediction consistency further assessed through Bland-Altman plots.

RESULTS: The LSTM model achieved the lowest RMSE (0.2423) and Bias (0.1060), indicating its high accuracy and consistency in predicting energy expenditure. It also displayed the highest $R^2$ value (0.9255), demonstrating its strong ability to interpret the data.The TCN model also performed well, with an RMSE of 0.2710, an $R^2$ of 0.9068, and the lowest Bias (0.0216) among the models. The low Bias value indicates that TCN offers a reduced systematic error in predictions compared to other models. TCNs ability to capture long-term contextual information through its convolutional structure helped it mitigate biases effectively. BiLSTM, GRU, and CNN+LSTM showed moderate performance. Overall, LSTM and TCN were the top-performing models.

CONCLUSION: In this study, we developed an EE model for incremental loading exercise by utilizing acceleration and heart rate data, comparing the predictive performance of multiple time series models, including LSTM, BiLSTM, GRU, TCN, and CNN+LSTM. Through evaluation metrics such as RMSE, $R^2$, and Bias, along with Bland-Altman plots to assess prediction consistency, we identified LSTM and TCN as the most accurate and stable models for EE prediction. Our findings underscore the effectiveness of time series-based algorithms in capturing dynamic patterns in incremental loading exercise. Moreover, incorporating joint internal (heart rate) and external (acceleration) metrics as input features proves effective in reflecting exercise intensity. This approach suggests that the integration of multiple metrics enhances the accuracy of EE estimation, providing a reliable means for quantifying exercise load and calculating exercise intensity.

**BIOFEEDBACK IN ATHLETIC PERFORMANCE: A SYSTEMATIC REVIEW**

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INTRODUCTION: Biofeedback technologies are increasingly applied in sports science to optimize neuromuscular control and psychophysiological adaptation [1-3]. Current research demonstrates methodological inconsistencies in efficacy assessments across athlete populations, particularly regarding long-term outcomes and modality-specific mechanisms.

METHODS: This systematic review aim at evaluating biomechanical pathways and proposes evidence-based training through multilevel data synthesis. Following PRISMA guidelines, Web of Science, PubMed, and SPORTDiscus were systematically searched. 32 studies (2019–2024) were analyzed from using search terms: ("biofeedback" OR "neurofeedback") AND ("athletic performance" OR "sport*") . Dual-blind AMSTAR2 assessments excluded studies scoring <22% on methodological rigor (κ=0.81). Data extraction categorized outcomes by European College of Sport Science biofeedback taxonomy: physiological (HRV/EMG), biomechanical (kinematic), and neurocognitive (EEG) .

RESULTS: HRV biofeedback demonstrated moderate effects on endurance performance (d=0.62–1.15) and stress resilience, while EMG interventions improved strength output variability by 18–27% in power sports . Neurocognitive protocols enhanced decision-making accuracy (p<0.05, ES=0.89) but showed conflicting results in motor learning retention between RCTs and non-randomized trials . Biomechanical feedback reduced injury-risk movement patterns (Cohen's $f^2$=0.31) yet exhibited limited transfer to competition contexts.

CONCLUSION: Theoretical integration of psychophysiological adaptation models clarifies biofeedback's task-specific efficacy. Practitioners should prioritize multimodal protocols combining HRV and kinematic feedback for compound adapta-

tions. Limitations include heterogeneity in outcome measures and underrepresentation of female athletes (18% of samples).

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**AORTIC IMPEDANCE DURING MODERATE-INTENSITY HANDGRIP EXERCISE: A TIME-RESOLVED PHASE-CONTRAST MRI STUDY**

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INTRODUCTION: Resistance exercise increases afterload on the left ventricle during stroke volume ejection. While afterload is traditionally assessed using total peripheral resistance (TPR), this measure overlooks the pulsatile nature of the cardiovascular system. Aortic input impedance, which reflects the dynamic pressure-flow relation at the ventricular-vascular interface, may offer a more accurate and comprehensive assessment of the afterload. This study aimed to evaluate aortic input impedance during moderate-intensity rhythmic handgrip exercise (RHE) in young, healthy men and women. We hypothesized that RHE would increase characteristic impedance (Zc), a key pulsatile component of aortic input impedance, and that this increase would correlate with left ventricular workload.

METHODS: Fifteen healthy young adults (6 women, 24 ± 3 years) participated in the study. Aortic flow and pressure were measured simultaneously at rest and during RHE at 40% of maximum voluntary contraction using time-resolved phase-contrast magnetic resonance imaging (PC-MRI) and a generalized transfer function method, respectively. Aortic input impedance was derived from frequency-domain analysis of aortic flow and pressure waveforms. Zc was calculated as the mean impedance modulus between the 3rd and 8th harmonics of heart rate. Left ventricular workload was assessed using the augmentation index (AIx) and tension-time index (TTI) derived from the aortic pressure waveform.

RESULTS: During RHE, heart rate and mean arterial pressure increased significantly ($p < 0.001$), while stroke volume showed a trend of decrease (74 ± 16 to 71 ± 18 mL, $p = 0.084$). Cardiac output (4.56 ± 0.80 to 5.12 ± 0.97 L/min, $p = 0.011$), TPR (17.70 ± 2.51 to 19.72 ± 4.10 L/min/mmHg, $p = 0.033$), and AIx (-1.19 ± 11.73 to 4.86 ± 12.72%, $p = 0.045$) increased significantly. Zc also increased significantly during RHE compared to rest (480 ± 94 to 602 ± 215 dyne/cm³/s, $p = 0.033$). While TPR was not associated with TTI ($r = 0.402$, $p = 0.138$), changes in Zc during RHE correlated with increased TTI ($r = 0.598$, $p = 0.018$).

CONCLUSION: These findings indicate that cardiac afterload increases during moderate-intensity handgrip exercise, as reflected by both TPR and aortic Zc. However, the association between cardiac afterload and workload was observed only for Zc. This suggests that aortic input impedance is a more relevant marker of left ventricular workload during resistance exercise than TPR.

**ANALYSIS OF THE WAKE-SLEEP CYCLE IN ESPORTS ATHLETES AND ITS RELATIONSHIP WITH REACTION TIME**

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INTRODUCTION: The eSports has attained a significant level of professionalism [1]. The main strengths of an eSports athlete are hand-eye coordination and reaction time [2]. Studies indicate that the lifestyle of electronic eSports athletes can be considered unhealthy, even of those athletes with high engagement and commitment to the eSport [3]. Sleep is directly responsible for interfering with reaction time, and poor sleep quality directly leads to increased reaction times [4]. Therefore, the aim of this study is to evaluate the wake-sleep rhythm of professional eSports players and their reaction times.

METHODS: 27 professional players from a traditional eSports team in São Paulo were evaluated. The athletes used the actigraph for 10 consecutive days and performed three reaction tests during the period, upon waking up, upon starting training and at the end of training, in addition, the players sleep regularity was also analyzed.

RESULTS: The eSports players have poor sleep quality, with low total sleep time (6:39 hours) and efficiency (83.70%), as well as a high number of wake after sleep onset (47 minutes), regarding sleep regularity 7 players were considered irregular sleepers with an average score of 67.72±5.37, while the 7 regular sleepers had an average score of 90.37±1.17. There was an association between the sleep time of players who slept more and reaction time, in which athletes with longer total sleep time showed greater accuracy in reaction tests, in addition, players with better sleep regularity showed faster reaction times.

CONCLUSION: We can conclude that the players had low general sleep quality and athletes with longer total sleep time and better sleep regularity are those who performed better during the reaction tests.

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**BLOOD BIOMARKERS AND WINGATE TEST PERFORMANCE IN LATVIAN YOUTH ATHLETES: DESIGN AND PRE-SEASON ASSESSMENT**

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INTRODUCTION: Nowadays youth athletes experience high physical workload due to increasing number of competitive matches, including participation among older age groups. Proper monitoring of youth athletes throughout the season are of importance to ensure optimal development, recovery, and injury prevention. To evaluate the health of Latvian youth athletes project within National Research Programme Sport (IMRSportsLV; Nr. VPP-IZM-Sports-2023/1-0001) has been initiated. This project aims to develop research methods and guidelines for evaluation of physical and mental health of youth athletes across the season.

METHODS: Pre-season testing of 12–18-year-old athletes began in fall 2024, evaluating physical fitness (aerobic and anaerobic capacity), movement quality (Functional Movement Screen, Y-Balance Test), anthropometry (BMI, waist circumference, bioimpedance), blood biomarkers and questionnaires of burn out, well-being, and competition anxiety. This abstract focuses on some baseline measures. So far fasting blood samples have been collected from 112 athletes (48 females, 54 males; age 15.5±3.07). Anaerobic performance has been estimated using the Wingate 30-second maximal power test on a Cyclus2 veloergometer for 77 athletes (29 females and 48 males, age 15.9±1.6), who did not report bodily pain or discomfort. Follow-up assessments in mid- and end-season will be performed to track changes over time.

RESULTS: When compared to reference values pre-season assessments showed insufficient vitamin D levels in 60% of youth athletes with varied magnitude (severe: 8.55±1.91 ng/mL, n=2; moderate: 16.22±2.86 ng/mL, n=15; mild: 24.31±2.98 ng/mL, n=51). Low ferritin was observed in 13 athletes (5.78±1.3 ng/mL), while 9 had decreased hemoglobin (116.44±2.40 g/L). 2.40 g/L). Elevated glucose levels were detected in 3 athletes (6.79±1.77 mmol/L). Lipid profile analysis showed low HDL in 5 athletes (0.96±0.019 mmol/L) and elevated LDL in 9 (3.28±0.22 mmol/L). Baseline testosterone-to-cortisol ratio was 0.004±0.002 in females and 0.062±0.025 in males ($p<0.001$). Wingate test results showed that female relative peak anaerobic power (8.35±0.93 W/kg) and relative anaerobic capacity (6.88±0.73 W/kg) was significantly lower ($p<0.001$) than for males (10.88±1.21 W/kg and 8.84±0.87 W/kg, respectively). There was no correlation between blood biomarkers and anaerobic performance when adjusted for sex.

CONCLUSION: Pre-season results show that notable number of athletes have low ferritin and hemoglobin levels. Furthermore, vitamin D insufficiency among youth athletes is highly prevalent. Hormonal analysis revealed sex-based differences in testosterone-to-cortisol ratios, while Wingate test results showed notable differences in anaerobic power and capacity between males and females. These findings highlight the need for continuous monitoring of youth athletes and such interventions as supplementation of vital micronutrients for optimal physical health and performance.

**CAFFEINE OR SODIUM BICARBONATE INGESTED 180-90 MINUTES PRIOR TO TESTING DID NOT AFFECT REPETITIONS, RATING OF PERCEIVED EXERTION OR ELECTROMYOGRAPHY**

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INTRODUCTION: Caffeine supplementation has gained renewed interest since its removal from the World Anti-Doping Agency's prohibited substances list in 2004[1]. Research suggests caffeine as a supplement for high-intensity physical tasks[2] and it may enhance force production and endurance[3,4]. Similarly, sodium bicarbonate has been shown to enhance high-intensity exercise performance[5]. This study aimed to assess the efficacy of an acute caffeine and sodium bicarbonate supplementation on leg extension and chest press resistance training performance.

METHODS: Fourteen resistance-trained individuals (≥6 months of training, daily caffeine consumers) ingested caffeine, sodium bicarbonate or a placebo at 120, 90, and 60 minutes before testing. Participants performed six sets of chest press or knee extension at a 12-repetition maximum (12RM) load with 60-second rest intervals. Electromyography (EMG) of the rectus femoris and triceps brachii, movement velocity, time under tension, and blood lactate levels were recorded. Heart rate and rate of perceived exertion (RPE) were measured after each set.

RESULTS: Chest press repetitions significantly differed between conditions ($F(2,20)=4.35$, $p=0.027$, eta2: 0.303, OP: 0.686). Although the highest repetitions were observed following sodium bicarbonate supplementation (7.42; 95%CI: 6.8-7.9), post-hoc tests could not specify a significant difference. No significant effects were found for knee extension repetitions. There were no significant main effects or interactions for EMG activity or RPE in either exercise. Caffeine significantly increased diastolic blood pressure compared to sodium bicarbonate and placebo (79.2 mmHg; 95%CI: 74.6-83.7 vs. 72.7 mmHg; 95%CI: 67.5-77.9 and 74.5 mmHg; 95%CI: 71.7-77.3). Blood lactate, systolic blood pressure, and extracellular water-to-total body water (ECW/TBW) ratio increased pre- to post-test across all conditions. A significant time x sex interaction ($F(1,9)=5.46$, $p=0.04$, eta2: 0.378, OP: 0.55) showed both males and females experienced an increase in extracellular water/total body water (ECW/TBW). All conditions led to significant ECW/TBW increases ($F(2,18)=16.49$, $p=0.001$, eta2: 0.647, OP: 0.977) with no differences between supplement groups.

CONCLUSION: The overall findings of this study found that caffeine increased diastolic blood pressure but had no apparent effects on repetition performance while sodium bicarbonate supplementation improved chest press performance. Although there were no obvious benefits for knee extension, both supplements caused an increase in blood lactate and EWC/TBW ratio.

1. Del Coso et al. (2011) 2. Guest et al. (2021) 3. Ferragut et al. (2014) 4. Grgic (2021) 5. Saunders at al. (2022)

**DOES SLEEP PATTERN AFFECT RESISTANCE TRAINING-INDUCED MUSCLE HYPERTROPHY?**

CANOY, L., SANZO, K., DIMICELI, S., MUNDOK, E., RAUCCI, J., CARY, P., YAMEEN, N., SEUNATH, D., CLARK, L., SHINE, T., SMALL, J., KOUREMENOS, K., ALIAS, T., UGRINOWITSCH, C., DE SOUZA, E.O.

*THE UNIVERSITY OF TAMPA*

INTRODUCTION: Anecdotal evidence suggests that sleep is a significant part of the training process due to its function in skeletal muscle recovery and adaptation. Thus, comparing short- and regular-sleepers (i.e., <360 min and > 360 min per night, respectively) resistance training (RT) -induced muscle hypertrophy may provide empirical evidence for such a claim. In addition, we tested if high RT volume would overcome allegedly lower muscle hypertrophy in short sleepers. Thus, our study aimed to determine if total sleep time, number of awake periods during the night, and differences in RT volume may affect RT-induced muscle hypertrophy.

METHODS: Twenty-five sedentary college students (20 females and 5 males) volunteered to participate in the study (mean ± standard deviation [SD]—age: 20.0 ± 2.0 years, body mass: 61.6 ± 18.9 kg). Total sleep time (TST) and wake after sleep onset (WASO) were assessed over seven days at pre-training via wrist-worn actigraphy. The sum of anterior thigh muscle thickness (ΣMT) (i.e., rectus femoris and vastus intermedius) at 40% and 60% of femur length was assessed pre- and post-training by researchers blinded to the training protocol. Classification of participants into short- and regular-sleepers was performed non-randomly at post-training for blinding purposes (i.e., a non-randomized controlled trial). Participants' lower limbs were randomly assigned to low- and high-RT volume conditions (1 set vs. 3 sets per exercise [leg press and knee extension], respectively—i.e., within-subject design) and trained for eight weeks, twice a week, under the supervision of researchers blinded to sleep patterns. General linear models were used to compare changes in MT from pre- to post-training and delta change in VL thickness between the low- and high-RT volume limbs.

RESULTS: Means and SD for TST and WASO were 442.0±63.4 min and 32.3±2.32 times per night, respectively. As our sample had only 3 short and 22 regular sleepers, TST and WASO were modeled as covariates instead of a fixed effect. Covariates TST and WASO did not change the interpretation of our findings, and they were removed from the statistical models. The lower-volume limb presented a significant increase in the ΣMT from pre- to post-training (7.99±0.29 and 8.77±0.25 cm: p=0.05, respectively). In contrast, the high-volume limb presented a trend (8.16±0.29 and 8.82±0.24 cm: p=0.09, respectively). The comparison of the delta change in ΣMT between the low- and high-volume limbs showed that the former had significantly higher anterior thigh hypertrophy than the latter (p=0.001).

CONCLUSION: College students with no previous experience in RT demonstrate sleep patterns that do not appear to affect RT-induced anterior thigh hypertrophy. However, our data suggest that a low RT volume is more beneficial than a high volume for this cohort.

**THE RELATIONSHIP BETWEEN EMGT AND ENERGY METABOLISM RESPONSE DURING INCREMENTAL EXERCISE**

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INTRODUCTION: The relationship between Electromyographic thresholds (EMGT1 as the first increased point and EMGT2 as the second increased point) and cardiorespiratory and blood lactate response have still not been fully understood. The purpose of this study was to evaluate the relationship between EMGTs and cardiorespiratory and blood lactate response during an incremental exercise test on a bicycle ergometer.

METHODS: Sixteen adult male subjects (25.6 ± 9.3 years) with exercise habits were subjected to incremental exercise test on a bicycle ergometer. The workload at the beginning of the exercise was set at 30 watts (constant at 60 rpm), and the workload was increased by 30 watts every 2 minutes. Wireless electromyography (EMG, Sports sensing, Japan) sensors were attached to the vastus lateralis muscles, and EMG was recorded during exercise. Exhaled gas exchange was measured with an exhaled gas analyzer (Minato, AE-310s, Japan). Blood lactate concentration (Arkley, Lactate pro 2, Japan) was measured before the start of the exercise, every 2 minutes during the exercise, and immediately after the end of the exercise.

The EMGTs were determined by visual inspection, using the first (EMGT1) and second (EMGT2) points at which the magnitude of the EMGTs began to increase sharply. Two EMGTs (EMGT1 and EMGT2) were detected.

VT was defined as the time when VE started to increase sharply.

LT was defined as the time when blood lactate levels start to increase significantly.

RCT was defined as the time when $PetCO_2$ started to decrease from its peak.

OBLA was defined as the time when the blood lactate concentration exceeded 4 mmol.

Significant level of Pearson's correlation coefficients were assessed among these variables.

RESULTS: EMGT1 and EMGT2 were detected in the vastus lateralis muscles of 15 subjects. Good correlations were observed between VT, LT and EMGT1: VT and LT ($r = 0.69$, $p < 0.05$), EMGT1 and VT ($r = 0.65$, $p < 0.05$), EMGT1 and LT ($r = 0.71$, $p < 0.05$).

And also better correlations were observed between RCT, OBLA and EMGT2: RCT and OBLA ($r = 0.77$, $p < 0.05$), EMGT2 and RCT ($r = 0.83$, $p < 0.05$), EMGT2 and OBLA ($r = 0.78$, $p < 0.05$).

CONCLUSION: A good correlation can be observed between the EMGT2 and RCT, OBLA.

RCT (Respiratory Compensation Threshold) and OBLA (Onset of Blood Lactate Accumulation)

## Conventional Print Poster Presentations

### CP-AP33 Hockey, Ice Hockey and Warm-up

**SCORING, SAVING, AND STAYING OUT OF THE BOX: STATISTICAL DETERMINANTS OF SUCCESS IN ICE HOCKEY TOP DIVISION WORLD CHAMPIONSHIPS**

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*BASKENT UNIVERSITY*

INTRODUCTION: The International Ice Hockey Federation (IIHF) World Championships are among the most prestigious international ice hockey tournaments, with success determined by a combination of offensive, defensive, and strategic metrics. Understanding the factors that drive success in these championships is crucial for teams seeking to improve their competitive edge. Previous research has explored individual performance factors in ice hockey, but there has been limited systematic investigation into the determinants of medal-winning teams at the international level.

METHODS: This study applies Bayesian Ridge Regression and Ordinal Logistic Regression to analyze data from the IIHF World Championships (2010–2024) for both mens and womens tournaments. A comprehensive dataset was compiled, including key performance indicators such as goals scored, assists, penalty minutes, shots on goal, save percentage, and player age metrics. Teams were categorized into four groups—gold medalists, silver medalists, bronze medalists, and non-medalists—allowing for a more granular analysis of success factors. Multinomial logistic and ordinal regression models were employed to assess the relationship between team statistics and medal rankings.

RESULTS: Results indicate that offensive performance metrics, such as goals per game ($\beta = 0.825$, $p < 0.01$) and assists per game ($\beta = 0.789$, $p < 0.01$), were the strongest predictors of gold medal success in men's hockey, while save percentage ($\beta = 0.005$, $p < 0.01$) and shooting efficiency ($\beta = 0.689$, $p < 0.05$) played a more significant role in women's hockey. The effect of penalty minutes per game (PIM/GP) was found to be negatively correlated with success in men's hockey (-0.0565, $p < 0.05$) and women's hockey (-0.0406, $p < 0.05$).

CONCLUSION: In men's hockey, offensive metrics such as Goals per Game and Assists per Game were dominant predictors for winning gold medals, whereas Save Percentage was more important for securing silver and bronze medals. In women's hockey, shot efficiency (Shot Percentage, Shots per Game) had the strongest impact on winning gold, while Penalty Minutes per Game (PIM/GP) showed a moderate correlation with medal success. These findings highlight the distinct determinants of success in men's and women's tournaments. The results emphasize the importance of offensive efficiency in men's hockey and a balanced approach between offensive and defensive metrics in women's hockey. Additionally, minimizing penalties could improve team success, as aggressive playstyles do not necessarily lead to better outcomes.

**RELATIVE AGE IN SWEDISH ICE HOCKEY: DIFFERENTIATING RELATIVE AND ABSOLUTE REPRESENTATION TO REVEAL HIDDEN BIASES IN JUNIOR AND ADULT ELITE TEAMS.**

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*KAROLINSKA INSTITUTET*

INTRODUCTION: The relative age effect (RAE) describes an overrepresentation of athletes born early in a chronological selection year. In this report, the dynamics of the RAE in ice hockey were described by analysing the distributions of relative age (RA) across junior and adult elite selections in a large Swedish cohort.

METHODS: This retrospective, longitudinal study was conducted using birth dates collected from a cohort of players attending certified Swedish ice hockey high schools between 1998 and 2017 (n=2363). First, RA was defined as a numeric variable ranging from 0 to 0.99, along with the quarterly terms of the birth year (Q1 – Q4). Data on player selection to the Swedish national U16 team and the National Hockey League (NHL) were retrieved from open databases. Next, RA in the cohort was compared to the general Swedish population using birth data from Statistics Sweden (1), covering the number of children born per month between January 1, 1982, and December 31, 1998. Finally, distributions and group-based differences of RA across elite teams were visualised and described, and generalized logistic regression models were used to compute RA-associated selection probabilities adjusted for relevant confounders.

RESULTS: Individuals with a higher RA were overrepresented in Swedish ice hockey programmes. In detail, 36.7% vs. 13.2% of the included players in the sample were born in Q1 and Q4, respectively, compared to 26.1% (Q1) and 21.7% (Q4) in the Swedish national reference.

Key differences in the absolute distribution of players and relative selection probabilities across RA were observed. Players born in Q1 were about twice as likely to reach the U16 national team than late-born players (Q4), corresponding to absolute numbers of 169 (19.5%) and 32 (10.3%) players, respectively. Consequently, numeric RA was identified as a significant predictor of U16 selection in a regression model ($P < 0.01$). In contrast, 44 (5.1%) born in Q1 and 25 (8.0%) players born in Q4 were selected for the NHL, suggesting trends favouring late-born players. However, in a regression model, numeric RA was not a significant predictor of reaching the NHL ($P = 0.21$).

CONCLUSION: Early-born players are overrepresented in certified Swedish high school programmes, and they are more likely to be selected for the U16 national team. Considering adult success, RA was not identified as an important predictor of NHL selection, and the overrepresentation of early-born players here may be due to earlier selection biases.

Reference

1. Births and deaths per month by sex, 1851 – 2023. Statistics Sweden.

**THE RELATIONSHIP BETWEEN ANTHROPOMETRICS, ON-ICE, AND OFF-ICE PERFORMANCE IN SLOVAK NATIONAL ICE HOCKEY TEAMS ACROSS DIFFERENT UNDER-18 AGE CATEGORIES**

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*NATIONAL SPORT CENTER OF SLOVAKIA*

INTRODUCTION: The relationship between anthropometric characteristics and both on-ice and off-ice performance in ice hockey players over 18 years of age is well-documented (Potteiger et al., 2010; Peterson et al., 2015; Runner et al., 2016). However, these characteristics have not been thoroughly examined across different age categories of players under eighteen. The purpose of this study was to analyze differences in anthropometric characteristics, on-ice, and off-ice performance and to investigate potential relationships among these factors in Slovak National Hockey Teams in the U15, U17, and U18 categories.

METHODS: A total of 120 male members of the Slovak National Hockey Team participated in this study, including players from the U15 (n = 44; age 14.8 ± 0.24 years), U17 (n = 34; age 16.7 ± 0.34 years), and U18 (n = 42; age 17.6 ± 0.48 years) categories. First, body height (BH), body composition, and two off-ice tests—squat jump (SJ) and countermovement jump (CMJ) were performed. Subsequently, on-ice testing in full hockey gear was conducted, consisting of a 40m forward sprint (40FS), a 40m backward sprint (40BS), an agility test with the puck to the left (AGL) and right (AGR), and six 40m shuttle sprints (60SS). Standardized warm-up protocols, tailored separately for on-ice and off-ice measurements, were conducted before each testing session. All testing procedures took place on the same day.

RESULTS: U18 players had significantly greater BH ($p < 0.01$), body weight ($p < 0.01$), and muscle mass ($p < 0.01$) compared to U17 players. However, no significant differences were observed between U18 and U17 players in either on-ice or off-ice performance. Except for BH, U17 and U18 players showed significantly higher values across all measured variables compared to U15 players ($p < 0.01$). A significant relationship was observed between SJ and 60SS (U18, $r = -0.695$, $p < 0.001$; U17, $r = -0.727$, $p < 0.001$), 40FS (U18, $r = -0.851$, $p < 0.001$; U17, $r = -0.686$, $p < 0.001$), and 40BS (U18, $r = -0.552$, $p < 0.001$). Similarly, CMJ correlated with 60SS (U18, $r = -0.672$, $p < 0.001$; U17, $r = -0.657$, $p < 0.001$), 40FS (U18, $r = -0.808$, $p < 0.001$; U17, $r = -0.650$, $p < 0.001$), and 40BS (U18, $r = -0.515$, $p < 0.01$). No significant relationships were found in the U15 category.

CONCLUSION: The results of this study suggest that natural physiological differences between age groups (U15 vs. U17 and U18) may account for the observed disparities in performance and anthropometric characteristics. While relationships between on-ice and off-ice performance were evident in U17 and U18 players, no correlations were found in U15 players. This lack of correlation in U15 players may be attributed to limited training experience with jumping exercises and/or lower levels of strength and power development.

**BILATERAL ASYMMETRIES IN ECCENTRIC KNEE-FLEXOR STRENGTH AND THEIR IMPACT ON CHANGE OF DIRECTION AND DECELERATION ABILITY IN FEMALE FIELD HOCKEY PLAYERS : A PILOT STUDY**

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*LUNEX*

INTRODUCTION: Eccentric knee-flexor strength is a critical determinant of deceleration and change of direction (COD) performance in field hockey. Given the sports unilateral demands and potential for muscular imbalances, this study investigates the relationship between bilateral asymmetries in eccentric knee-flexor strength and COD ability in female field hockey athletes.

METHODS: Thirteen female field hockey players (mean ± SD age: 28.3 ± 9.3 years; mean ± SD body mass: 62.1 ± 7.6 kg) underwent eccentric knee-flexor strength testing using an instrumented Nordic hamstring device (NordBord, Vald Performance). Bilateral asymmetries were quantified based on peak torque and strength normalized to body mass (N/kg). COD performance was assessed using the 505 test (dominant and non-dominant plant foot trials), while deceleration ability was measured via distance to stop and time to stop using GPS-based tracking. Normal distribution was assessed for all variables using the Kolmogorov Smirnov Test. Pearsons product moment correlation coefficients was used for normally distributed variables and non-parametric method Spearman's rank correlation was used for non-normally distributed variables.

RESULTS: Bilateral asymmetry in eccentric strength ranged from 1% to 21%, with five athletes exceeding 10% imbalance. Sprint performance (10m, 15m, and 30m splits) was negatively correlated with higher strength asymmetries ($r = 0.615–0.598$, $p < 0.05$). 505 COD performance was negatively correlated with higher strength asymmetries ($r = -0.42$, $p < 0.05$). Acceleration and deceleration characteristics were strongly correlated, with athletes displaying greater acceleration rates also requiring more significant braking adaptations ($r = 0.846$, $p < 0.001$)

CONCLUSION: Athletes with greater bilateral asymmetries in eccentric knee-flexor strength exhibited reduced COD efficiency, slower sprint times, and altered deceleration mechanics. These findings emphasize the need for individualized

training strategies to improve bilateral strength symmetry, sprint acceleration, COD performance, and braking ability in female field hockey players. Further research should investigate whether targeted eccentric strength interventions can reduce these asymmetries and improve COD efficiency.

**UNILATERAL VERTICAL FOOT-ANKLE REACTIVE STRENGTH INDEX: A NEUROMUSCULAR READINESS INDICATOR FOR PLYOMETRIC ACTIVITIES IN FLOORBALL PLAYERS ACROSS AGE GROUPS, PLAYING POSITIONS AND LEVELS**

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INTRODUCTION: The reactive strength index (RSI) is a key assessment of lower limb neuromuscular efficiency, whereas kinetic variables provide in-depth information into an individuals jumping performance [1]. High-intensity movements impose a significant mechanical load on the ankle joint [2]; therefore, unilateral RSI can more accurately reflect an athletes single-limb readiness for plyometric activities and the potential risk of ankle-complex injury. This study aimed to indicate floorball players unilateral RSI as a readiness indicator for plyometric activities and compare metrics across age groups, playing positions, and levels.

METHODS: Seventy-six male floorball players (age: 18.9 ± 3.9 years; height: 180.0 ± 7.1 cm; body mass: 76.1 ± 9.9 kg; body mass index: 23.4 ± 2.5) from the three highest and first league teams (grouped as follows: U17: n = 29, U20: n = 23, 20+ years: n = 24) performed a unilateral foot-ankle 10/5 rebound jump test on an infrared contact grid (MuscleLab, Norway). Jumping strategy-based metrics, including jump height (JH), contact time (CT), flight time (FT), vertical stiffness (Kvert), average power (AP), and RSI, were determined and used for correlational analysis. For the jump strategy, standardised z-scores were calculated; however, for the readiness, t-scores as RSI benchmarks were used. However, a one-way ANOVA test was used to compare age groups and eta squared ($\eta^2$) to determine effect size, but an independent t-test and Cohen's d for playing position and level. All test results were statistically significant if $p < .05$.

RESULTS: Significant differences in RSI, JH, and FT were indicated among age groups ($p < .05$, $\eta^2 = .111$ to .133), but no differences in CT. RSI is significantly higher in U20 than U17 ($p = .014$), but U17 showed shorter CT than U20 and the 20+ group ($p < .05$). Higher-league athletes had higher RSI, JH, FT, and AP compared to the first league ($p < .001$), but no differences by playing position. Unilateral RSI was negatively associated with Kvert ($r = -.49$, $p < .05$) in the U20 group. Twelve athletes had good RSI, while twelve showed poor RSI, indicating unpreparedness for plyometric activities. Twenty-seven athletes showed short CT with low JH jumping strategy, mostly from U17, while longer CT with higher JH was mostly utilised in the U20 group (n = 10).

CONCLUSION: Athletes with poor RSI have low reactive strength capabilities and are unprepared for moderate to high-intensity plyometric activities, where low AP and JH indicate a need for strength development. These findings indicate that unilateral RSI from rebound jumps is a key dynamic performance indicator and a useful data-driven tool to assess an athlete's readiness, providing coaches with athlete-centred monitoring and appropriate training decision-making.

1. Suchomel et al. (2016) 2. Radtke et al. (2021)

**INVESTIGATING THE DYNAMICS OF EYE-HAND COORDINATION IN FIRST-PERSON SHOOTER VIDEO GAMES**

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Introduction:

Eye-hand coordination is critical in many daily tasks and essential in sporting contexts, directly relating to performance outcomes (1). This topic has been central in research on traditional sports, such as soccer (2) or basketball (3). However, newer gaming-related sports (e-sports) are rapidly emerging, involving sensorimotor control and the coordination of various cognitive processes, such as attention and memory (4). These skills are currently understudied. This work addresses this gap by examining the learning patterns underlying eye-hand coordination and performance in video games, focusing on the interplay of different cognitive functions.

Methods:

Twenty non-professional males (M = 28,2; SD = 2,57) and females (M = 26,1 ; SD = 3,22) played eight different first-person shooter video games (e.g., shooting fixed or moving targets, decision-making, memory, audio-spatial tasks, etc.) drawn from the "Aimlab" platform. Participants eye movements were tracked using "EyeLink 1000" , while their hand responses were concurrently collected through "Weblink", a screen recording software. Each game was repeated four times (4 repetitions x 8 games, totalling approximately 1 hour of gameplay).

Results:

The analysis focused on three of the eight video games: "gridShot" (fixed targets), "flickShot" (object tracking), and "decisionShot" (colour-based action selection), all involving rapid target selection. Using linear mixed-effects models with a by-subject random effect, we predicted the duration of the final fixation before clicking on a target as a function of a performance metric (integrating shot frequency, hit/miss rates, and reaction time) across the four repetitions. Overall, performance linearly improved across sessions in all games. Importantly, each game exhibited distinct patterns of overt attention time-locked-to-hand responses. "gridShot" showed a progressively linear increase in fixation duration over sessions, while "flickShot" showed the opposite trend. In "decisionShot," fixation duration displayed a non-linear dynamic, reaching an individual-specific maximum threshold that optimised performance.

Discussion:

To the best of our knowledge, this study is the first to demonstrate that the duration of target fixation before a hand response does not linearly predict performance in these types of video games. This finding contrasts with the "quiet eye" concept often described in traditional sports, where a linear relationship between overt attention and performance is typically observed. Future work will investigate whether this type of learning can enhance relevant cognitive functions and whether expertise influences eye-hand coordination strategies.

References:

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**THE INFLUENCE OF QIGONG ON THE BALANCE CAPABILITIES OF PRACTITIONERS**

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INTRODUCTION: According to various authors, the systematic practice of qigong exercises has a beneficial effect on health, reducing stress, improving balance, and more. The aim of this study is to prove the positive effect of warming up with qigong exercises on balance capabilities. The object of the study is to compare the warm-up effects between two different types of exercises: qigong and basic gymnastics.

METHODS: Thirty-two students from different sports, between 20-25 years old, 16 males and 16 females, participated in the study. The balance assessment was conducted with the help of a stabilometric force platform. The Flamingo test in four conditions was used: eyes open and eyes closed with balancing on the left and right leg. Testing before and after two types of warm-ups was performed: with qigong exercises and with basic gymnastics exercises. A statistical processing of the results by descriptive analysis, Shapiro-Wilk Test, and Paired-Samples t Test was done. The effect size was calculated. Most of the differences observed in the center of gravity deviation during the balance tests were statistically significant, except for those with the left leg pre- and post-, and the right leg with eyes closed pre- and post- warm-up with basic gymnastics.

RESULTS: The mean center of gravity deviation pre- and post- the two types of warm-ups was established. When using qigong exercises, the following results were found: for right leg 7.7±1.8 vs 5.7±1.4 cm, for right leg with eyes closed 12.1±4.2 vs 9.3±3.2 cm, for left leg 8±2.1 vs 6.1±1.6 cm and for left leg with eyes closed 12.2±4.4 vs 9.2±3.2 cm. The results recorded from applying a warm-up with basic gymnastics were 5.9±2.0 vs 7.0±2.0 cm for right leg, 9.5±3.1 vs 9.6±3.0 cm for right leg with eyes closed, 6.5±1.8 vs 6.8±1.8 cm for left leg and 9.4±2.2 vs 11.2±3.5 cm for left leg with eyes closed, respectively. The calculated differences showed that qigong exercises led to a decrease in this indicator for all variables: for right leg by 2 cm, for right leg with eyes closed by 2.8 cm, for left leg by 1.9 cm, and for left leg with eyes closed by 3 cm. The use of basic gymnastics exercises produced the opposite effect, as evidenced by the negative differences recorded: -1.08 cm, -0.09 cm, -0.38 cm, and -1.85 cm for right leg, right leg with eyes closed, left leg and left leg with eyes closed, respectively. The calculated large and very large effect size with values of 1.17, 1.15, 0.99 and 1.4 for the four conditions confirms the good influence of qigong on balance capabilities. The effect size of using basic gymnastics was negative with calculated values of -0.57, -0.04, -0.17, and -0.58.

CONCLUSION: On the basis of the results obtained, it can be firmly concluded that a warm-up using qigong exercises positively influences balance capabilities. This type of warm-up favours the performance of balance exercises and has a place in the training programs. Warming up with qigong is preferable to basic gymnastics when working up to balance exercises.

**PERCUSSIVE MASSAGE DOES NOT REDUCE ECCENTRIC AND CONCENTRIC TORQUE DECLINE DURING AND AFTER FATIGUING ECCENTRIC KNEE EXTENSIONS**

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INTRODUCTION: Percussive massage is commonly used to enhance performance and recovery. Pre-exercise applications verifiably improve ROM and flexibility, while post-exercise use may help to reduce DOMS [1]. However, its acute effects on performance indicators remain unclear, with studies reporting both performance benefits [2] and drawbacks [3]. This study examined the effects of intra-set percussive massage on torque decline during isokinetic eccentric and concentric contractions in a fatiguing exercise protocol, compared to a placebo treatment.

METHODS: This study used a randomized crossover design, with participants completing one familiarization and two testing sessions. A total of 20 healthy, physically active individuals (f = 2, m = 18; age: 25.5 ± 2.2 years; height: 178.9 ± 8.8 cm; weight: 79.3 ± 12.8 kg) were included. The primary outcome was the isokinetic knee extensor peak torque (60°/s) measured concentric (PRE and POST) as well as during an eccentric fatiguing protocol. The protocol consisted of 5 sets of 15 maximal eccentric leg extensions on an isokinetic dynamometer (60°/s), with 3 min intra-set breaks. During these breaks, participants received either 3 minutes of percussive massage (40 Hz) targeting the vastus medialis, vastus lateralis, and rectus femoris, or a placebo "light therapy" using a conventional laser pointer.

RESULTS: Test-retest reliability (ICC 2.1) for the initial concentric and eccentric torque values were (ICC(2,1) = 0.74, 95% confidence interval (CI) [0.55; 0.86]) and (ICC(2,1) = 0.73, 95% confidence interval (CI) [0.53; 0.85]), respectively. For concentric torque, no significant intervention × time interaction was observed. However, a significant time effect was found ($F(1,39) = 15.54$, $p = .0003$, $\eta^2 = .032$ [small]), indicating a torque decline in both interventions. For eccentric torque, a significant intervention × time interaction was detected ($F(2.28,89.08) = 4.30$, $p = .013$, $\eta^2 = .004$ [trivial]), along with significant intra-set fatigue effects ($F(2.28,89.08) = 4.30$, $p = .013$, $\eta^2 = .004$ [trivial]), showing a torque decline within sets in both interventions. Additionally, a significant main effect of time ($F(1,39) = 13.64$, $p = .0006$, $\eta^2 = .011$ [small]) indicated a decline in eccentric torque from PRE to POST in both interventions.

CONCLUSION: The comparison of percussive massage with a physiologically irrelevant "light therapy" placebo intervention in this study suggests that intra-exercise percussive massage has no impact on maximum strength parameters. These findings have practical implications for recreational exercisers, coaches, and athletes, indicating that incorporating percussive massage during workouts does not enhance performance. As a result, its use should be critically evaluated to ensure efficient exercise time management.

1. Sams, L., et al. (2023).

2. García-Sillero, M., et al. (2021).

3. Greene, D.R., J.J. Ruiz-Ramie, and A. Craig-Jones (2024).

## Conventional Print Poster Presentations

### CP-BM03 Motor Learning and Motor Control II

**RECOGNITION OF VOLLEYBALL SETTING TACTICS USING BIOLOGICAL MOTION**

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INTRODUCTION: Volleyball players ability to observe the setters movements and predict the sets direction and tactics is critical for improving blocking success. This relies on players sensitivity to movement cues and is closely associated with specialized training. Studies have shown that experienced players detect movement cues earlier and over a broader range [1]. Using biological motion created by dynamic point-light displays, observers can focus on the relative movements of the setter's body segments without viewing the ball's trajectory. This approach enables the examination of observers' visual discrimination sensitivity to setting movements. The purpose of this study was to investigate differences in recognizing various setting tactics among individuals with different levels of volleyball proficiency.

METHODS: This study recruited 90 collegiate Division A, 84 Division B volleyball players, and 81 individuals without volleyball training. Using Simi Motion software, 17 markers were placed on specific body parts (toes, ankles, knees, hips, shoulders, elbows, wrists, fifth metacarpals, and head) of 6 Division A players (3 males) to record movements during 3 successful setting scenarios: A quick, an outside set (position 4), and a back-row attack (position 6). Wolfram Mathematica was used to create 18 dynamic point-light videos randomly ordered and embedded in Google Forms. Participants were briefed on the experiment and watched the videos on their phones in a quiet environment, completing the task within 10 minutes. A one-sample, one-tailed t-test determined whether the correct rates of each group exceeded the random guessing probability of 0.33. One-way analysis of variance (ANOVA) compared correct rates among the three groups. The significance level was set at $\alpha = .05$.

RESULTS: The results showed that correct rates for all three groups were significantly higher than the random guessing probability of 0.33 ($ps < .001$). ANOVA indicated significant differences in correct rates among the three groups ($p < .001$). Post hoc comparisons revealed that Division A players significantly outperformed Division B and untrained individuals, while Division B players scored higher than untrained individuals ($ps < .05$).

CONCLUSION: This study found significant differences in recognizing volleyball-setting tactics using dynamic point-light displays among individuals with different skill levels. Division A players excelled in identifying setting motion cues, likely due to their extensive volleyball experience and training. Division B players demonstrated higher visual discrimination abilities than untrained individuals, but their performance was still lower than that of Division A players, likely due to less exposure to standard setting skills. These findings suggest that professional sports skills are influenced by physical performance and perceptual abilities specific to sports scenarios.

Reference

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**WHERE DO YOU LOOK WHEN HITTING A SOFTBALL OFF A TEE?**

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INTRODUCTION: Striking a ball off the tee-stand is commonly used as the batting practice in softball. When striking a ball off the tee, the visual focus is often on the ball; while hitting a ball from a pitch, the visual focus is on the coming ball. The

batter needs to perceive the pitching event and swing at the ball when the ball enters the home plate based on the speed of the ball. Therefore, the visual focus should be on the direction of the incoming ball to perceive the distance that affords the swing time based on the ball speed. This study examined the performance of fast softball batters striking softballs off the tee under different visual focuses.

METHODS: 4 active collegiate Division I female softball players performed the tee strikes under 4 visual focus conditions. The visual focus was on the ball for the regular tee strike (T); the other 3 visual focuses were at right (R), right-front (RF), and directly in front (F) of the player at a distance (4.5m) to simulate 70 km/h pitching speed and 0.23 s of swing time. Players performed 5 trials in each condition, and the order of conditions was randomly assigned. 3-D kinematics of the ball and the bat's tip were captured using 2 high-speed cameras and the Simi Motion software. Based on the bat-ball speed change after the hit, the hitting results were classified into 3 groups: miss, decrease, and increase. A Chi-square test of independence was performed on the classification of batting results and the visual focus conditions. In addition, (T F) and (R RF) were further grouped, and the independent sample t-test was performed for each player. The significant level was set to $\alpha$=.05.

RESULTS: The chi-square test result was significant, p=.014. R and RF had a positive association with the number of misses, with a standardized residual of 3.184. There were individual differences in the t-test results: 2 batters at the T and F conditions performed significantly greater than that at the R and RF conditions, ps < .05, and one of the batters swing-and-missed all trials at the R and RF conditions; the other two batters did not reach significant difference between conditions, ps>.3.

CONCLUSION: This study provides preliminary observations of the effect of visual focus on the softball tee strike performance. Overall, when the visual focus is not on the ball at the tee or in front of the simulated position of the ball, the probability of swing-and-miss increases. When focusing on the part unrelated to the hitting situation, half of the hitters' performance was significantly affected. Striking the ball on the tee does not simulate the dynamic hitting situation, and the perception-and-action coupling is also different from the actual striking situation. In addition to increasing the sample size for future research, we suggest that if tee strikes are unavoidable due to equipment and resource issues, the visual focus should be placed at an appropriate distance in front to simulate the pitching situation.

**WHEN DEFENDERS CLOSE IN: PERFORMANCE AND ADAPTION IN THREE-POINT JUMP SHOTS**

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INTRODUCTION: In basketball, the presence of a defender forces shooters to adjust their movements, such as modifying shooting trajectories and shortening movement time. These adjustments are strategies to avoid blocking, but they often come at the cost of reduced stability and shooting success. Most prior research has focused on the impact of static defensive distances or the presence of defenders on jump shot performance, while the dynamic interaction between shooters and defenders remains underexplored. This study investigates how varying defensive starting distances and actions (hands-up or hands-down) dynamically influence shooters' movements and performance.

METHODS: Eight female division 1 collegiate basketball players made sixty 3-point jump shots at the 45-degree angle under 3 defensive starting distances (5.75m, 4.75m, 3.75m), each with hands-up or hands-down defensive actions. Video-based kinematics analysis was used with Simi Motion analysis software. 3-D data of the shooter's right hip was used to determine the preparation and shooting phases as well as the air time. 3-D data of the ball was used to derive the ball release heights, angles, and velocity. In addition, 2-D data from the defender's left hip was used to calculate the kinematics of the defender's displacement. Shooting results were recorded manually. Shooters' data were analyzed using two-way repeated measures ANOVA to examine the interactions between defensive distance and action. The relation between the shooter's preparation time and defender displacement was examined using Pearson's correlation analysis.

RESULTS: The shorter defensive distance (3.75m) significantly reduced preparation and shooting times but increased air time and ball release angle, ultimately decreasing shooting accuracy (ps <.05). Defensive actions (hand-up or hand-down) and the interaction effect did not show any significant result. Six participants showed significantly positive correlations ranging from 0.78 to 0.92 between the preparation time and defender's displacement (ps<.05). The other two shooters showed no significant correlation (ps>.1).

CONCLUSION: The study shows that the shooting motion adjusts according to the defenders movement among different starting distances. The shooting movement time decreased as the initial defensive distance shortened. The shooter also increases the release angle and air time to avoid being blocked at the closest distance. These adaptations, however, reduced shooting accuracy. The results of correlation analysis indicate that most shooters spent more time in the preparation phase when defenders were further away. Future research should investigate defensive distances shorter than 3.75m and possibly the minimum shooting preparation time.

**INFLUENCE OF PELVIC BELT-EQUIPPED GARMENT ON BALANCE AND MUSCLE SYNERGIES DURING SINGLE LEG LANDING**

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INTRODUCTION: Landing stability is essential for preventing lower limb injuries. Pelvic belts reduce landing impact by limiting lumbar motion and enhancing hip energy absorption (1), and they improve Y-balance performance and dynamic stability (2). Moreover, lumbar compression may increase intra-abdominal pressure, enhance trunk stiffness and reduce

muscle activity (3). Thus, pelvic belts may improve landing stability while reducing trunk effort. However, because landing requires coordinated trunk and lower limb activation, decreased trunk activity might alter lower limb strategies, though this remains unclear. This study examined how wearing a pelvic belt-equipped garment (PBG) affects balance and muscle synergies during single leg landing (SLL). Muscle synergy analysis quantifies coordinated activation patterns among multiple muscles. We hypothesized that PBG would reduce trunk muscle weightings in synergies while also modifying lower limb muscle weightings.

METHODS: Eleven male athletes (age: 20 ± 1 years; height: 1.70 ± 0.03 m; body weight: 62 ± 7 kg) participated in sports at least three times per week and performed SLL under two conditions, one with PBG and the other without PBG (CON). During each trial, surface electromyography was recorded from 10 trunk and lower limb muscles, and ground reaction forces were measured at 1000 Hz. Non-negative matrix factorization was performed to the electromyography data from toe-off to 5 seconds after toe-off. We compared differences in synergy weightings and center of pressure (CoP) sway between conditions using paired t-tests. CoP sway was quantified over the 5 seconds following landing by total path length, rectangular area, and mean velocity.

RESULTS: CoP sway tended to be higher in PBG than in CON ($p < 0.08$). Three muscle synergies were extracted. Synergy 1 was related to absorbing landing impact. Synergy 2, mainly activates immediately after landing, was associated with postural recovery. Synergy 3 was associated with maintaining single leg balance. In Synergy 2, the external oblique weighting was lower in PBG than in CON ($p = 0.02$), and modulation of lower limb weightings was also observed, as the weightings for the ankle plantar flexors and knee extensors were higher in PBG ($p < 0.07$). No significant differences were found in overall synergy activation between the two conditions.

CONCLUSION: PBG increased CoP sway and modulated Synergy 2 weightings. Modulation of Synergy 2 weightings may reflect PBG support to the external oblique and a landing strategy that pushes off the ground using the ankle and knee. Within the postural recovery synergy, we concluded that PBG not only reduced the external oblique weighting but also increased the weightings of the ankle plantar flexors and knee extensors.

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**MECHANISMS OF PREMOTOR CORTEX IMPACT ON MOTOR CORTEX OUTPUT: A STUDY OF NEUROPHYSIOLOGICAL CONNECTIVITY WITH TRANSCRANIAL MAGNETIC STIMULATION**

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INTRODUCTION: Connectivity between the premotor (PMC) and primary motor (M1) cortices is critical for coordinated voluntary movement. Interactions between these areas, both within and across hemispheres, have been extensively studied in non-human primates with invasive stimulation techniques. In human studies, distinct subregions, including the dorsal (PMd) and ventral (PMv) areas, may exert time and region-specific influences on M1 output, however the precise mechanisms remain poorly understood. To address this gap, we systematically assessed the neurophysiological connectivity between PMd/PMv and M1 using transcranial magnetic stimulation (TMS).

METHODS: : Thirty right-handed adults (15 females, aged 18–39) were recruited. T1-weighted MRI scans guided TMS coil placement (Brainsight) over PMd, PMv, and M1. Individualized M1 "hotspots" were identified to evoke ~1 mV motor-evoked potentials (MEPs) in the contralateral first dorsal interosseous muscle. For the first assessment with dual-site TMS, a conditioning stimulus (CS) was delivered over the non-dominant PMd, PMv, or M1, followed by a test stimulus (TS) over the dominant M1 "hotspot" at inter-stimulus intervals (ISIs) of 0 ms, 10 ms, and 50 ms. Interhemispheric inhibition (IHI) was quantified by comparing MEP amplitudes from CS+TS trials to TS-alone trials, calculating an IHI ratio where lower values indicate greater inhibition. For the second assessment and to evaluate transcallosal inhibition, the ipsilateral silent period (iSP) was measured by stimulating each site at 150% of resting motor threshold during a 50% maximum voluntary contraction of the FDI. iSP magnitude was calculated as the percent decrease in EMG amplitude from a pre-stimulus baseline, and iSP onset was defined as the latency from the TMS pulse to the first drop in EMG below baseline.

RESULTS: IHI was strongest at 0 ms for all sites. PMd consistently inhibited M1 across all ISIs with 0ms having the strongest inhibition, whereas PMv showed more variable inhibition with nearly no inhibition at 10 ms and little inhibition at 50 ms. The iSP results showed robust inhibition from all sites, with M1 producing the largest magnitude (~45%) and the shortest onset latency. Although PMd (35%) and PMv (~25%) also induced significant iSP, yet to a lesser extent than M1. By integrating measures of both IHI and iSP, this study provides a more comprehensive view of the temporal and regional dynamics underlying PMC–M1 connectivity.

CONCLUSION: Our findings highlight that PMd and PMv differentially modulate M1 excitability via distinct pathways. Early (0 ms) inhibition likely reflects subcortical or reticular circuits, while longer intervals (10 ms and 50 ms) may involve callosal or higher order corticocortical connections. Understanding the temporal and regional dynamics of interhemispheric connectivity with M1 could benefit targeted neuromodulation strategies or tailored rehabilitation to optimize motor recovery following stroke.

**EFFECTS OF DUAL-TASKING ON GAIT PARAMETERS AND CORTICAL ACTIVATION IN OLDER ADULTS ACROSS DIFFERENT WALKING CONDITIONS**

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INTRODUCTION: Performing a motor and a cognitive task simultaneously (dual tasking, DT) is essential in daily life but often leads to cognitive-motor interference (CMI), in older adults. With increasing age, walking requires more cognitive control. In addition, different walking conditions (e.g. barefoot, minimal and conventional footwear) can influence gait parameters (1). This study investigates how DT affects motor and cognitive performance and prefrontal cortex (PFC) activity across different walking conditions.

METHODS: Eighteen older adults (69.5 +/- 4.4 years; n = 8 barefoot, n = 4 Leguano, n = 6 control) completed four conditions: 1 - baseline, 2 - visual discrimination task (ST visual), 3 - single task walking (ST walking), and 4 - a motor-cognitive dual task (DT visual: responding to peripheral visual stimuli). Gait was assessed using Optojump Next (speed, step length, double support time, cadence). Cognitive performance was assessed by reaction time and response accuracy, while PFC activity was measured based on HbO2 concentration using near-infrared spectroscopy (fNIRS). A general linear model (GLM) with repeated measures was used to analyse differences in gait parameters, HbO2 concentration, reaction times, and response accuracy across task conditions (ST walking, DT visual), with walking condition (barefoot, minimal footwear, control) and sex as between-subject factors, and age as a covariate. Group differences were examined using a multivariate GLM.

RESULTS: Motor performance revealed no significant differences between ST walking and DT visual ($p > 0.05$). However, the three walking conditions differed significantly in motor performance ($F(16,18) = 2.437$; $p = 0.036$; eta_p^2 = 0.684), with significant differences observed for gait speed and step length (control group > barefoot group; $p < 0.01$) as well as for double support time (barefoot group > control group; $p < 0.05$). Cognitive performance declined under DT conditions, indicated by significantly reduced response accuracy ($F(1,10) = 124.734$; $p < 0.001$; eta_p^2 = 0.926). Furthermore, walking condition significantly affected changes in reaction time from ST visual to DT visual ($F(2,9) = 4.614$; $p = 0.042$; eta_p^2 = 0.506), with a decrease in the control group ($p < 0.05$) and an increase observed in the barefoot and Leguano shoe groups ($p > 0.05$). PFC activation varied across walking conditions and was highest during ST walking (barefoot, leguano) and DT visual (control), but did not show significant differences.

CONCLUSION: The findings indicate that older adults prioritise motor performance under DT conditions, leading to a decline in cognitive performance. Moreover, the influence of walking conditions on both motor and cognitive outcomes highlights the role of footwear in dual-task scenarios. However, due to the small sample size, further studies are required.

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**AN ACCELEROMETER-BASED SINGLE-ARM DYNAMIC STABILITY TEST FOR THE ASSESSMENT OF THE SENSORIMOTOR CONTROL OF THE SHOULDER**

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INTRODUCTION: Myers introduced the Single-Arm Dynamic Stability (SADS) test to assess the sensorimotor control of the shoulder by analysing the sway of the centre of pressure of the supporting hand during a one-handed push up position on a force platform [1]. However, in the SADS test, stability does not depend solely on the shoulder muscles due to other support points, load modulation is limited to part of the body mass, and the closed-chain configuration weakly reflects the shoulder injury patterns. Aim of this research was to address such limitations by designing and validating a variation of the SADS test as performed in an Open Kinetic Chain (SADS-OKC) with the subject lying supine while holding a dumbbell still in one hand with the extended arm.

METHODS: The dumbbell was assumed as the endpoint of an inverted pendulum linked at shoulder level while its sway was measured using a triaxial accelerometer, applying the same stability parameters typically used for standing balance assessments with a waist-mounted accelerometer [2]. SADS-OKC test was performed by 20 healthy subjects (16 males and 4 females aged 23±2 years) in two sessions of day1 and in one session of day2. Each session was performed with both arms and consisted of three randomised trials with 15%, 25% and 35% of a reference load (RL) determined as the mass measured by a scale placed under the hands while maintaining a quadruped position (five attempts). Based on previous studies on SADS test, test duration was set to 30 s but stability parameters were also computed over the first 20 s. Stereophotogrammetry was used to detect any elbow or wrist motion that could invalidate the pendulum assumption. ICC analysis assessed intra- and inter-day reliability of time- and frequency-domain stabilometric parameters. Spearman's rank correlation analysed the relationship between load variations and stability parameters.

RESULTS: Both elbow and wrist flexion never exceed 2° during all trials. Average RL was 28.3±5.5 kg (2.2% CV). ICC analysis revealed that the SADS-OKC test at 15% RL exhibited the highest intra- and inter-day reliability for both sides and test durations, while reliability decreased at higher loads. Specifically, Jerk and swayArea exhibited good to excellent intra-day reliability (ICC=0.866–0.947) and moderate to good inter-day reliability (ICC=0.707–0.766). All other stabilometric parameters showed moderate or moderate-to-good reliability. Overall, swayFreq, F50, F95, CF and FD appeared to be moderately affected by load increase ($0.4<\rho<0.59$).

CONCLUSION: The SADS-OKC test, as performed with 15% of RL for either 20 or 30 s, has proven to produce a set of reliable stabilometric parameters that may be related to the neuromuscular control of the shoulder. Further studies should investigate whether any of these parameters can also identify deficits in the neuromuscular control of the shoulder in clinical populations. [1] Myers JB, et al. J Athl Train 1999;34(4):362-7. [2] Mancini M, et al. J Neuroeng Rehabil 2012;9:59.

**TOWARD THE DEVELOPMENT OF A MOVEMENT QUALITY ASSESSMENT FOR ATHLETES: A MODIFIED DELPHI APPROACH**

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INTRODUCTION: Assessing athletic motor skill in talent development environments helps practitioners identify developmental gaps in individuals and groups (1). Movement quality assessments can be used to assess athletic motor skills, with some measures of movement quality associated with certain physical fitness attributes (2,3). However, these assessments have been developed with varied academic rigour and none have been developed to assess movement quality that may associate with multiple fitness attributes (4). This study aimed to draw upon previous research and the experiential knowledge of discipline experts to design a movement quality assessment that may associate with physical fitness attributes.

METHODS: Academics (n=5), strength and conditioning coaches (n=18) and physiotherapists (n=1) with five years of experience assessing movement quality within athletic populations years were recruited via personalised email and social media. Participants completed three stages of online surveys designed to establish expert consensus about the structure of a novel movement quality assessment using a modified Delphi approach. Participants rated their agreement with each component of the assessment using a 9-point (Stage 1) or 5-point (Stage 2 and 3) Likert scale with consensus defined as 70% agreement to a component of the assessment.

RESULTS: Consensus was reached for the instructions to use, movements within the assessment and scoring system and criteria of the movement quality assessment. The novel movement quality assessment included the active straight leg raise, shoulder mobility test, squat, push up, triple hop and lateral bound. Each movement was scored out of five with a maximum composite score of 45 achievable.

CONCLUSION: A novel movement quality assessment was developed for athletes using high academic rigour. The assessment includes movements assessed with scoring criteria that could associate with various physical fitness attributes. Hence, this assessment may be more useful for practitioners assessing athletic motor skills within talent development environments than current assessments.

References

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**WHOLE-BODY MUSCLE SYNERGY ANALYSIS DURING THROWING MOTION IN YOUNG CHILDREN**

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INTRODUCTION: Throwing is a fundamental skill in sports such as baseball and handball requiring coordinated activation of muscle throughout the body. Muscle synergy analysis enables a quantitative approach to evaluating muscle coordination. Despite its importance , the mechanisms underlying whole-body coordination during throwing, particularly its development across different stages of growth, remain unclear. Therefore, this study aimed to investigate the development of whole-body coordination during throwing in children at different developmental stages by examining muscle synergies.

METHODS: Eleven preschoolers (3–6 years old) and nine primary school children (7–9 years old) participated in this study. Each participants performed 8 to 13 throws toward a net located 2 meters away, with instructions to throw balls as fast as possible. Ball and body movements were captured using high-speed cameras. Electromyographic (EMG) activities were recorded from the 16 muscles across the dominant upper limb, bilateral trunk and lower limbs, including the pectoralis major, middle deltoid, infraspinatus, middle trapezius, rectus abdominis, erector spinae, rectus femoris, biceps femoris, tibialis anterior, and soleus. Ball speed was defined as the magnitude of the velocity vector at the moment of ball release. Muscle synergy analysis was conducted using non-negative matrix factorization (NMF), with the number of synergies determined as the minimum number required to achieve a variance accounted for (VAF) >90%. Synergies from each group were clustered using the k-means, and cluster consistency was compared based on cosine similarity. Clusters with cosine similarity exceeding 0.8 were considered common synergies.

RESULTS: The average ball speed in preschool children (22.1±6.1 km/h ) was significantly lower than that in primary school children (33.6±10.7 km/h)($p<0.05$). The number of muscle synergies in preschoolers (5.5±0.82) was fewer than that in primary school children (6.3±1.41)($p<0.05$). No significant correlation was observed between the number of muscle synergies and ball speed. K-means clustering identified eight muscle synergy clusters in preschool group and nine in primary

school group. Of these, six clusters were common between the two groups, while two clusters were unique to preschoolers and three were unique to primary school children.

CONCLUSION: Ball speed increases significantly from preschool to primary school age. Our findings suggest that this increase is not solely due to the natural increase in muscle strength with growth but may also be related to changes in muscle synergies, indicating the maturation of motor control. The disappearance of preschooler-specific muscle synergies and the acquisition of new, refined synergies enable more efficient coordination of force generation and transfer across the entire body. This highlights the importance of whole-body coordination and neuromuscular adaptation in the motor skill development.

## Conventional Print Poster Presentations

### CP-BM12 Running Biomechanics

**THE RELATIONSHIP BETWEEN BODY COMPOSITION, LOWER EXTREMITY BIOMECHANICS AND RUNNING ECONOMY IN RECREATIONAL FEMALE RUNNERS**

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INTRODUCTION: The influence of anthropometry and running biomechanics on running economy in recreational female runners is unclear, with previous investigations on this topic involving small homogeneous groups of runners and only examining a limited set of anthropometric or biomechanical measurements [1]. As such, this study aims to investigate the relationships between anthropometry and lower extremity biomechanics with running economy within a homogenous sample of female runners.

METHODS: Twenty-six female recreational runners (age 34.7 ± 9.4yrs), performed a standardised incremental running protocol on a force-sensing treadmill (4-minute stages at 8km/h, 10km/h, and 12km/h). During the final minute of each stage ground contact time (GCT), flight time, stride length (SL), stride frequency (SF), leg stiffness and vertical oscillation (VO) were collected and compared to respiratory gases to determine the submaximal (<1.00 respiratory exchange ratio) locomotory cost (LEc) of running. Whole body and segmental anthropometry were also obtained using dual-energy x-ray absorptiometry and correlated to LEc.

RESULTS: Absolute LEc (ABSLEc) was positively associated with 8 out of 9 anthropometric variables in the first two stages of the running protocol and 7 out of 9 during the final stage. Only SL and VO out of the six biomechanical variables were positively associated with ABSLEc at 8 and 10km/h, respectively. Relative LEc (RELLEc) was positively correlated with body mass (BM) and height during the first stage. SL showed significant correlations with RELLEc at 8km/h (R=0.401; P=0.03). At faster velocities, significant positive and negative correlations were identified between GCT (R=542 (10km/h); R=0.451 (12km/h) and SF (R=-0.545 (10km/h); R=-0.407 (12km/h), respectively. Backward multiple linear regression analysis revealed four anthropometric measures (BM, bone mass, leg fat mass, and fat-free mass), plus VO at 12km/h, explained most variance in ABSLEc (R2=0.742 (8km/h); R2=0.704 (10km/h); R2=0.433 (12km/h). In addition, regression analysis suggested that BM, height, and SL explained variance in RELLEc at a slower velocity (R2=0.162, (8km/h). At faster running speeds, combined effect of GCT and SF explained a small variation in RELLEc (R2=0.137, (10km/h); R2=0.075, (12km/h).

CONCLUSION: This study presents novel evidence that anthropometric and body composition factors explain a substantial proportion of the variance in running economy compared to running biomechanics alone among recreational female runners, maintaining a slim physique, minimising GCT, and increasing SF result in a lower LEc. These findings indicate that coaches and practitioners working with female recreational runners should optimise individual anthropometrics beneficial for running, while concurrently addressing specific spatiotemporal variables to enhance running economy, and distance running performance.

1) Van Hooren B et al., Sports Medicine, 2024

**RELATIONSHIP BETWEEN MEDIAL LONGITUDINAL ARCH AND GROUND REACTION FORCES IN LONG-DISTANCE RUNNERS DURING RUNNING**

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INTRODUCTION: The incidence of running disorders is as high as 79.3%, highlighting the importance of examining the factors that contribute to their development. During running, the vertical ground reaction force (vGRF) can reach two to three times the body weight, putting significant stress on the lower extremities. In particular, a higher peak value of vertical ground reaction force, Vertical Instantaneous Loading Rate (VILR), and Vertical Average Loading Rate (VALR) have been reported to be associated with running disorders. Moreover, some studies have reported that differences in foot arch morphology, such as flat feet or high arches, may lead to abnormal movement of the lower leg and foot during running. This abnormal movement may affect the ground reaction force during ground contact. However, few studies have reported on the interactive effects of arch height and ground reaction forces during running. Therefore, the purpose of this study was to examine the relationship between foot arch morphology and ground reaction forces in runners.

METHODS: Twenty-one male university long-distance runners (age: 19.6 ± 1.2 years, height: 172.9 ± 5.1 cm, weight: 58.5 ± 4.2 kg) participated in this study. The morphology of the foot arch was evaluated using the Arch Height Index (AHI), which was calculated by dividing the height from the floor to the dorsum of the foot at 50% of the foot length in a seated position by the length from the heel to the first metatarsophalangeal (MTP) joint. Ground reaction forces during running were measured with a force plate. Participants were instructed to run at a speed of 18 km/h. Ground reaction forces data were sampled at 1000 Hz, smoothed using a low-pass filter with a cutoff frequency of 35 Hz, and normalized to body weight. We calculated the initial peak value, maximum peak value, force product, VILR, and VALR during the stance phase of running. Pearson correlation analysis was performed to examine the association between AHI and the ground reaction forces in each direction (vertical, braking, medial/lateral). The significance level was set at less than 5%.

RESULTS: A significant positive correlation was found between AHI and the vertical ground reaction force

(maximum peak value: $r = 0.45$, $p < 0.05$; initial peak value: $r = 0.68$, $p < 0.01$; VILR: $r = 0.59$, $p < 0.01$; VALR: $r = 0.53$, $p < 0.05$).

CONCLUSION: In male long-distance runners, a higher foot arch may be associated with a greater initial and maximum peak value, VILR, and VALR of vertical ground reaction force during running.

**COMPARISON OF MULTI-SEGMENTAL FOOT KINETICS BETWEEN NEUTRAL FOOT AND HIGHLY PRONATED FOOT IN NON-REARFOOT STRIKE RUNNERS**

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INTRODUCTION: Foot posture is a risk factor for running-related injuries (RRIs). In a case-control study, the odds of RRIs were 20 times higher for highly pronated foot than for neutral foot [1]. Although differences in foot kinetics according to foot posture may be a contributing factor, it is unclear whether foot kinetics differ between the neutral and highly pronated foot during running. The purpose of the present study was to compare multi-segmental foot kinetics during running between neutral foot and highly pronated foot groups.

METHODS: Nine females running with mid- and forefoot strike participated in this study. Foot posture was evaluated using the Foot Posture Index (FPI) [2]. Total score ranges from -12 to +12. Four participants were classified as neutral foot (0 to +5) and five participants were classified as highly pronated foot (+10 to +12) according to the FPI score. Participants were attached to reflective markers and plantar pressure sensor and asked to run at 3.3 m/s ± 10% on a 10-m runway. We synchronously collected plantar pressure, ground reaction force, and kinematics including shank, rear-, and forefoot during the running task. Ankle and midfoot moments were calculated from distal to proximal using the Newton-Euler equation. Joint power was calculated as the scalar product of the joint moment and angular velocity. Joint work was calculated as the time integration of the joint power. Independent t-test or Mann-Whitney U test was used to compare peak moment, peak power (positive and negative), and work (positive and negative) in sagittal plane at ankle and midfoot between two groups ($\alpha = 0.05$).

RESULTS: The FPI scores of the neutral foot and the highly pronated foot groups were 0.5 ± 0.6 and 10.4 ± 0.5, respectively. There were no differences in demographics, running speed, and stance time between groups. The neutral foot showed significantly larger peak positive power and negative work at ankle compared to the highly pronated foot (8.77 ± 2.26 W/kg vs. 5.99 ± 1.00 W/kg; $p = 0.04$, -0.50 ± 0.13 J/kg vs. -0.31 ± 0.11 J/kg; $p = 0.05$).

CONCLUSION: The neutral foot demonstrated large power absorption and efficient power generation at ankle. The neutral foot showed a greater peak dorsiflexion angle at ankle than the pronated foot during gait [3]. Thus, the increase of dorsiflexion angular velocity in the neutral foot appears to result in large negative work. The large positive power in the neutral foot could be explained by the increase of plantarflexion angular velocity at rearfoot. The neutral foot has a higher arch stiffness than the pronated foot [4], which could promote efficient propulsive force generation at ankle by elevating the arch immediately. This study emphasizes the need to consider changes in foot kinetics associated with foot posture.

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**DISTRIBUTION OF THIGH MUSCLE ACTIVITY DURING SPRINTING IN MALE SPRINTERS USING T2-WEIGHTED MAGNETIC RESONANCE IMAGING**

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INTRODUCTION: Sprint performance is enhanced when the bodys muscular system functions as an integrated unit, with particular emphasis on the lower limb muscles that drive the sprinting action. Therefore, it is essential to evaluate lower limb muscle activity during sprinting. Surface electromyography has been widely used to measure lower limb muscle activities during sprinting (Kuitunen et al. 2002, Kakehata et al. 2022); however, this technique is limited by its inability to measure deep muscle activities and distinguish between muscle crosstalk. To address these limitations, T2-weighted magnetic resonance imaging (MRI) can be used as an alternative method for assessing lower limb muscle activity during

sprinting (Yoshimoto et al. 2022). This study aimed to determine the distribution of thigh muscle activity during sprinting using T2-weighted MRI.

METHODS: Twelve male sprinters (age: 20.3±1.5 years, body height: 173.8±6.0 cm, body mass: 66.9±4.8 kg, 100-m personal best time: 10.89±0.39 sec) completed a repeated sprint protocol consisting of three 60-m sprints, each performed at maximal effort, with 2-min rest intervals. Before and after the sprint protocol, 15 axial T2-weighted images, covering a total of 30 cm of the thigh (i.e., 15 cm proximal and distal to the mid-thigh), were acquired using a 3T MRI system. The distribution of thigh muscle activity was assessed based on pre-post changes in T2 values for 13 thigh muscles, and site-specific differences in the T2 value changes within each muscle. A paired t-test and one-way repeated ANOVA with a Bonferroni post-hoc test were conducted to determine the pre-post changes and site-specific differences.

RESULTS: T2 values significantly increased in the rectus femoris, sartorius, adductor longus, adductor magnus, gracilis, semimembranosus, semitendinosus, and both the long and short heads of the biceps femoris after the sprint protocol (corrected $P<0.05$). Site-specific differences were observed, with a greater increase in T2 in the proximal region of the long head of the biceps femoris compared to the middle and distal regions ($P<0.05$). In contrast, T2 values increased more in the middle and distal regions of the semitendinosus than in its proximal region ($P<0.05$). T2 changes were significantly higher in the middle region of the semimembranosus than in the distal region ($P<0.001$).

CONCLUSION: Our findings indicate that sprinting induces non-uniform muscle activation in the thigh, with certain regions demonstrating greater involvement. Notably, the site-specific differences observed in the hamstrings indicate varying regional muscle engagement. These results highlight the importance of evaluating both whole-muscle and regional activation patterns using T2, providing valuable insights for enhancing sprint performance and preventing sports injuries.

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**ANALYSIS OF THE TEMPORAL PATTERN OF NEUROMUSCULAR ACTIVATION DERIVED FROM THE FLOATING HEEL RUNNING TECHNIQUE**

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INTRODUCTION: Running is one of the most practiced sports activities worldwide today. The rise and popularization of this sport have led to an increase in the incidence of injuries resulting from its practice. Injury mechanisms include poor running technique (1) or excessive impact during foot strike (2).

To address the challenge of injuries, various products have been introduced to the market. Specifically, floating heel running shoes (FBR concept) have been seen as a solution to help runners avoid heel strikes and reduce vertical impact (3). Additionally, this concept has proven effective in the injury recovery process (4). These shoes have the structure of conventional sneakers, with the main characteristic being that they lack a heel and do not have a midsole in the rear part of the shoe.

Surface EMG measures muscle action during movement. It has been observed that with heel strike running technique (RFS), muscle activity occurs after contact, whereas with forefoot strike (FFS), it occurs before contact (5). This shows that the muscle contraction scenario seen in FFS presents advantages over RFS.

The objective of this study is to analyse the temporal pattern of muscle activation derived from the floating heel running technique.

METHODS: The study sample consisted of 16 runners who are accustomed to running with floating heel shoes. An analysis of surface muscle electrical activity (sEMG) was conducted on the lateral gastrocnemius (GNL) and medial gastrocnemius (GNM) muscles following the SEINAM guidelines (Surface Electromyography for the Non-invasive Assessment of Muscles). The sEMG measurement system was synchronized with an accelerometer to detect ground contact (Gwalk BTS). Additionally, an analysis of the foot strike pattern was performed using a high-speed camera (240Hz) in the sagittal plane (6). The variables analysed were the timing of muscle activation relative to ground contact and the foot strike pattern during running.

RESULTS: The results showed that all runners run with a midfoot strike technique. Additionally, the same temporal activation pattern of the GNL and GNM was observed in all participants. They all activated the calf muscles before ground contact.

CONCLUSION: The results of this study confirm that the running technique associated with floating heel shoes promotes a midfoot strike technique, similar to findings in previous studies (3). Regarding muscle activation, the temporal activation pattern obtained is similar to the activation pattern of the forefoot strike technique (5). This temporal activation scenario is considered positive for the protection of the runners muscle-tendon unit.

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**RELATIONSHIP BETWEEN THE ACCELERATION PERFORMANCE AND GROUND REACTION FORCES DURING THE SPRINTING START IN SOCCER PLAYERS**

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INTRODUCTION: In soccer matches, sprinting ability is crucial for competitive performance. Indeed, competitive soccer teams exhibit longer high-intensity running distances during matches1). Moreover, as most sprinting performed by soccer players during a match are less than 20-m2), sprinting acceleration performance is particularly important. The ability to accelerate during sprinting would be related to the amount of force exerted at the start of the sprinting. Therefore, this study aimed to clarify the relationship between the sprinting acceleration performance and ground reaction force (GRF) during the sprinting start in soccer players.

METHODS: Sixty-three soccer players performed a maximal-effort 10-m sprinting from a standing split-stance position. Sprinting time, speed, and horizontal force were recorded using a motorized towing device without load. Acceleration was obtained by differentiating the speed with respect to time, while power was calculated as the product of speed and horizontal force. In addition, GRFs data during the standing start and the first step after the start were recorded from force plates embedded in the runway. Then, the relationships between each variables—10-m sprinting time, peak speed, peak horizontal force, peak acceleration and peak power—and the GRFs of the front and rear leg at the start, as well as those during the first step, were determined using Pearson's Partial Correlations.

RESULTS: The results of the relationship between sprinting time and GRF indicated a weak negative correlation between peak vertical GRF of the rear leg at the start and sprinting time ($r = -0.41$, $p < 0.001$), as well as a moderate negative correlation between peak anteroposterior GRF and sprinting time ($r = -0.56$, $p < 0.001$). Furthermore, a moderate positive correlation was observed between peak vertical GRF of the rear leg at the start and peak acceleration ($r = 0.53$, $p = < 0.001$), as well as a strong positive correlation between peak anteroposterior GRF and peak acceleration ($r = 0.70$, $p < 0.001$). Additionally, a weak negative correlation was found between the peak vertical GRF of the front leg at the start and the sprinting time ($r = -0.33$, $p = 0.009$). However, neither sprinting time nor peak acceleration showed a significant correlation with the GRFs of the first step after the start.

CONCLUSION: The findings of this study suggest that acquiring GRFs with the rear leg during the sprinting start is crucial for enhancing sprinting acceleration performance. Adjustments in kinematics, such as the forward lean angle of the body3), may contribute to the acquisition of greater GRFs.

In conclusion, sprinting acceleration performance in soccer players was particularly associated with the magnitude of the GRFs exerted by the rear leg at the start.

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**INTERLIMB COORDINATION PATTERN DURING RUNNING WHILE TURNING**

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INTRODUCTION: During human running gait, the left and right limbs exhibit mirror-symmetric kinematic and neuromuscular patterns, with each limb executing the same movement sequence shifted by 50% of the gait cycle. However, when running along a curve, the limbs are forced to operate somewhat independently, to properly redirect the center of mass laterally. Therefore, the neuromuscular control of each limb must present specific and shared patterns.

METHODS: In this study, we investigated the organization of the neuromuscular control of running using surface electromyography (EMG) of 14 bilateral muscles in 11 participants at different speeds on a straight line (SLR) and on circular curves with a 6 m curvature. We extracted muscle synergies from the EMG envelopes of the left and right limbs separately using non-negative matrix factorization, decomposing the data into a linear combination of muscle weight vectors (W, spatial parameters) and activation coefficients (C, temporal parameters). The similarity index between W and C of the right and left limb, based on their scalar product normalized to the Euclidean norm1, was then compared across speed and radius of curvature.

RESULTS: Four synergies accounted for more than 90% of the total EMG variance in all tested conditions. As compared to SLR, greater differences were observed between the neuromuscular patterns (both W and C) of both limbs when running along a curve. In particular, patterns 1, 2 and 4, occurring at the braking and propulsive parts of stance and at the end of the swing phase respectively, showed specific limb adaptations, whereas pattern 3, initiating the swing, was shared by both limbs at all running conditions. Such differences can be related to the distinct functional roles of the limb to accommodate lateral forces. Indeed, the inner limb primarily managed lateral redirection of the body, with greater muscular contribution of the hip muscles to accommodate the greater lateral forces2.

CONCLUSION: Our findings align with research on split-belt treadmill walking, where each leg is subjected to different belt speeds, leading to distinct neuromuscular responses3. Identifying both left-right common and specific neuromuscular patterns provides key insights into the adaptive strategies during curved running. This knowledge can contribute to refining training and rehabilitation strategies, particularly for athletes and individuals recovering from locomotor impairments.

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**SPRING-MASS MODEL OF THE LOWER LIMB USING AN INERTIAL SENSOR-BASED APPROACH**

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INTRODUCTION: During running, the lower limb behaves like a spring-mass system bouncing on the ground. Lower limb stiffness (kleg) and vertical stiffness (kvert) describe its mechanical response and the centre of mass (CoM) vertical oscillations during ground contact. Although a sine-wave-based method exists (1), data collection requires bulky, expensive equipment, limiting its use in natural conditions. With wearable sensors, such as inertial measurement unit (IMU) now validated for biomechanical assessment (2-3), in-run measurements in ecological settings have become feasible. This study aimed to validate an IMU-based method for estimating spring-mass model parameters, hypothesising comparable results to reference methods using ground reaction force (GRF) or sine-wave modelling (SINE).

METHODS: Eleven participants (3 women and 8 men, 1.76 ± 0.10 m, 69 ± 7 kg) completed a running test on an instrumented treadmill (Zebris FDM-TDM System, Zebris Medical GmbH, Germany). Each participant performed, in a randomised order, 9 trials combining three running speeds (10, 12, and 14 $km \cdot h^{-1}$) and 3 stride frequencies (100, 110, and 90% of the self-selected frequency) for 120 seconds. Simultaneously, each participant worn three IMUs (Movella DOT, Movella, Henderson, NV, USA) placed on the sacrum and bilaterally on the lateral side of the shank. Contact and aerial times were obtained from the treadmill (TDM; reference) and used to compute the spring-mass model parameters (kleg; kvert; $\Delta z$: vertical displacement of the CoM; $\Delta L$: lower limb shortening) from the SINE approach (1). At each stance, the vertical ground reaction force was estimated based on the weighted sum of the vertical accelerations from the IMUs as proposed by (2). From these estimated vertical force traces, contact and aerial times were calculated. Therefore, two spring-mass models were computed from the IMUs data (IMU-GRF and IMU-SINE). Bland-Altman comparative analyses were conducted for comparison between both devices (TDM and IMU) across all running trials.

RESULTS: The IMU-GRF vs. TDM-SINE comparison showed a bias of 2.58 ± 6.78 kN/m and -0.76 ± 2.88 kN/m for kvert and kleg, respectively. The bias was -0.72 ± 1.99 cm and 2.08 ± 3.72 cm for $\Delta z$ and $\Delta L$, respectively. The IMU-SINE vs. TDM-SINE comparison showed a bias of -4.17 ± 4.82 kN/m and -1.76 ± 2.04 kN/m for kvert and kleg, respectively. The bias was 0.92 ± 1.16 cm and 2.36 ± 2.92 cm for $\Delta z$ and $\Delta L$, respectively.

CONCLUSION: Based on these results, IMU-based spring-mass model seemed suitable to assess the mechanical behaviour of the lower limb during running. More specifically, the IMU-GRF approach seemed to provide better results compared to IMU-SINE. While this wearable approach enables the ecological analysis of running, future studies should investigate its validity in conditions involving slopes.

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## Conventional Print Poster Presentations

### CP-BM13 Neuromuscular Physiology

**SURFACE EMG FEATURES IN UNILATERAL AND BILATERAL ECCENTRIC MOVEMENT PATTERNS IN COMPARISON**

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INTRODUCTION: Eccentric training, which involves muscle lengthening under load, enhances athletic performance and prevents injuries. While most interventions focus on bilateral exercises, unilateral movements are crucial in real-life activities, aiding balance, coordination, and rehabilitation. However, differences in muscle activation between unilateral and bilateral exercises remain unclear. Therefore, the current study investigated these variations to guide training and rehabilitation programs.

METHODS: A cross-sectional laboratory-controlled design was used. Twenty-five male participants performed four self-weighted eccentric tasks: single- and double-leg Nordic hamstring exercise (NHE-S/NHE-D) and eccentric leg extension (ELE-S/ELE-D). Electromyographic (EMG) data were collected using the Delsys Trigno Wireless system (Delsys Inc., Natick, MA, USA) from dominant side muscle groups: rectus abdominis (DRA), lumbar erector spinae (L3ES), multifidus (L5MF), biceps femoris long head (BFlh), semitendinosus (ST) at mid (50%) and distal (30%) regions, and gluteus maximus (Gmax). EMG parameters included RMS (normalized to MVIC), mean frequency (MF), waveform length (WAV), and tension index (TI). A Mann-Whitney U test was used to analyzed EMG features across four tasks. ($P<0.05$).

RESULTS: The BFlh and Gmax exhibited significantly higher RMS values during unilateral tasks compared to bilateral tasks ($P<0.001$). While the ST showed no significant difference in the NHE, it demonstrated higher RMS values during ELE-S ($P<0.01$). In terms of trunk muscle (DRA, L3ES, L5MF) responses, most of them showed no significant differences in activation, except for the DRA during NHE-S exhibited increased RMS ($P=0.01$). The lumbar muscles (L3ES, L5MF) had significantly higher activation levels compared to the DRA ($P<0.01$, all comparisons), with the L5MF displaying higher levels of MF and TI than the L3ES during ELE ($P<0.01$, all comparisons). Regarding regional patterns, MF values consistently followed the hierarchy: BFlh50 > ST50 > ST30 > BFlh30 ($P<0.05$). The RMS of ST50 exceeded that of BFlh50 only during NHE-D ($P=0.02$), and ST50 demonstrated greater WAV and TI compared to ST30 during NHE ($P<0.05$, all comparisons). These differences in inter-muscle comparisons were consistent across both unilateral and bilateral patterns.

CONCLUSION: Unilateral eccentric training elicited greater activation in BFlh and Gmax than bilateral training, while ST showed increased activation only in ELE. Trunk muscle activation remained largely unchanged, except for higher DRA activation in NHE-S. L5MF exhibited greater fatigue and tension than L3ES in ELE, and muscle fatigue patterns followed a consistent ranking (BFlh50 > ST50 > ST30 > BFlh30). These findings suggest that unilateral training can enhance hamstring activation and may be valuable for athletic performance, rehabilitation, and injury prevention.

**RATE CODING OF FDI MOTOR UNITS DURING FINGER FLEXION AND PINCH TASKS**

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INTRODUCTION: The force output produced during muscle contraction is modulated by activating different numbers of motor units (i.e., recruitment) and modulating their discharge rates (i.e., rate coding) [1]. However, there is still limited knowledge regarding how rate coding modulation across force levels differs between isolated and synergistic muscle contractions. In this study, we examined the first dorsal interosseous (FDI) motor unit (MU) discharge rates across three submaximal force levels during isolated finger flexion and synergistic pinch task.

METHODS: Eight healthy adults sat in front of a custom-made manipulandum with their right arm and wrist stabilised and their index finger and thumb fixed to adjustable supports attached to load cells. After performing maximum voluntary isometric contractions (MVC), subjects were asked to perform submaximal contractions at different target forces (10%, 20%, and 30% MVC). Subjects followed trapezoidal feedback with a ramp up phase from 0% MVC to the target force at 3% MVC/s, keep at the target force for 30 s (plateau), and a ramp down phase from the target force to 0% MVC at 3% MVC/s. Each force level was repeated for two conditions: isometric finger flexion and pinch. During the tasks, high-density surface electromyograms (HDsEMG) were recorded from the FDI muscle. MU spike trains were decomposed from HDsEMG signals [2] and matched between 10% and 20% MVC (10-20%), as well as between 20% and 30% MVC (20-30%). MU matching was achieved by reapplying the MU separation vectors [3]. The mean discharge rate (MDR) during recruitment (up), plateau, and de-recruitment (down) phases was calculated and compared using linear mixed models, with force level and task as fixed effects and subject as random effects. The analyses were carried out separately per matching conditions (10-20% and 20-30%).

RESULTS: A total of 586 matched MUs were identified across subjects. In both the 10-20% and 20-30% matching conditions, MDR during plateau phase increased at higher force levels ($p < 0.001$) and was higher in the pinch task compared to the isolated finger flexion ($p < 0.001$). No significant changes were observed in recruitment or de-recruitment phase. Additionally, no significant interaction was found between force level and task in all phases.

CONCLUSION: By reapplying MU separation vectors in the concatenated decomposed files, it was possible to track motor units across force levels and analyse their mean discharge behaviour. Our results confirmed that FDI MU discharge rate increased with force level, but this increase did not depend on whether the task involved isolated or synergistic contraction. Interestingly, pinch task required higher MU discharge rates than isolated finger flexion, revealing a task-dependent modulation in rate coding.

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**THERE ARE NO DIFFERENCES IN RETICULOSPINAL TRACT EXCITABILITY ACROSS ISOMETRIC, CONCENTRIC AND ECCENTRIC MUSCLE ACTIONS AT THE SAME ABSOLUTE FORCE OUTPUT**

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INTRODUCTION: Human movement involves a dynamic interplay of isometric, concentric, and eccentric muscle actions. There is a need to understand the contribution of the reticulospinal tract (RST) to human movement control during different muscle actions. This research aimed to determine the excitability of the RST during isometric, concentric and eccentric muscle actions.

METHODS: Fourteen neurologically intact participants (Age: 26 ± 7 years; Sex: 3 female, 11 male; Stature: 176 ± 8 cm; Mass: 78.5 ± 10.9 kg) performed isometric, concentric, and eccentric muscle actions with the biceps brachii. Participants performed a submaximal contraction at 25% of their isometric maximum voluntary contraction (MVC) during all muscle actions. Neurophysiological electrical stimulations to indirectly measure RST excitability consisted of conditioned (startling auditory stimulus of ≥110 dB) and unconditioned (no auditory stimulus) cervicomedullary motor evoked potentials (CMEPs).

RESULTS: Larger conditioned CMEP responses compared to unconditioned CMEPs were observed for all muscle actions ($p = 0.008$). However, no differences in RST excitability, inferred from the difference between conditioned and unconditioned CMEP responses, were observed across the three muscle actions ($p = 0.319$).

CONCLUSION: These results suggests that across isometric, concentric, and eccentric muscle actions, there are no differences in RST excitability whilst performing a submaximal contraction at 25% of their isometric MVC. It could therefore be inferred from this that RST input to motoneurons is not different between isometric, concentric, and eccentric muscle actions of the biceps brachii at relatively low contraction intensities.

**ACUTE AND PROLONGED HIGH-ALTITUDE EXPOSURES ALTER INDICES OF AXONAL EXCITABILITY**

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INTRODUCTION: Hypobaric hypoxia experienced at high altitude may influence the neuromuscular propagation of action potentials, as evidenced by changes to the maximal compound muscle action potential. However, equivocal findings highlight the need for more comprehensive evaluations of the effect of high altitude on neuromuscular propagation. This study used an automated threshold-tracking paradigm known as the TROND protocol1 to assess multiple measures of axonal excitability at sea level (SL; 350 m) as well as after acute (AH; 1-2 days) and chronic (CH; 5-6 days) exposure to high altitude (3800 m).

METHODS: In 13 healthy, young participants (5 females; 27.0+/-3.4 years), axonal excitability was assessed by repeatedly stimulating the median nerve with various currents, pulse widths, and conditioning pulses. Evoked responses were recorded from the right abductor pollicis brevis (APB) using surface electromyography. Five examinations were completed: (i) the stimulus-response curve; (ii) the strength-duration time constant (SDTC); (iii) the threshold electrotonus to depolarizing and hyperpolarizing conditioning currents (TEd and TEh, respectively); (iv) the current-voltage (I/V) relationship; (v) the recovery cycle after supramaximal activation

RESULTS: Compared to SL, resting I/V slope (AH: 122% SL, CH: 111% SL), TEh (AH: 124% SL, CH: 117% SL), and relative refractory period (AH: 137% SL, CH: 123% SL) were greater for AH and CH ($p<0.05$). Resting I/V slope was also greater for AH than CH ($p<0.05$). Superexcitability for AH (126% SL) was greater than both SL and CH ($p<0.05$), while there was no difference between SL and CH (103% SL). The slope of the stimulus-response curve for CH (120% SL) was greater than SL and AH, with AH (102% SL) not different to SL. The SDTC, TEd, and subexcitability were unchanged across sessions ($p>0.05$).

CONCLUSION: Our findings demonstrate that motor axons innervating the APB became less hyperpolarized and moved closer to threshold with exposure to high altitude for 1-6 days. Differences between AH and CH for resting I/V slope and superexcitability indicate acclimatization of some indices of axonal excitability, with a return towards the control state (i.e., SL). In contrast, the slope of the stimulus-response curve required more than 1-2 days of exposure to high altitude before an adaptation occurred. These alterations to motor axons should be investigated further, and axonal excitability should be accounted for when evaluating the effects of high altitude on cortical and motoneuronal excitability.

**THIGH MUSCLE ACTIVATION PATTERNS DURING UNILATERAL AND BILATERAL LEG PRESS EXERCISE VARIATIONS**

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INTRODUCTION: The leg press is a multi-joint exercise primarily engaging quadriceps, hamstrings and gluteal muscles simultaneously in a complex manner (1). The widespread applicability of the exercise is explained by the simplicity of its technique since it is a guided movement (2). At the same time, it has substantial transfer to functional movements such as walking, squatting, running, or jumping (2,3). Therefore, the exercise is frequently included in any training or rehabilitation program regardless of age or training goal for strengthening the lower limbs (2,4,5,6). Myoelectric muscle activity during leg press exercises is a critical area of study in resistance training, as it provides insights into muscle activation patterns and their implications for strength training and rehabilitation (7). The objective of this study was to compare the myoelectric activity of thigh muscles during unilateral and bilateral leg press exercise variations in resistance-trained men.

METHODS: Ten young college resistance-trained men (age 23.46±1.66 years, height 181.7±5.17 cm, weight 83.65±7.51 kg) performed maximal voluntary isometric contraction (MVIC) during unilateral (UL) and bilateral (BL) leg press exercise at a 90-degree knee angle. Surface electromyography (Delsys EMG Trigno Wireless Research System) was used to assess muscle activation pattern and integrated myoelectric activity (iEMG) of m. vastus medialis (VM), m. vastus lateralis (VL) and m. biceps femoris (BF). A non-parametric Wilcoxon t-test was used to measure differences in iEMG of VM, VL and BF between UL and BL leg press exercise. The level of significance was set at alpha = 0.05 for all statistical analyses.

RESULTS: The iEMG of the VM was significantly higher in BL compared to UL leg press exercise (p=0.01). The BL leg press exercise variation generated significantly greater VL activity than the UL variation (p=0.02). There was no significant difference in myoelectric activity of the BF between the two leg press exercise variations. For BL and UL leg press exercise variations, the greatest muscle activation was for the VM, followed by the VL, and the BF.

CONCLUSION: The results indicated that BL leg press was more effective in VM and VL muscle activation. The UL leg press exercise was as effective as the BL leg press exercise in BF muscle activation. When the objective is to activate the VM muscle, unilateral and bilateral leg press exercise variations can be used, because both are equally effective in greatest VM muscle activation. The study was supported by grant VEGA no. 1/0415/23 and by the Slovak Research and Development Agency no. APVV-21-0164.

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**INTER-INDIVIDUAL DIFFERENCE AND RELATIONSHIP WITH MOTOR FUNCTION AND MUSCLE MORPHOLOGY IN MOTOR UNIT NUMBER OF ABDUCTOR POLLICIS BREVIS MUSCLE IN HEALTHY MIDDLE-AGED MALES AND FEMALES**

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INTRODUCTION: The number of motor units (MUs) decreases with aging and this accelerate from 40-50s. This anatomical characteristic would be a crucial biomarker for age-related muscle dysfunctions because MU numbers should contribute to both motor functions and muscle morphology. However, MU number has been mainly measured in patients with neurological diseases, and its inter-individual variability and the associations between MU number and muscle functions and/or muscle morphology have not been investigated in healthy subjects. We aimed to investigate the inter-individual variability of MU number and its associations with motor function and muscle morphology in middle-aged healthy males and females.

METHODS: The participants were 93 healthy middle-aged males and females (40s: n=59, 50s: n=29, 60s: n=5). The maximal voluntary contraction pinch force (MVC) and muscle thickness of abductor pollicis brevis muscle measured by ultrasonography (MT). MU number was estimated from a detailed electrical stimulation-electromyographic response curve by MScanFit-2 for abductor pollicis brevis muscle (MUNE). Inter-individual variability of MVC, MT, and MUNE were quantified by coefficient variation (CoV). Relationships between MVC, MT, and MUNE were quantified by the Spearmans rank correlation coefficient.

RESULTS: MVC, MT, and MUNE were 9.7 ± 2.5kg, 0.4 ± 0.1cm, and 107.6 ± 28.7 and their CoV were 25.3%, 28.4%, and 26.7%, respectively. A significant correlation between MVC and MT was detected ($r = 0.334$, $p = 0.001$). There were no significant correlations with MUNE in MVC and MT ($p > 0.05$).

CONCLUSION: In healthy middle-aged populations, MU number has similar amount of inter-individual variability with those of motor function and muscle morphology and is a biomarker independent of motor function or muscle morphology.

**THE EFFECTS OF ONLINE VS. OFFLINE APPLICATION OF TRANSCRANIAL DIRECT CURRENT STIMULATION IN AN ISOMETRIC ENDURANCE TEST OF THE QUADRICEPS MUSCLES**

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INTRODUCTION: A novel approach to improve athletic performance is the use of Transcranial Direct Current Stimulation (tDCS). tDCS can induce neuronal excitability changes through the application of weak subthreshold direct current to the brain. The ability of tDCS to modulate cortical excitability could be harnessed to mitigate the effects of central fatigue in the context of muscular endurance exercises. Through the application of tDCS, output from the primary motor cortex (M1) can remain elevated, which may prolong time to fatigue (TTF) . However, while some prior studies have found tDCS to improve TTF, other studies have not. Reasons could relate to the timing of tDCS application and, controlling for individual differences in electric fields generated by tDCS. Thus, this study aims to evaluate different tDCS application protocols and their

effects on TTF. The study protocols are different in 1) the time of tDCS application, and 2) whether a personalized tDCS dosage is applied verses a generic dosage. It is hypothesized that the individualized condition will lead to the longest TTF. EMG data was also collected from the quadriceps to help confirm the effect of tDCS on neuromuscular fatigue.

METHODS: To date, 8 strength trained varsity athletes have been tested who have completed 4 testing sessions, in a within subject design (data collection is ongoing with a target of 15). Participants first received an MRI scan that was used for current flow modelling to determine individualized current intensities at M1. Each of the following sessions began with 3 maximal voluntary isometric contraction leg extensions using a biodex dynamometer. Participants then received one of the following 4 conditions per session: (1) sham tDCS, (2) offline (priming), (3) online, and (4) individualized online tDCS, all with the anode over M1 and cathode over Fp2. Offline tDCS consisted of 6 minutes of stimulation at 2mA prior to a TTF leg extension at a 90-degree angle, at 20% of peak torque. Online tDCS followed the same protocol but occurred during the TTF task. Individualized tDCS also occurred online, but with a personalized current intensity. Rate of perceived exertion (RPE) was collected every 30 seconds and mean power frequency (MnPF) (data analysis is ongoing), calculated from the surface EMG, was also collected as subjective and objective measures of fatigue, respectively.

RESULTS: Preliminary results suggest that there was a trend toward a significant effect of stimulation condition on TTF [$F(3,21)=2.670$, $p=0.074$, $\eta p2 = 0.276$]. Data from 5 of the 8 participants tested support the hypothesis; the individualized condition led to the longest TTF. The stimulation condition had no significant influence on the slope of RPE increase during the TTF task [$F(3,21)=0.785$, $p=0.516$, $\eta p2= 0.101$].

CONCLUSION: These findings will help to inform future studies on the optimal tDCS application protocol that can be used to mitigate central fatigue and improve endurance performance.

**EFFECTS OF ACUTE PASSIVE BLOOD FLOW RESTRICTION ON MOTOR UNIT RECRUITMENT THRESHOLD AND DISCHARGE RATE**

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INTRODUCTION: Periods of mechanical unloading following injury or surgery lead to neuromuscular deconditioning and altered motor control. Passive blood flow restriction (BFR), applied without movement, has been shown to reduce muscle atrophy and strength loss. However, its effects on motor unit (MU) properties remain unclear. This study investigated changes in MU properties before and after a passive BFR intervention.

METHODS: Eighteen male handball players (age: 18-28 years, BMI: 21-30 kg/m²) participated in the study, where vastus lateralis activity was recorded using a 64-channel High-Density surface EMG (HDsEMG) grid before and after a 5-minute passive BFR intervention at 80% arterial occlusion pressure. Isometric ramp contractions at 20, 30, and 40% maximal voluntary contraction (MVC) were performed before BFR and at 20% immediately after BFR. HDsEMG signals recorded before BFR were decomposed (1) to analyse MU recruitment threshold (RT), derecruitment threshold (DERT), and discharge rates (DR). Analyses were performed in Python with the openhdemg V0.1.1 library (2). Identified MUs were tracked post-BFR using individual MU filters (3). Effects on MU properties were assessed using linear mixed models.

RESULTS: MVC values did not change as a result of the BFR intervention (from 732 ± 153 N to 738 ± 147 N, $t=-0.54$, $p=0.59$, $d=-0.13$). Relative MU RT and DERT for MUs tracked across the contractions performed at 20% MVC before and after BFR did not differ (from 12.2 ± 0.8 % to 12.1 ± 0.8 %, $p=0.94$ for RT; from 11.9 ± 0.6 % to 11.2 ± 0.6 %, $p=0.31$ for DERT). Similarly, the MU DR measured during the steady-state phase did not change after BFR (from 9.1 ± 0.3 pps to 9.5 ± 0.3 pps, $p=0.06$). For MUs tracked across contractions performed at 30 (15 MUs) or 40% (12 MUs) MVC before BFR and at 20% MVC after BFR, relative MU RT and DERT were reduced after BFR (from 23.3 ± 0.5 % to 17.7 ± 0.5 %, $p<0.001$ for RT; from 20.8 ± 1.0 % to 15.0 ± 1.0 %, $p<0.001$ for DERT). MU DR measured during the steady-state phase decreased after BFR (from 10.7 ± 0.5 pps to 8.1 ± 0.5 pps, $p<0.001$).

CONCLUSION: This study analysed the effects of a passive BFR intervention on MU properties of exactly the same MUs non-invasively. Hence, additional recruited MUs (MUs that were unrecruited before BFR) remain unconsidered. Although only a small number of MUs were detected showing a reduced RT, these results provide direct evidence that a preceding passive BFR changes the excitability, particularly of the same MUs.

**ACUTE EFFECTS OF OXYGEN ADMINISTRATION ON NEUROMUSCULAR FATIGUE IN CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS WITH CHRONIC RESPIRATORY FAILURE AND LONG-TERM OXYGEN THERAPY**

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INTRODUCTION: Patients with chronic obstructive pulmonary disease (COPD) and chronic respiratory failure (CRF) experience exaggerated neuromuscular fatigue (NMF). Reduced muscle oxygen availability leads to increased metabolite production, exacerbating peripheral component of NMF, while chronic hypoxemia leads to exacerbation of central components of NMF. Oxygen therapy can correct hypoxemia, enhance aerobic metabolism, and reduce ventilatory effort. However, its effects on NMF development in COPD remain unclear.

This cross-sectional study hypothesizes that NMF is sensitive to changes in the inspired oxygen fraction (FiO2). The aim was to evaluate whether different levels of FiO2 (%) influence NMF development in COPD patients with CRF.

METHODS: Twenty patients (81% male, age 72±6 YRS, BMI 25±6, FEV1 34.5±10.9%, FEV1/FVC 39.6±9.3, RV 206.5±53.1%) completed three intermittent isometric quadriceps tests at 80% of the time to exhaustion at 30% of maximal voluntary contraction (MVC). Tests were performed under three different FiO2 conditions using a Venturi mask®: A) 21%, B) 31%, and C) 60%. NMF was assessed through changes in MVC, voluntary activation (VA), and quadriceps potentiated twitch force (Qtw,pot) following exercise. Oxygen saturation (SpO2) was monitored throughout.

RESULTS: The mean test duration was 739.6±260.1 seconds. Changes in MVC were -27.6±9.5%, -24.4±7.8%, and -22.0±7.1% for conditions A, B, and C, respectively (P=0.023), with significant differences observed between A-B (P=0.043) and A-C (P=0.035). ΔQtw,pot showed changes of -31.1±14.3%, -31.3±16.7%, and -26.7±16.1% for conditions A, B, and C, respectively (P=0.019), with differences between A-C (P=0.023) and B-C (P=0.014). VA decreased similarly across conditions: A -3.9±4.1%, B -2.7±3.0%, and C -2.2±3.9% (P=0.211).

SpO2 remained stable during the tests but differed significantly between conditions: A) 88.7±4.2%, B) 95.8±2.7%, and C) 98.5±1.5% ($P < 0.001$).

CONCLUSION: The progressive changes in the MVC suggest that the acute oxygen administration reduces neuromuscular fatigue development in COPD patients with CRF. Indeed, this result was primarly determined by greater responses on the peripheral component of NMF.

**BILATERAL LIMB DEFICIT IN DORSIFLEXION: INVESTIGATING FORCE PRODUCTION, MOTOR UNIT DISCHARGES, AND OFF-DIRECTION FORCES**

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INTRODUCTION: The bilateral limb deficit (BLD) refers to the reduced maximal force production observed during bilateral contractions compared to the sum of unilateral contractions. This phenomenon occurs across various movement types (isometric and dynamic), with its magnitude ranging from 11% to 36.7% in explosive contractions(1). Identifying BLD is essential, as it may reflect neuromuscular control limitations affecting force production (2). The aim of the present study to investigate the effect of motor unit discharges characteristics and off-direction forces on force production during unilateral and bilateral rapid contractions.

METHODS: Eighteen young adults performed maximal and submaximal explosive isometric contractions (at 80% MVC) using the dorsiflexors of both legs (3). To assess the magnitude of bilateral deficit we used the bilateral index (BI (%) = 100 x[bilateral/(right unilateral + left unilateral)]1-100) (4). Additionally, we recorded off-direction forces (abduction & adduction) and motor unit discharge characteristics of the tibialis anterior. A two-way ANOVA was conducted to compare force production between unilateral and bilateral contractions, while linear mixed-effects models analyzed motor unit (MU) discharge characteristics.

RESULTS: Bilateral index during maximal voluntary contraction was 20% lower compared to unilateral (BI: 164.8 ± 40 N, UNI: 207.8 ± 54.4 N, $p < 0.05$). A BLD was present in explosive force across all time points (F50, F100, F150, and Fmax) (4), with force being 23%, 19%, 28%, and 24% lower, respectively, in the bilateral condition.

Examining 358 motor units, we found no significant differences in maximal discharge rate (BI: 65.6 ± 27.1 pps, UNI: 63.4 ± 29.8 pps, $p = 0.71$) or recruitment speed (BI: 16.3 ± 8.8 ms, UNI: 16.8 ± 7.8 ms, $p = 0.56$). However, neuromechanical delay was significantly shorter in unilateral contractions (43 ± 10 ms) compared to bilateral contractions (49 ± 13 ms). Furthermore, off-direction forces were greater in bilateral contractions (663.5+366.9 N) compared to the unilateral contractions (526.4+265.4 N) ($p < 0.05$).

CONCLUSION: The reductions in maximal force and rate of force development were not associated with differences in motor unit discharge rates, suggesting that supraspinal mechanisms may contribute to the BLD. Additionally, the increased off-direction forces in bilateral contractions indicate a greater force loss strategy in bilateral contractions, suggesting less efficient movement coordination that possibly exacerbating the BLD.

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Conventional Print Poster Presentations

CP-BM17 Perception and Balance - Mixed

**PERCEPTION OF EFFORT IN MOTOR AND COGNITIVE TASKS: A COMPUTATIONAL ANALYSIS**

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INTRODUCTION: Pain affects performance by increasing the perceived task difficulty. According to the motivational intensity theory (1), in the presence of pain, individuals must allocate additional effort to maintain performance, leading to an increase in the perception of effort (PE).

The objective of this study is to test the effect of pain on performance. As effort is present in the motor and cognitive domains, we investigated the effect of pain on motor and cognitive performance. We hypothesized that performance could be maintained in the presence of pain at the cost of higher PE. To explore the underlying mechanisms of PE in the motor and cognitive domains, we performed computational modeling.

METHODS: Two experiments (n=20 each, exp1: motor, exp2: cognitive) were conducted. In exp1 participants had to match a line using a handgrip dynamometer. Performance was measured as force steadiness. In exp2 participants performed a modified Simon task. Performance was measured as reaction time and accuracy. In both experiments task demand (TD) was manipulated with 3 levels and each trial lasted 15s. An individualized thermal stimulation (warm – control, light or high pain) was applied during each trial. After each trial, participants reported their PE and pain. Data were analyzed using linear mixed models. Then we compared mathematical and theoretical models using maximum likelihood estimate to predict PE. In each computational model, we used the linear and logarithm of the TD as well as the objective level of thermal stimulation and subjective pain ratings as predictors.

RESULTS: In both experiments, performance was maintained (ps >.387) in the presence of pain and PE was higher compared to the warm conditions (ps<.009). In addition, task completion was associated with a reduced pain perception (ps<.004).

Computational analyses revealed in the motor domain that all models favored the logarithm of the TD rather than the linear. In cognitive domain, the logarithm of the TD was a superior predictor in most models (10 models better, 3 equivalents, none were worse). Moreover, subjective pain ratings consistently provided a better prediction of perceived effort than did the objective level of stimulation. The best-fitting model differed between the motor and cognitive domain.

CONCLUSION: According to our hypothesis, the maintenance of performance in presence of pain is possible at a cost of higher effort in the task, in both motor and cognitive domains. Computational analyses highlight that the logarithm of TD predicts PE more accurately than linear models. These analyses also reveal that subjective pain perception is a better predictor of PE than the objective level of thermal stimulation. Although these analyses reveal similar components (logarithm and subjectivity), the model that best explains the data differs between the two domains, suggesting the PE underlying mechanism may be domain-specific.

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**CRICKET COACHES PERCEPTIONS OF A 'GOOD LENGTH' IN CRICKET BOWLING**

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INTRODUCTION: Bowlers play an important role in cricket, seeking to meet the dual task goals of dismissing a batter, and limiting the batting team's score. Finding a length (distance) to bowl to the batter which increases uncertainty in their responses, colloquially termed a 'good length', helps achieve these dual aims. There is conjecture around the location of this region, with a range of distances (between 3-8m) previously reported [1]. When viewed from a theoretical framework of learning, such as ecological dynamics, regions offering more than one movement solution are considered metastable regions [2]. This study explored coaches understanding of the concept of a 'good length' in relation to cricket bowling.

METHODS: An online questionnaire (Qualtrics) targeting cricket coaches internationally included fixed-response and free-text questions, with demographic and coaching experience data presented as frequencies. Thematic analysis [3] using NVivo (v15.0.0) software explored coaches understanding of key characteristics and perceptions of a 'good length' region in cricket, comparing two groups (coaches predominantly coaching either junior (<18 yrs) or senior (>18 yrs) cricketers).

RESULTS: 104 coaches (93% male, 7% female) aged 20-69 years from 11 countries responded, with 52% coaching junior and 48% coaching senior cricketers. A central theme (a region for success) emerged after thematic analysis of coaches perceptions of a 'good length', with three sub-themes. Those coaching juniors focused on the batter's role within the 'doubtful batter' sub-theme, while those coaching seniors also commented on challenging the batter. Both coaching groups shared similar sentiments for the sub-themes of 'a pause on scoring' (inhibiting performance) and 'just out of reach' (focus on the location being not too full or not too short). Three themes on characteristics that determine a 'good length' delivery emerged. The contextual nature of the region was reported by both groups (theme 1: the role of context), with those coaching seniors reporting strategic elements in addition to the individual and environmental constraints reported by those coaching juniors. Both groups included comments identifying the importance of line when defining this

region (theme 2: multidimensionality of the region), with some coaches from both groups identifying fixed distances for this region (theme 3: fixed dimensions of this length).

CONCLUSION: Insights from cricket coaches conceptualisation of the 'good length' region depict an understanding aligned to the concept of metastability [2], moving beyond common interpretations of a fixed distance. Overall, both groups of coaches shared similar sentiments around the dynamic nature of this region, with coaches of senior cricketers often demonstrating more tactical nuance to their interpretation. Findings may assist with broadening understanding of these concepts at different levels of coach education.

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**POSTURAL STRATEGIES ASSESSED BY JOINT TORQUES – DIFFERENCES BETWEEN CHILDREN WITH AND WITHOUT ADHD**

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INTRODUCTION: Children with ADHD often struggle with balance and postural control unlike their unaffected peers (1). While balance ability with a focus on postural sway has been broadly investigated in the patient-group, less is known about postural strategies employed to maintain equilibrium. We complement the hip and ankle postural strategies by an upper body strategy, to additionally take movements of the head, arms and trunk into account in the effort of regaining balance (3). Our study aimed at investigating the differences in postural control strategies between children with and without ADHD.

METHODS: 41 children (17 diagnosed with ADHD, 24 unaffected controls) with a mean age of 10.0 ± 1.4 years participated in the study. For the assessment of static balance, a 25-second one-leg stand was conducted. Dynamic balance was tested by balancing over a narrow wooden beam. Kinetic data was recorded with Kistler force plates. Kinematic data was collected with the Qualisys motion capture system. Joint torque amplitudes were calculated with an inverse-dynamics approach employing the Myonardo software (4).

RESULTS: Children with ADHD generated significantly higher torques during static and dynamic balancing. While torques of the ADHD-group were only 11% higher (dynamic task) and 7.5% higher (static task) for the upper body joint group, they were 22% higher (dynamic) and 20% (static) for the ankle joint. No group differences were found for hip joint torques.

CONCLUSION: Problems with proprioception and neuromuscular control are common among children with ADHD and may demonstrate as reduced precision in muscle activation (5). Cerebellar deficits in the patient-group negatively influence balance and coordination (1). Such deficits likely interfere with the adjustment of joint torques involved in maintaining balance and stability. Children with ADHD seemingly employ the ankle- and upper body strategies more intensely than the unaffected controls. The topic is of great importance as impairments in balance and motor control may interfere with activity and participation and may increase the risk of injuries.

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**STATIC AND DYNAMIC POSTURAL CONTROL UNDER DIFFERENT LEVELS OF VISUAL INFORMATION IN INDIVIDUALS WITH ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION, MENISCUS SURGERY, AND HEALTHY CONTROLS**

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INTRODUCTION: Individuals with knee surgeries, such as anterior cruciate ligament reconstruction (ACLR) and meniscus surgery may exhibit altered joint proprioception, resulting in an increased reliance on the visual information for balance control. This study compared postural control in individuals with ACLR and meniscus surgery to healthy controls under three different visual information conditions during static and dynamic balance tasks.

METHODS: Forty-five individuals (15 ACLR; 15 meniscus surgery; 15 matched healthy control) were studied. Participants performed static and dynamic balance tasks under three different conditions: (1) eyes opened (EO); (2) eyes closed (EC); and (3) strobe vision (SV; 100-ms clear & 150-ms opaque vision) [1]. For the static task, participants performed a single-leg stand for 10-sec on a force plate (1,000 Hz). For the dynamic task, participants performed the Y-balance test. Data from the single-leg standing, CoP velocity (anterior - posterior: AP and medial - lateral: ML; cm/sec) were calculated [2]. Y-balance test scores were obtained for the anterior (ANT), posteromedial (PM), and posterolateral (PL) directions, and were normalised by the limb length. Data were recorded from the involved limb (the dominant limb for controls). A 3 (group) by 3 (con-

dition) analysis of variance along with Tukey tests, was conducted to evaluate the differences in each dependent variable (a=0.05).

RESULTS: There was no group by condition interaction in CoP velocity ($F_{2,84}<0.79$, $p>0.46$). CoP velocity differed regardless of group (AP: $F_{2,84}=30.25$, $p<0.01$; ML: $F_{2,84}=76.77$, $p<0.01$). In both AP and ML directions, the EC condition showed a higher velocity than the EO and SV conditions (both $p<0.01$). In ML direction, the SV condition showed a higher velocity than the EO condition ($p<0.01$). There was no group by condition interaction in Y-balance score ($F_{2,84}<0.20$, $p>0.82$). Y-balance score differed regardless of condition (ANT: $F_{1,84}=8.33$, $p<0.01$; PM: $F_{1,84}=6.64$, $p=0.01$; PL: $F_{1,84}=5.72$, $p=0.02$). The ACLR group showed lower ANT scores than the control group ($p<0.01$). The ACLR and meniscus surgery groups showed lower PM and PL scores than the control group (both $p<0.01$). Regardless of group, each direction of Y-balance score differed (ANT: $F_{2,84}=9.83$, $p<0.01$; PM: $F_{2,84}=11.89$, $p<0.01$; PL: $F_{2,84}=8.53$, $p<0.01$). The scores of the SV condition were lower than those of the EO condition in the ANT ($p<0.01$), PM ($p=0.01$), and PL ($p=0.02$) direction.

CONCLUSION: The influence of the level of visual information on static and dynamic postural control appears to be similar between individuals with a history of knee surgery and healthy controls. Individuals with ACLR may exhibit impaired dynamic postural control compared to those with meniscus surgery or healthy controls, highlighting the need for proprioceptive training in ACLR rehabilitation to enhance dynamic stability.

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**DYNAMIC ASSESSMENT OF THE TALUS-LATERAL MALLEOLUS DISTANCE DURING FORWARD SINGLE-LEG DROP LANDING IN INDIVIDUALS WITH AND WITHOUT CHRONIC ANKLE INSTABILITY**

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INTRODUCTION: Lateral ankle sprain (LAS) has a high recurrence rate, which has considered to be associated with chronic ankle instability (CAI). LAS often occurs during landing, accounting for 35% of all scenario of non-contact LAS, and ankle instability before landing has seemed as a risk factor. As an assessment of ankle instability, the talus-lateral malleolus distance has been measured using ultrasound, and it was longer in patients with CAI than that of healthy adults. Recently, we developed an assessment of the dynamics of the talus-lateral malleolus distance during gait [1]. Then, we aimed to assess the dynamics of the talus-lateral malleolus distance during forward single-leg drop landing and compare between individuals with and without CAI.

METHODS: In total, 24 young adults (38 feet, 21.8±1.9 years) participated, and they were divided into the healthy group (12 adults, 24 feet) and the CAI group (12 adults, 14 feet) depending on the history of LAS and score of a Cumberland ankle instability tool [2]. The task movement was a forward single-leg drop landing from 30 cm high box to the force plate (AMTI Inc., USA). The talus-lateral malleolus distance and ankle joint angles were captured by ultrasound (Telemed Ltd., Lithuania) synchronized with three-dimensional motion capture systems (Vicon motion systems Ltd., UK). We also assessed the peak value of ground reaction force (GRF). The analysis interval was 200 ms before to after initial contact (IC) and normalized for 100%. Statistical parametric mapping was used to compare the time course of the talus-lateral malleolus distance and ankle joint angles between 2 groups. The unpaired t-test was conducted for the GRF data. The significance level was set at $p<0.05$.

RESULTS: The talus-lateral malleolus distance before IC (10%-35%) was longer in the CAI group than that of the healthy group ($p<0.01$). The CAI group showed larger ankle adduction angle before IC (0%-35%) compared to the healthy group ($p<0.05$). The vertical GRF (vGRF) was greater in the CAI group than in the healthy group ($p<0.05$).

CONCLUSION: There is deterioration of proprioception in ankle adduction position and impairment of activity in the peroneus muscles before IC in patients with CAI [3]. These dysfunctions after LAS might increase ankle adduction angle in the CAI group. In this position, the talus shifts forward and internal rotation, enlarging the talus-lateral malleolus distance. Ankle instability before IC has been considered to induce "giving way", and increased talus-lateral malleolus distance can cause LAS. Moreover, the CAI group showed greater vGRF, and repetitive high landing impact causes abnormal stress on the ankle joint structure, leading to higher ankle instability. This study suggests researcher should focus on the talus-lateral malleolus distance before IC in the CAI case.

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**ACUTE EFFECT OF CONTINUOUS PERTURBATIONS OF THE BASE OF SUPPORT ON REACTIVE BALANCE RESPONSE**

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INTRODUCTION: The understanding of the role of immediate previous experience to continuous balance perturbation in reactive postural responses and skill acquisition to an unexpected stimulus is warranted. Therefore, we aimed to investi-

gate whether exposure to two different types of continuous perturbations (CP) of the base of support (i.e., random and wave-like platform translation) affects the postural response to a sudden unexpected perturbation (UP) of the base of support, compared to a control condition (CTRL) where no CP was applied.

METHODS: Twenty-seven young adults participated in the study (N=27; F=14; 21.56±1.31yrs; 1.71±0.14m; 72.30±16.06kg). Postural balance was tested on a force plate (AMTI BP400600, USA) positioned on an electro-actuated movable plate (EnginLAB s.r.l., Italy). Subjects performed three different conditions in a random order assessed on three different days, namely: random (RND), sine wave (SIN), and control (CTRL). For each condition, in five out of ten trials, subjects did not randomly receive the UP to prevent them from always expecting a perturbation following the CP. The CP lasted 30 s, and the total displacement was the same for both SIN and RND perturbations. The UP had the following characteristics: forward direction, 50mm of displacement, and 200mm/s of ramp rate. The Area95, the mean velocity, the first peak, and the maximal oscillations (ΔCoPMax) of the center of pressure (CoP) trajectory were calculated in the 2.5s window after the UP occurred. In the CP, the Area95 and the mean velocity were calculated over the 30-second perturbations.

RESULTS: One-way ANOVA showed improvements in balance response to the UP following the RND ($p<0.001$) and SIN ($p<0.001$) compared to the CTRL condition for all the CoP-related parameters. Regarding balance control during the CPs, the two-way ANOVA showed a significant ($p<0.001$) main effect of the condition (RND vs. SIN) with lower values in the SIN compared to RND for both the Area95 and the mean velocity.

CONCLUSION: These findings suggest that young, healthy subjects could benefit from acute exposure to continuous postural perturbations in the reactive balance response to a subsequent unexpected perturbation. Therefore, it would be interesting to investigate whether continuous perturbations may be used as training, regardless of their nature, to assist or improve the response of postural control to external perturbations.

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## Conventional Print Poster Presentations

### CP-BM18 Muscle / Tendon and Exercise - Mixed

**LOWER-BODY MUSCLE FORCES DURING PREFERRED AND NON-PREFERRED DEADLIFT TECHNIQUES IN POWERLIFTERS**

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INTRODUCTION: The deadlift is the last discipline of powerlifting and is crucial for competition success. The International Powerlifting Federation (IPF) allows two techniques, the sumo (SDL) and conventional (CDL) [1]. This study aims to investigate differences in muscle forces during preferred and non-preferred deadlifts. We hypothesised that those performing their preferred deadlift technique would require lower hip extensors, hip flexors, hip adductors, and knee extensors muscle forces compared to the non-preferred technique.

METHODS: Two national-level powerlifters (1 female), active members of the Austrian Powerlifting Federation, were recruited for this study. Individual one-repetition maximum was self-estimated (e1RM) according to the athlete's information in previous training sessions. The female athlete was using the sumo deadlift as the preferred technique (57.6kg; e1RM: 120kg; 20y; 4y of strength training experience). The male athlete was executing the conventional deadlift as the preferred technique (98kg; e1RM: 290kg; 27y; 8y of strength training experience). After an individual warm-up, each participant performed four sets of one repetition at 80% of preferred e1RM both in the preferred and non-preferred techniques. Lifts were performed following the rules of the IPF [1]. Joint kinematics were calculated using a Vicon motion capture system with 12 infrared cameras. Ground-reaction forces were captured with two Kistler forces plates and used to compute joint moments and muscle forces in OpenSim 4.5 [2,3]. Forces for each muscle group were calculated (hip extensors (HE), hip adductors (HAd), and knee extensors (KE)) and time-varying waveforms were used to estimate significant differences using paired t-tests via statistical parametric mapping.

RESULTS: Results indicate that during the preferred SDL, HE and KE muscle forces were lower compared to the non-preferred lift. The athlete who prefers CDL, lifts with higher KE and HE muscle forces, compared to his non-preferred technique. No significant differences in HE between the SDL and CDL were observed. In both participants KE muscle forces during the CDL were significantly higher than those during SDL, independently of the athlete's preference. The HAd muscle forces were also significantly larger during CDL compared to the SDL for both athletes.

CONCLUSION: The results of this preliminary study contradict our initial hypothesis, suggesting the preferred deadlift technique cannot be explained by lower muscle forces compared to the non-preferred technique. We suggest that athletes with lower muscle force capabilities in the HE and KE should use the SDL. However, when the goal is to train the HE and KE, the CDL is recommended.

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**HIP & KNEE MOMENTS IN THREE VARIATIONS OF THE COPENHAGEN ADDUCTOR EXERCISE**

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INTRODUCTION: The Copenhagen adductor exercise (CAE) is effective for improving hip adductor muscle strength. However, CAE variations have been proposed that may increase or decrease loading of these muscles. Specifically, CAE may be performed with the support at the knee, ankle, or between these joints (MID). This study aimed to determine hip and knee loading for these CAE variations.

METHODS: Twenty-four participants (13 women) performed three repetitions of each CAE variation using their right lower limb. Reflective markers were used to model the pelvis and right lower limbs. A wooden support was placed on a force platform and the force acting on the lower limb was calculated. Sagittal, frontal, and transverse plane hip and knee net joint moments (NJM) were calculated.

RESULTS: The hip adductor NJM was 0.93 ± 0.16 Nm/kg for knee, 1.36 ± 0.21 Nm/kg for MID, and 1.54 ± 0.23 Nm/kg for ankle support placements. The sagittal hip NJM was an extensor moment (knee: -0.17 ± 0.23 Nm/kg; MID: -0.28 ± 0.32 Nm/kg; ankle: -0.38 ± 0.40 Nm/kg). Both hip adductor and extensor NJM were greatest for the ankle and smallest for the knee ($P < 0.005$) support. Hip sagittal plane NJM was significantly correlated with thigh transverse plane orientation for all variations ($R2 = 0.94$-$0.96$; $P < 0.001$). There was a knee abductor (-0.12 ± 0.03 Nm/kg) and knee extensor (0.08 ± 0.04 Nm/kg) NJM for the knee support. The other variations had knee adductor (MID: 0.44 ± 0.09 Nm/kg; ankle: 0.73 ± 0.14 Nm/kg) and flexor (MID: -0.16 ± 0.01 Nm/kg; ankle: -0.43 ± 0.21 Nm/kg) NJM. Knee frontal and sagittal NJM were different between each condition ($P < 0.005$). Knee sagittal plane NJM was significantly correlated with leg transverse plane orientation for all variations ($R2 = 0.80$-$0.87$; $P < 0.001$).

CONCLUSION: Hip adductor loading increased as the CAE support location was moved from the knee to the ankle. Most participants had a hip extensor NJM, however some utilized a hip flexor NJM. The correlations between thigh transverse plane rotation and hip sagittal plane NJM demonstrated that a more medially rotated thigh had hip flexor NJM while less medial thigh rotation resulted in a hip extensor NJM. Most hip adductor muscles are hip flexors while the ischiocondylar head of adductor magnus is a hip extensor. Therefore, these muscles may act synergistically to generate the hip adductor NJM while neutralizing the flexor and extensor actions. Changing thigh transverse plane rotation may alter this load sharing to favour those adductors that are flexors or extensors. CAE variations with the support distal to the knee had internal knee adductor and flexor NJM, which are equivalent to external knee abduction and extension moments. This combination of external moments may place stress on the anterior cruciate and medial collateral ligaments. As support location for the CAE moves distally, hip and knee moments increase. Consequently, potential stress on the knee ligaments should be considered when attempting to increase hip muscle loading.

**EFFECTS OF MUSCLE MECHANICAL PROPERTIES ON SWEEP AND SCULL ROWERS FOLLOWING A 2000-METER ON-WATER ROWING TIME TRIAL**

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INTRODUCTION: Due to sport profile, rowing is classified into sweep rowing (single oar) and scull rowing (double oar) (1). Athletes have to repeat the rowing movement throughout the race, during the race load will accumulate continuously (2), it will affect particular muscle groups' muscle mechanical properties and promoting injury risk (3). Rowers may have bilateral muscle asymmetry due to specific technical factors. Many studies have pointed out that changes in muscle mechanical properties, such as muscle tone and stiffness, are related to sports performance and injuries (4,5). The purpose of this study was to investigate the differences in bilateral muscle mechanical properties between the dominant side and the non-dominant side of sweep and sculls rowers before and after the 2000-meter time trial test of water rowing.

METHODS: Six male sweep rowers (SW, n=6) and 6 male sculls rowers (SC, n=6) were recruited for this study. The handheld MyotonPRO device was used to collect muscle tone (frequency) and stiffness data of the posterior deltoid (PD) and vastus medialis (VM) (dominant and non-dominant sides) before and after the 2000-meter time trial test of water rowing. Two-way mixed-design analysis of variance was used to analyze differences in muscle tone (frequency) and stiffness between dominant and non-dominant at pre- and post-rowing time-trial.

RESULTS: The results of the mixed-design two-way ANOVA showed that in the sweep group, the muscle tone (frequency) of the non-dominant side PD ($F = 5.06$; $p = 0.048$) and VM ($F = 5.89$; $p = 0.036$), as well as the dominant side PD ($F = 10.45$; $p = 0.009$) and VM ($F = 6.08$; $p = 0.033$) were significantly increased after the 2000-meter time trial test. On the other hand, the muscle stiffness of the non-dominant side PD ($F = 6.12$; $p = 0.033$) and VM ($F = 5.14$; $p = 0.047$), as well as the dominant side PD ($F = 5.42$; $p = 0.042$) and VM ($F = 9.26$; $p = 0.012$) were significantly increased after the 2000-meter time trial test. In the sculls groups, the muscle tone (frequency) of the non-dominant side PD ($F = 4.40$; $p = 0.062$) and VM ($F = 3.47$; $p = 0.092$), as well as the dominant side PD ($F = 4.00$; $p = 0.074$) and VM ($F = 2.69$; $p = 0.132$) showed no significant increase after the 2000-meter time trial test. On the other hand, the muscle stiffness of the non-dominant side PD ($F = 0.67$; $p = 0.431$) and VM ($F = 2.75$; $p = 0.128$), as well as the dominant side PD ($F = 2.03$; $p = 0.185$) and VM ($F = 3.42$; $p = 0.094$) showed no significant increase after the 2000-meter time trial test.

CONCLUSION: After a high-intensity, high-load 2000-meter water rowing time trial, PD and VM in the sweep group showed an increase in muscle tone and stiffness, as well as symmetrical changes in bilateral muscle mechanical properties.

**TORQUE-VELOCITY RELATIONSHIP FOR UPPER LIMBS IN POSTMENOPAUSAL WOMEN: GOODNESS OF FIT OF LINEAR AND CURVILINEAR MODELS AND DERIVED PARAMETERS.**

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INTRODUCTION: Women face an accelerated loss of muscle mass and strength at an earlier age than men, notably with the onset of the menopause (1). The evaluation of isokinetic metrics has been considered the gold-standard method for testing muscle strength (2) and it is not commonly used in postmenopausal women. The main aims of this study were to evaluate the goodness of fit and estimated parameters of linear and non-linear models for fitting the torque-velocity (TV) relationship, and to compare the outcomes by utilizing either target or real maximum velocities as the independent variable.

METHODS: 16 physically active postmenopausal women completed a study funded by the Spanish Ministry of Science, Innovation and University (PID2021-124277OB). Elbow flexors (EF) muscle strength was evaluated in the dominant limb using an isokinetic dynamometer. Range of motion was 20º (elbow close to full extension) to 120º(elbow flexed). Test was completed at 30, 60, 120, 180, 240, 300 and 400°/s. Peak torque was identified where >90% of the maximum target velocity was attained. Linear, polynomic and Hill regression models (3) adjusted the TV data. Since the dynamometer recorded torque even when the target velocity has not been reached, we derived the TV relationship by considering both real (i.e., the velocity achieved; TVR) and target velocity (i.e., the velocity preset on the dynamometer; TVT). The TV parameters derived from each model, the coefficient of determination (R2) and mean square error (MSE) were calculated for TVR and TVT relationships.

RESULTS: Isokinetic dynamometer did not achieve the target velocities, for values higher than 180°/s. The dynamometer report presented a peak torque reached at a lower velocity than the target velocity. The goodness of fit of linear and non-linear models for fitting TVR and TVT was excellent (R2>0.940). Nonsimilar values were observed for goodness-of-fit and parameters derived from the linear and polynomial models, indicating that TVR and TVT may not be considered equal ($p<0.05$). From Hills model, goodness of fit was similar for TVR and TVT but the derived parameters were significantly different ($p<0.037$). Considering TVR data, the best adjustment was obtained using polynomial model (R2=0.975; MSE=1.31±0.93N2·m2) and the worst using Hills model. Moreover, the theoretical maximum torque (T0) and velocity (V0) obtained from Hills model were higher compared with the values obtained from linear and polynomial models. The polynomial model estimated the value of T0 and V0 lower than the other models ($p<0.001$).

CONCLUSION: The isokinetic evaluation can include errors due to assigning torque measurements to incorrect velocities. It is recommended that the raw data be reviewed after evaluation, as TVR and TVT cannot be used indistinctly. We recommend the polynomial model to fit the TV data for EF in postmenopausal women.

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**MUSCLE FIBER TYPOLOGY IS ASSOCIATED WITH PASSIVE MUSCLE STIFFNESS IN A LENGTHENED POSITION IN HUMANS**

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INTRODUCTION: Skeletal muscle is composed of several components with different elastic properties such as fast-twitch (FT) and slow-twitch muscle fibers and intramuscular fat. There is considerable individual variation in its composition (1). However, it remains unknown whether the individual variation in the composition affects the stiffness of the muscle as a whole. Identifying the source of variation is important for advancing the understanding of muscle stiffness from both an athletic and clinical perspective, as the muscle stiffness is relevant to physical performance (2) and injury susceptibility (3). Here, we examined whether muscle fiber typology and fat fraction are associated with passive muscle stiffness using non-invasive approaches, proton magnetic resonance spectroscopy (1H-MRS) (4) and Dixon magnetic resonance imaging, respectively.

METHODS: In 20 healthy young males, the shear modulus of the vastus lateralis (VL) was measured at rest using shear wave elastography at 50% of the right thigh length from 0° (full knee extension) to 110° of knee flexion angles (every 10°). At the same region as the shear modulus measurement, muscle carnosine concentration (an index of muscle fiber typology) and fat fraction (an index of intramuscular fat) were assessed using 1H-MRS and two-point Dixon imaging, respectively. The Pearsons correlation coefficient was used to examine the relation between VL shear modulus at slack angle (the joint angle beyond which the shear modulus firstly increased) and at 110° of knee flexion and the other measured variables.

RESULTS: The VL shear modulus at the slack and 110° of knee flexion was 3.6 ± 0.7 kPa and 9.7 ± 1.8 kPa, respectively. The carnosine concentration was 6.2 ± 1.7 mM, and the fat fraction was 7.6 ± 1.8%. The carnosine concentration was significantly and positively correlated with the shear modulus of VL at 110° of knee flexion ($p = 0.026$, $r = 0.50$), but not at the

slack angle. There were no significant correlations between fat fraction and VL shear modulus at slack angle or 110° of knee flexion.

CONCLUSION: This is the first study to show that individuals with a relatively higher carnosine concentration (higher estimated proportion of FT fibers [4]) exhibit a higher passive muscle stiffness in a lengthened position. Interestingly, these results contradict the observed characteristics of each fiber type in an animal study (5), possibly due to interactions with muscle structural factors other than intramuscular fat (e.g., the number of in-series sarcomeres and extracellular matrix mechanical properties) in humans. Our findings provide new insights into the determinants of passive muscle stiffness and would be fundamental information for understanding the adaptive plasticity of passive muscle stiffness.

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**THE EFFECTS OF INTER-SET STRETCHING ON BENCH-PRESS PERFORMANCE**

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INTRODUCTION: Static muscle stretching is typically performed before and/or after a training session. However, especially when performed prior to exercise, such approach may impact the subsequent performance. The effects of performing stretching between sets during resistance-training has been poorly investigated. Thus, this study aims to investigate the effects of inter-set stretching, applied to the agonist (AG) and antagonist (AN) muscles, on bench-press performance.

METHODS: Twenty-one healthy male participants (23.8±3.99 years, 173±6.79 cm, 75.6±11.8 Kg) were recruited. Before data collection, the bench press 1-RM was calculated through a standardized and validated protocol. Following the 1-RM, each participant underwent three conditions in a randomized order: pectoralis muscle stretching (AG), dorsal muscle stretching (AN) and a control condition (CC). Prior to starting the first session, anthropometric measures were taken. After a warm-up period, the main protocol consisted of performing five sets to failure of bench press at 70% of 1-RM with 90sec rest between sets. In the AG and AN sessions, participants performed 30 seconds of static stretching during the rest periods between sets. In the CC session, no stretching intervention was performed during the rest periods. Data were collected using the T-Force® device. The primary outcome was the total lifted volume across each AG, AN and CC session. The secondary outcomes were force (N), velocity (V) and power (W).

RESULTS: Our results showed no difference in the total lifted volume (p=0.395) between the three conditions. Similarly, no differences were found in N production (p=0.642), V (p=0.940) and W (p=0.921) between groups.

CONCLUSION: Based on our results, inter-set static stretching has no effects on bench-press performance. Acutely incorporating static stretching during inter-set rest periods may optimize training time efficiency without hampering performance.

**HEALTHY YOUNG ADULTS EXECUTE COMMONLY PRESCRIBED LEG STRENGTH-TRAINING EXERCISES WITH AN ASYMMETRICAL KNEE FLEXION-EXTENSION KINEMATICS PROFILE**

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INTRODUCTION: Resistance training is a key exercise modality for increasing muscle strength and size. While health policy governing agencies clearly define the dose parameters of resistance training, there is limited information on how individuals execute the recommended resistance training exercises. The purpose of the present study was to characterize knee joint kinematics of often-prescribed resistance training exercises and determine the day-to-day kinematic consistency of execution.

METHODS: Healthy young adults (n=8; 4 females; age: 27.1± SD 5.8 yrs; height: 172.6±7.6 cm; mass: 73.8±13.1 kg) participated in the study. Technogym leg press (LP) and knee extension (KE) machines were programmed to 40% eccentric (ECC) and 40% concentric (CON) overload of 60% 1RM baseload. The extension-flexion phases of LP and KE were paced at 60 bpm by a metronome. Volunteers performed the two exercises twice one week apart. We video-recorded knee joint angular displacement in the sagittal plane and computed knee joint range of motion (ROM) and average and maximum knee angular velocity during LP and KE.

RESULTS: In LP, average knee ROM did not differ between CON (64.8±8.4°) and ECC overload (64.5±6.6°, $p>0.05$). In KE, knee ROM also did not differ between CON (72.1±7.2°) vs. ECC overload (71.4±9.5°, $p>0.05$). In LP, mean angular flexion and extension velocity during CON overload was 37.2±6.4°/s vs. 28.4±5.0°/s. In LP, mean angular flexion and extension velocity during ECC overload was 34.1±4.7°/s vs. 30.8±3.7°/s. In KE, mean angular flexion and extension velocity during CON overload was 37.5±6.3°/s vs. 34.2±5.6°/s. In KE, mean angular flexion and extension velocity during ECC overload was 42.0±5.9°/s vs. 31.3±3.7°/s. In both exercises, the flexion vs. extension velocity was always faster (all $p<0.05$). Intra-

class correlation coefficients revealed low day-to-day consistency of knee ROM for LP (CON: 0.54; ECC: 0.60) and for KE (CON:0.46; ECC:0.39).

CONCLUSION: Even healthy young adults seemed to have difficulty in following metronome-paced LP and KE with an ECC and CON overload and performed these exercises with an asymmetric flexion-extension velocity profile inconsistently across two days of testing.

**USING MACHINE LEARNING MODEL FOR THE ELECTROMYOGRAPHY DATA CLASSIFICATION OF THE DOMINANT AND NON-DOMINANT LIMB**

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INTRODUCTION: Skeletal muscle plays a pivotal role in body movement. Surface electromyography (EMG) is a non-invasive technique for measuring muscle activity, but its interpretation remains complex. Recent developments in machine learning offer the potential to improve EMG classification with acceptable accuracy. The aim of this study was to develop and evaluate a machine learning-based model to classify the activity of dominant and non-dominant limb based on their EMG signals.

METHODS: A data series from 8 healthy participants (aged 28.5 ± 7.6 years) was used for the machine learning development process. Participants performed a knee extension maximum voluntary isometric contraction (MVIC) to measure the EMG activity of the vastus lateralis. Data were collected for the dominant and non-dominant vastus lateralis muscles. EMG signals were recorded at a sampling rate of 2000 Hz, amplified, filtered, and stored for analysis.

The machine learning pipeline involved signal preprocessing, feature extraction, clustering, and evaluation. Preprocessing included signal standardization, normalization, and segmentation to isolate meaningful EMG data. Frequency-domain features were extracted using the Fast Fourier Transform to capture spectral characteristics of muscle activity. Unsupervised Fuzzy C-Means clustering was applied to classify data into dominant and non-dominant limb groups based on EMG signal properties.

RESULTS: The classification model successfully grouped the data into two clusters using fuzzy c-means clustering. The results indicated a clear separation between the activity of the dominant and non-dominant limb based on muscle activation patterns. The fuzzy membership values indicated a strong separation between clusters, with an overall classification accuracy of 88%.

CONCLUSION: This study used an advanced machine learning framework to classify muscle activation patterns. The results showed acceptable accuracy, demonstrating the models potential to distinguish the activity of dominant and non-dominant limb. These results support the use of ML in evaluating muscle activity status and its applications in rehabilitation, musculoskeletal research, prosthetics, and muscle disorder diagnosis.

## Conventional Print Poster Presentations

### CP-MH10 Physical Activity / Inactivity

**ASSOCIATIONS BETWEEN PHYSICAL FITNESS AND WEIGHT STATUS IN PORTUGUESE CHILDREN: A MULTIVARIATE ANALYSIS**

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INTRODUCTION: Physical fitness (PF) is a significant factor in children's health and well-being [1]. Excess body weight is often linked to lower PF levels [2]. The extent to which this relationship persists after accounting for other relevant factors remains unclear. Hence, this cross-sectional study aimed to examine whether PF differs between normal-weight and overweight/obesity children in boys and girls after adjusting for age, fundamental movement skills (FMS), and moderate-to-vigorous physical activity (MVPA).

METHODS: A total of 1,031 children (52.9% girls) aged 6–10 years were randomly selected from schools in northern Portugal [3]. PF was assessed with five standardized tests: standing long jump, handgrip strength, shuttle run, 50-yard dash, and PACER. Body mass index was calculated, and children were classified as normal weight or with overweight/obesity using WHO cut-off points [4]. FMS was evaluated using five object control tasks [5]. MVPA was objectively assessed with accelerometry (Actigraph wGT3X-BT) over seven consecutive days. Multivariate analysis of covariance (MANCOVA) was used separately for girls and boys, with age, FMS, and MVPA as covariates.

RESULTS: After adjusting for age, FMS, and MVPA, weight status differentiates PF multivariate profiles within each sex (girls: Wilks' Lambda=0.749, $p<0.001$; boys: Wilks' Lambda=0.751, $p<0.001$). More specifically, girls with overweight/obesity performed worse than their normal-weight peers in all PF tests (standing long jump: $F=26.29$, $p<0.001$; shuttle run: $F=32.72$, $p<0.001$; agility: $F=27.16$, $p<0.001$; PACER: $F=43.18$, $p<0.001$), except for handgrip strength ($F=63.58$, $p<0.001$), where they had higher values. A similar profile was observed in boys, with those with overweight/obesity being less fit in

standing long jump (F=20.98, p<0.001), shuttle run (F=45.13, p<0.001), agility (F=19.17, p<0.001), and PACER (F=49.20, p<0.001), but stronger in handgrip strength compared to normal-weight peers (F=51.18, p<0.001).

CONCLUSION: This study reinforces that even after adjusting for age, MVPA, and FMS, boys and girls with overweight and obesity are less physically fit than their normal-weight peers, except in handgrip strength. Excess weight is critical in determining PF levels, independent of other contributing factors. Therefore, we recommend implementing interventions combining weight management strategies with targeted efforts to enhance PF as early as possible, ensuring a holistic approach to improving childrens health and well-being.

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This project was funded by the FCT – Foundation for Science and Technology Portugal (PTDC/SAU-DES/2286/2021).

**PHYSICAL ACTIVITY AND SELF-CARE AS PREDICTORS OF RESILIENCE IN HEALTHCARE PROFESSIONALS: A CROSS-SECTIONAL STUDY IN NORTHERN GREECE**

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INTRODUCTION: Healthcare professionals (HPs) experience significant occupational stress, increasing their risk of burnout and mental health issues. Resilience—the ability to adapt to adversity—is critical for well-being. Self-care and physical activity (PA) are linked to lower stress and improved emotional regulation, yet HPs often struggle to engage in PA due to workload demands (1-3). While research highlights the role of self-care and PA in reducing burnout, their direct influence on resilience remains underexplored. This study explores their impact on HPs resilience in Northern Greece.

METHODS: A cross-sectional study was conducted (Sept-Dec 2023) with 438 HPs (mean age: 44.6±9.5 years, work experience: 16.4±9.7 years) from three public hospitals in Northern Greece (response rate: 79.6%). The sample included 200 physicians and 238 nurses. Participants were recruited via hospital website invitations and completed anonymous self-administered questionnaires: (a) demographic and professional characteristics, (b) the Self-Care Scale (Cronbach's $\alpha > 0.90$), (c) the IPAQ-SF for PA (MET-min/week), and (d) the CD-RISC-10 for resilience (Cronbach's $\alpha = 0.895$). Data analysis used SPSS v.29.0, including descriptive statistics, the Kolmogorov-Smirnov test for normality, Spearman's correlation, and multivariate linear regression (significance level: $p < 0.05$).

RESULTS: Resilience was moderate (CD-RISC-10: 26.8±6.46), while self-care levels were high (134.51±21.83). PA was classified as moderate (1364.8±1408.6 MET-min/week), with 36.8% reporting low PA, 46.2% moderate, and 16.9% high PA. Male HPs exhibited higher resilience than females (p=0.01). Resilience correlated positively with self-care (r=0.555, p<0.001) and PA (r=0.282, p=0.002). Multivariate regression identified gender, self-care, and PA as resilience predictors (F=25.177, p<0.001, $R^2$=39.4%), with higher self-care and PA levels linked to greater resilience.

CONCLUSION: This study highlights the importance of self-care and PA in enhancing resilience among HPs. Higher self-care and PA levels were associated with greater resilience, reinforcing their protective effects against stress and burnout. The findings emphasise the need for structured PA programs and self-care initiatives to support HPs well-being. Future research should explore long-term interventions and policies promoting resilience in healthcare settings.

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**INFLUENCE OF 24-HOUR MOVEMENT BEHAVIOR ON ARTERIAL STRUCTURE, FUNCTION, AND HEMODYNAMICS IN ADULTS: THE ROLE OF PHYSICAL ACTIVITY, SEDENTARY BEHAVIOR, AND SLEEP**

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INTRODUCTION: Cardiovascular (CV) health is impacted by a range of lifestyle behaviors, including sedentary behavior (SB), sleep (SL), and physical activity (PA). Arterial structure, function, and hemodynamics are key indicators of CV risk. Parameters such as arterial stiffness, central and brachial blood pressure, and arterial diameters are associated with long-term CV outcomes. However, the extent to which PA, SB, and SL influence these vascular parameters remains unclear.

METHODS: In 233 healthy subjects (without physical limitations, known disease, or the use of medications with lipid-lowering, antihypertensive, or hypoglycemic effects), the following data were recorded: (1) weight, height, and body composition; (2) PA, SB, and SL assessed by accelerometry (recordings: 7 consecutive days, on wrist and waist; GT3X, ActiGraph, U.S.A.); and (3) at rest: (i) hemodynamic characteristics (aortic and brachial blood pressure [techniques: applanation tonometry and oscillometry]), (ii) structural characteristics (diameters and wall thickness of carotid, femoral, and brachial arteries [technique: ultrasound]), and (iii) functional characteristics (aortic, carotid, femoral, and brachial stiffness [techniques: pulse wave velocity; applanation tonometry and ultrasound]) of the CV system.

A stepwise analysis was conducted: (1) The association between PA, SB, and SL variables with levels of exposure to cardiovascular risk factors (CRF) was quantified, as well as the association between CV characteristics and levels of exposure to CRF. (2) CV variables were standardized to z-scores using the mean and standard deviation obtained from a reference subgroup that had no exposure to traditional CRF. (3) After quantifying the degree of association between z-scores of CV variables and CRF, multiple linear regression models were constructed using CV z-scores as the dependent variable and PA, SB, SL, and CRF as independent variables.

RESULTS: Arterial structural variables showed a stronger association with physical activity, particularly with vigorous physical activity and step count. Specifically, femoral diameter was positively related to average step count and energy expenditure. Additionally, significant relationships were observed with parameters related to sedentary break interruptions and sleep duration. Local arterial stiffness was more closely associated with sedentary behavior and sleep, showing that greater sleep efficiency and less sedentary time were linked to lower arterial stiffness. At the regional arterial stiffness level, carotid-femoral pulse wave velocity was associated with both PA and sleep efficiency. Specifically, more time spent in moderate-to-vigorous PA and higher activity counts were associated with lower arterial stiffness, whereas greater sleep fragmentation showed an inverse relationship. Hemodynamic variables, including brachial and central blood pressure, were primarily associated with moderate-to-vigorous physical activity.

CONCLUSION: Physical activity, especially higher-intensity activity, was associated with better arterial structural and functional characteristics. Sedentary behavior and sleep showed relationships with local and regional arterial stiffness. Blood pressure was mainly linked to moderate-to-vigorous physical activity and sleep parameters.

**HIGH-INTENSITY CIRCUIT TRAINING (HICT) FOR IMPROVING GENERAL AND JOB-SPECIFIC FITNESS IN STRUCTURAL FIREFIGHTERS.**

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INTRODUCTION: Structural firefighters (FF) perform strenuous work under hazardous and unpredictable conditions, where physical demands expose them to risks affecting their safety and health (Plat et al., 2011). Maintaining high physical fitness is essential to perform occupational tasks safely and efficiently (Smith et al., 2011). High-intensity circuit training (HICT) has been used to incorporate job-specific tasks such as lifting, pushing, pulling, and carrying, closely resembling FF duties (Gutiérrez-Arroyo et al., 2023). This study aimed to evaluate the effects of an HICT program on physical fitness and thermophysiological performance in a job-specific fitness test that includes key firefighting tasks.

METHODS: Seventeen professional Spanish FF participated in a 9-week HICT program (2 sessions per week). Sessions lasted 45–60 minutes and involved job-specific muscle actions at high intensity (>80% HRmax). Pre- and post-intervention assessments included body composition, physical fitness tests, and a simulated fire suppression test (FST) with five tasks (tool handling, tower ascent, mannequin drag, hose deployment and drag, and hose advancement), performed twice with a 25-minute rest interval. Performance, heart rate (HR), gastrointestinal temperature (Tgi), physiological strain index (PSI), rating of perceived exertion (RPE), and thermal sensation (TS) were measured.

RESULTS: After 9 weeks of HICT, significant improvements ($p<0.05$) were observed in multiple physical fitness parameters (range: 3.4–33.4%), as well as in total performance (11.2%) and heat tolerance (rate of increase in Tgi and PSI: -29.2% and -10.2%, respectively) during the FST. Additionally, the maximum Tgi decreased from 39.0 ± 0.4 °C pre-intervention to 38.4 ± 0.4 °C post-intervention.

CONCLUSION: HICT appears to be an effective training method to enhance both general and job-specific fitness in FF, improving thermophysiological response and potentially increasing safety during firefighting tasks. These findings highlight the importance of tailored physical conditioning programs for FF; however, further research is needed to confirm these results.

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**FIREFIGHTER FITNESS: LOOKING BEYOND OCCUPATIONAL STANDARDS**

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INTRODUCTION: Fitness assessments for firefighters in the UK are designed to ensure they meet the physical demands of their role. Gym-based tests for cardiorespiratory fitness and muscular strength are commonly used as they offer a practical and accessible way to assess fitness. This study evaluates the performance of a group of firefighters with varying

biological profiles on approved fitness tests, to examine whether these tests differentiate fitness levels beyond the necessary occupational requirement of passing the test.

METHODS: Firefighters (106 men and 30 women) from one of the UK's Fire and Rescue Services were assessed as part of their annual fitness testing. Cardiorespiratory fitness was assessed by the Chester Treadmill Test [1], muscular strength by an overhead barbell press (25 kg) and flexibility by the sit-and-reach test. All 136 firefighters included in the analysis successfully passed their Chester Treadmill and strength tests. Resting Blood Pressure (BP) and Heart Rate (HR) were followed by further measurements of HR and the rate of perceived exertion (RPE) during the Chester test. Several Independent-Samples T-tests were conducted to test for differences.

RESULTS: The sample's age was (38.81 ± 9.50 years), height (1.76 ± 0.08 m), mass (83.48 ± 15.13 kg), BPrest (143/88 ± 17/10 mmHg) and HRrest (73.71 ± 7.34 bpm). The group's HR and RPE at the end (12 min) of the Chester Test was 172.52 ± 16.47 bps and 14.18 ± 2.37 respectively. When the group was divided into sub-groups based on the median age, the younger sub-group (<38) showed lower BPrest ($p<0.001$) and RPE ($p<0.01$) at 2 and 4 min of the Chester test but higher HR at 2, 6, 8, 10, 12 min ($p<0.01$) than the older sub-group (≥38). When the split was based on BMI (cut-off: 25) the healthy-weight sub-group exhibited better flexibility ($p<0.05$), lower Systolic BPrest ($p<0.001$) and RPE at 12 min ($p<0.05$). Comparing 30 women and 30 men matched for age and BMI, revealed that the only difference beyond the lower Systolic BP ($p<0.001$) for women, was for RPE 12 min with men responding with 12.77 ± 2.06 compared to 14.30 ± 2.17 for women ($p<0.01$). When looking within the men (n = 106) and women groups separately, no differences were observed for women, whilst men with BMI less than 25 showed lower RPE 12 min ($p<0.01$), and those of younger age (<39) lower HR during the latter stages of the Chester test ($p<0.001$).

CONCLUSION: Despite variations in sex, age, BMI, blood pressure, heart rate, and RPE, all firefighters successfully met the required standards. Thus, regardless of individual physiological differences, the tests are generally achievable across the workforce. The uniform pass rate suggests that the tests may be suitable for ensuring a baseline level of fitness across this firefighter population, although it may not fully capture the range of fitness levels present within this diverse group.

**LONGITUDINAL CHANGES IN PHYSICAL ACTIVITY AMONG PARENTS OF YOUNG CHILDREN**

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INTRODUCTION: Physical activity is important for health, but it is low among parents in Japan, particularly those in their 20s to 50s. While cross-sectional studies have examined the relationship between childrens age and parents physical activity, longitudinal studies on this topic remain scarce. Therefore, the aim of this study is to investigate longitudinal changes in physical activity among parents of young children.

METHODS: This study was conducted in 2022 and 2023 among 1999 parents (age: 39.23±5.4 years; male: 546 [27.3%], female: 1451 [72.6%], other: 2 [0.1%]) with children aged 3-10 years in 2022, and analyzed changes in their physical activity over a one-year period. Physical activity was defined as engaging in at least 30 minutes of activities such as brisk walking or various sports on at least one day in the past seven days. The rate of initiation of new physical activity was assessed during the observation period. Statistical analyses were performed using McNemars test.

RESULTS: The age distribution was as follows: 20s: 51 (2.6%), 30s: 1014 (50.7%), 40s: 882 (44.1%), 50s/60s: 52 (2.6%). The implementation rate of parents who engaged in physical activity was 38.4% in 2022 and 44.7% in 2023. Significantly more participants started physical activity (287, 14.4%) than stopped (160, 8.0%) during the observation period ($p<0.001$, respectively). According to the age group, significantly more participants in their 30s and 40s started physical activity than stopped (30s: 146 [14.4%] started, 83 [8.2%] stopped; 40s: 125 [14.2%] started, 67 [7.6%] stopped; $p<0.001$). On the other hand, those in their 20s and 50s showed no significant change in their physical activity levels (20s: 8 [15.7%] started, 8 [15.7%] stopped, $p=1.000$; 50s: 8 [15.4%] started, 2 [3.8%] stopped, $p=0.109$).

CONCLUSION: Changes in physical activity varied by the age of parents with young children. Further research is required to identify other factors influencing parents' physical activity.

**CAN AEROBIC OR RESISTANCE-BASED EXERCISE SNACK IMPROVE PHYSICAL FITNESS IN YOUNG ADULTS?**

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INTRODUCTION: The previous study showed that a few adults met the physical activity guidelines due to lack of time (Garcia-Hermoso et al., 2023). Some time-efficacy exercises improved physical fitness and reduced the risk of cardiovascular disease (Islam et al., 2022). For instance, high-intensity interval training improved cardiorespiratory fitness (CRF) and muscle strength in young adults (Callahan et al., 2021). Short bouts of high-intensity exercise spread across the day, termed exercise snack (ES), has been shown to improve CRF and resting serum glucose concentration (Allison et al., 2017), but it is not clear the effects of ES on skeletal muscle mass and strength. Moreover, no study examines whether aerobic- (AES) or resistance-based ES (RES) is more effective in physical fitness. This study aimed to examine the effects of AES and RES on physical fitness.

METHODS: Eleven untrained young males were participated in this study and randomly assigned AES (n = 5, 22.2 ± 1.2 years old, Body mass index [BMI]; 24.7 ± 2.6 kg/m2) and RES (n = 6, 22.3 ± 1.8 years old, BMI; 21.9 ± 1.2 kg/m2). Participants performed to the training session (AES: step exercise with 20 cm stair, RES: squat) 2 times par day, 3 day a week, for a total of 54 sessions over 8 weeks. The exercise session consisted of vigorous-intensity exercise for a minute and rest on

chair, repeated three times. At the baseline, middle (4–5 weeks) and post intervention, body composition (i.e., body mass and skeletal muscle mass), peak oxygen uptake (VO2peak) and donated leg extension isometric maximum voluntary contraction (MVC) were measured.

RESULTS: Body composition did not significantly change in both interventions (p>0.05). Both interventions significantly increased VO2peak (AES: +6.0±0.9 ml/kg/min, p<0.001, RES: +4.8±2.8 ml/kg/min, p=0.002). Magnitudes of increases in MVC were higher in RES than in AES at the middle (AES; +10.7±7.4%, RES; +24.4±7.5%, p=0.014) and post intervention (AES: +12.3±6.5%, p=0.010, RES: +34.3±7.3%, p<0.001).

CONCLUSION: The present study demonstrated that AES and RES significantly improved VO2peak through the eight weeks intervention (11% and 10%, respectively), which is consistent with the previous study reported that a six-week ES with stair climbing improved CRF (12%) (Allison et al., 2017). Moreover, the present study revealed that RES was more efficiency to improve muscle strength than AES although AES and RES significantly improved muscle strength. The previous study suggested that high-intensity interval resistance training improved muscle strength (26%) (Moro et al., 2020), which is similar to the present results in RES. Therefore, RES in young adults may provide more health benefits than AES due to an increase in muscle strength. In conclusion, ES used in the present study, regardless of aerobic or resistance exercise, improved CRF and muscle strength in young adults. Additionally, RES improved muscle strength compared to AES.

**PHYSICAL ACTIVITY AND SEDENTARY LIFESTYLE AMONG FEMALE UNIVERSITY STUDENTS STUDYING SPORT SCIENCE AND PHYSICAL ACTIVITY AT TAIBAH UNIVERSITY, SAUDI ARABIA**

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*TAIBAH UNIVERSITY*

INTRODUCTION: In 2018, Saudi Arabia introduced the Sport Science and Physical Activity (SSPA) major for female students at several universities, including Taibah University in Madinah, western Saudi Arabia. A recent self-report study indicated that 52% of Saudi female university students spend more than 7 hours per day sitting (Alahamdi et al., 2024). However, physical activity and sedentary behaviors have not been objectively assessed among the SSPA female students using device-based tools such as pedometers. Therefore, this study aimed to objectively assess physical activity levels and sedentary behavior using pedometers among female SSPA students at Taibah University.

METHODS: A sample of 40 female university students from the College of Education at Taibah University participated in the study. Body weight (kg) was measured using a digital scale (Seca 813), and height (cm) was measured using a portable stadiometer (Seca 213). Participants wore pedometers for seven consecutive days, with their daily step counts recorded. The average daily steps taken by each participant were calculated for weekdays and weekends. The daily step average was calculated as follows: [(steps on weekdays × 5) + (steps on weekends × 2)] ÷ 7. A step count target of <5,000 steps/day indicated a sedentary lifestyle, 5,000–7,499 steps/day indicated less activity, and ≥7,500 steps/day indicated an active lifestyle (Tudor-Locke et al., 2012). Statistical analyses were conducted using SPSS (Version 22). Data are presented as mean ± standard deviation or frequency (percentage), and a paired t-test was used to compare daily step counts between weekdays and weekends.

RESULTS: The mean age, height, weight, and BMI of participants were 21.35 ± 1.63 years, 159.0 ± 4.26 cm, 51.25 ± 8.14 kg, and 20.36 ± 3.07 kg/m², respectively. The average daily steps were 8,737 ± 4,085 on weekdays and 7,688 ± 4,042 on weekends. There was no significant difference in step counts between weekdays and weekends (P = 0.16). The overall average daily step count was 8,437 ± 3,485 steps. Among the participants, 7.5% were sedentary, 32.5% were less active, and 60.0% were physically active. Additionally, only 22.5% of participants achieved ≥10,000 steps/day, meeting the physical activity guidelines.

CONCLUSION: The findings indicate that while a small proportion (7.5%) of SSPA female students exhibited a sedentary lifestyle, the majority (77.5%) did not meet the recommended physical activity guidelines of ≥10,000 steps per day.

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**PRELIMINARY STUDY ON THE EFFECTS OF SHORT-TERM CARDIAC REHABILITATION AND PHYSICAL ACTIVITY ON POSTURE AND RISK OF FALLING IN ELDERLY PATIENTS AFTER AN ACUTE CARDIOVASCULAR EVENT.**

CAMPOLI, F., VITARELLI, M., CAMINITI, G., GROSSI, A., FRANCHINI, A., VOLTERRANI, M., CAPRIOLI, L., EDRISS, S., BONAIUTO, V., ROMAGNOLI, C., ANNINO, G., PADUA, E., MESSINA, G.

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INTRODUCTION: Cardiac rehabilitation is recommended for patients with chronic heart disease and those recovering from acute cardiovascular events to restore functional capacity or maintain autonomy in daily activities, especially in elderly and frail individuals. Prolonged immobility from hospitalization increases risks of hypokinetic syndrome, orthostatic hypotension, mood swings, and vascular complications [1, 2]. This study evaluates the impact of cardiac rehabilitation and adapted physical activity on fall risk, balance, cervical mobility, and sleep quality in elderly patients post-acute cardiovascular event.

METHODS: 20 participants over 65 (6 women, 14 men; 72.7±5.4 years) were recruited from the cardiology department at IRCCS Pisana in Rome following a recent acute cardiac event. Initial assessments measured fall risk (Conley scale), the postural control (stabilometric test), cervical mobility (Moover® inertial sensor), and sleep quality (Pittsburgh Sleep Quality Index - PSQI) [3]. Participants underwent a 20-day intensive training protocol: day I: walking, days II-VII: calisthenics/balance exercises (30 min) and aerobics with pedals (30 min); day VIII-discharge: gym activity with aerobic exercise (50-60% maximum HR, 30 min) and group exercises. The final assessments were conducted before discharge.

RESULTS: Post-intervention, participants showed a low fall risk (0.5 ± 0.9 Conley Scale). the training protocol carried out in the gym allowed a maintenance of the stabilogram length with open eyes (pre 229 ± 63.1 mm, post 228,5 ±72.2 mm) and a reduction with closed eyes, demonstrating an improvement in postural control. Cervical mobility improved by an average of 2 degrees in all directions, with statistically significant improvement ($p<0.01$) in anterior flexion-extension. Sleep quality (PSQI) increased by 12% ($p=0.3$).

CONCLUSION: Intensive cardiac rehabilitation improved postural control and cervical mobility within 20 days in elderly patients post-acute cardiovascular event. Although sleep quality showed a 12% increase, it was not statistically significant, possibly due to the short duration of the study. The protocol supported functional capacity and autonomy, highlighting the value of a structured, personalized approach in post-cardiac event rehabilitation. Future research should examine the benefits of continuing the training protocol at home to determine if regular physical activity can sustain or enhance observed improvements.

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## Conventional Print Poster Presentations

### CP-MH20 Military Performance and Rehabilitation

**AVAILABILITY OF WATER AD LIBITUM DURING A 1 HOUR SIMULATED MILITARY MARCH IN THE HEAT DOES NOT ALTER THERMOREGULATION OR POSTURAL SWAY**

MARINO, F., COOKE, B., CHANG, M.

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INTRODUCTION: Adequate hydration and water availability are regarded as essential for maintaining both physical and cognitive performance, particularly in the heat. More recent studies suggest that ad libitum drinking is sufficient to maintain performance so that additional drinking may not be required to improve performance for a range of situations. Maintaining posture is a critical and complex ability with few studies showing that prolonged exercise without fluid ingestion negatively affects postural stability. However, it is not known whether fluid replacement overlaid by heat stress has a similar affect. This study investigated whether the availability of water ad libitum during exercise heat stress alters postural sway.

METHODS: Nine healthy volunteers (6 men, 3 women) completed a 60 min simulated military march in warm conditions (30 °C, 50% rh) dressed in military fatigues, helmet and carrying a pack (10% body mass). Participants completed two trials in randomised reverse order with either ad libitum fluid availability (HYD) or fluid restricted (NHYD). The march consisted of 3 x 20 min stages escalating each 10 min in speed and gradient (range 4 – 7 km/h; 1% -5.5% gradient) with each stage separated by ~ 5 min when measures of postural sway, lactate, and other measures of fatigue were completed. During the march, heart rate (HR), core and skin temperatures (Tc, Ts, respectively) were recorded continuously with perceptual measures of rating of perceived exertion (RPE) and thermal sensation (ThS) recorded each 5 min. Nude body mass pre and post march were recorded adjusted for consumed water to calculate sweat rate.

RESULTS: During the march Tc increased ($P < 0.05$) from 15 min in both conditions and was similar by the end (38.3 ± 0.6 NHYD vs 38.5 ± 0.5 °C HYD). Ts increased ($P < 0.05$) over time in both conditions and was 32.7 ± 1.0 °C for NHYD and 32. ± 1.1 °C for HYD ($P > 0.05$). HR increased during the march but was not different between conditions reaching 166 ± 9.9 bpm (HYD) and 156 ± 26.8 bpm (NHYD) by the end. The amount of water consumed during HYD was 495.1 ± 190.3 ml. The sweat rate was 1.65 ± 0.36 l/hr for HYD and higher than 1.23 ± 0.23 l/hr ($P <0.05$) for NHYD. Postural sway measured as the centre of pressure (COP) path at pre, 20, 40 min and post-exercise was not different between conditions ranging from 0.21 – 0.22m (NHYD) and 0.21 – 0.24m (HYD).

CONCLUSION: Heat strain during the simulated march with the addition of water availability did not result in thermoregulatory or cardiovascular differences between conditions. These findings are not dissimilar to studies showing that drinking to dictates of thirst is enough to maintain performance. However, postural sway as measured by COP was not different with and without the availability of water which suggests that this critical human motor control ability remains intact following a long march. The reasons for this are not clear but might include a different exercise modality.

**THE IMPACT OF PHYSICAL FITNESS AND READINESS ON ACUTE AND OVERUSE INJURIES IN SWISS CONSCRIPTS**

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INTRODUCTION: It is well known that basic military training (BMT) is physically and mentally demanding for the conscripts [1]. The current study aims to examine how conscripts in the Swiss Armed Forces physically prepare to BMT, what resources they utilize or what training methods are being used, if they feel "military ready" at the beginning of BMT and if a physical preparation for BMT results in less injuries during BMT.

METHODS: At the beginning of the BMT 532 male conscripts (20 ± 1 years, 178 ± 7 cm, 73.8 ± 11.1 kg) of communications intelligence, armored infantry, rescue technicians and fusilier infantry performed objective physical fitness tests (PFT) [1] and answered questionnaires to assess physical activity behavior and the use of supported training methods prior to the start of BMT. Additionally, musculoskeletal injuries suffered during the BMT was provided by medical records. Binomial logistic regressions were performed to predict the presence of an overuse or an acute injury based on points reached in the PFT, subjective readiness, MET-minutes of moderate physical activity before BMT ('MET moderate'), and MET-minutes of vigorous physical activity before BMT ('MET vigorous').

RESULTS: A 19% of the Swiss conscripts changed their physical activity training behavior due to the upcoming BMT and 10% of conscripts utilized a smartphone application as a training aid. A total of 194 (36.5%) conscripts were injured, 70 acute and 143 overuse injuries during BMT were reported. The Spearmans rank correlation between PFT and subjective readiness was r = 0.37, between subjective readiness and 'MET moderate' r = 0.19, and between subjective readiness and 'MET vigorous' r = 0.41. The binomial logistic model revealed the PFT as a significant predictor for overuse injury (β = -0.023, SE = 0.011, z = -2.213, p = 0.027, OR = 0.977). However, subjective readiness (p = 0.89), 'MET moderate' (p = 0.37), and 'MET vigorous' (p = 0.91) were not significant predictors. None of the investigated variables were significantly associated with acute injuries (all $p > 0.05$).

CONCLUSION: The PFT was found to be a significant predictor for overuse injuries in Swiss conscripts during BMT. This highlights the importance of adequate physical preparation in reducing the risk of overuse injury during BMT. The moderate correlation between the volume of vigorous physical activity and subjective readiness suggests that Swiss conscripts who engaged more in vigorous physical activity before BMT felt more ready for the military service. However, this feeling of readiness did not translate into a reduced injury risk. Only 10% of conscripts used a training application. This may indicate an unused potential of technology in supporting physical activity for BMT preparation. Military organizations could benefit from offering digital tools or training platforms to enhance conscripts' physical readiness even before the start of BMT.

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[2] doi.org/10.1519/JSC.0000000000001106

**TACTICAL ATHLETE – HOW UNIFORM INFLUENCE THERMOREGULATION**

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INTRODUCTION: Tactical athletes, including military personnel, firefighters, and police officers, face extreme conditions that impact their performance and thermoregulation. Uniform design and materials play a crucial role in heat management, influencing comfort, safety, and efficiency. Therefore, the aim of this study was to analyze the effect of uniform on skin temperature using infrared thermography.

METHODS: The research was conducted with a non-probabilistic sample of 10 male soldiers, age of 27.70±2.71 yrs. in a controlled environment, with air temperature and relative humidity monitored using an Instrutherm® HT-270 thermohygrometer. Infrared thermography with a Flir® E76 thermal camera was used to compare skin temperatures in two conditions: with and without the Brazilian Armys new camouflage uniform. Soldiers underwent acclimatization and body temperature monitoring before measurements. Data were described using descriptive and inferential statistics. A significance level of $p \leq 0.05$ was considered.

RESULTS: Soldiers with Armys new camouflage uniform presented statistically significant increases in skin temperature in the right trapezius (0.87%, p=0.028) and left trapezius (1.27%, p=0.007), right chest (2.16%, p<0.001) and left chest (2.83%, p<0.001), right biceps (2.35%, p=0.002) and left biceps (3.21%, p<0.001), right costal region (2.00%, p<0.001) and left costal region (1.51%, p<0.001), as well as the left knee (6.58%, p<0.001). On the other hand, regions such as the right neck (0.03%, p=0.906) and left neck (0.24%, p=0.466) showed no significant differences.

CONCLUSION: This study highlights the impact of military uniforms on skin temperature, particularly in high-metabolic muscle and joint regions. Increased heat retention was observed, emphasizing the need for uniform designs that enhance ventilation and thermal regulation. Optimizing these factors can improve comfort, performance, and operational efficiency for tactical athletes.

Keywords: thermoregulation, tactical athletes, uniform.

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**PREDICTING ENERGY REQUIREMENTS FOR SOLDIERS IN EXTREME COLD: A SIMPLE AND PRACTICAL APPROACH TO PREVENT BODY MASS LOSS**

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INTRODUCTION: Soldiers during military expeditions and athletes during competitions usually fail to compensate for the increase in energy expenditure, with potential deleterious consequences (body mass loss (BML), decrease in cognitive and physical performance…). Moreover, environmental constraints, particularly extreme cold, exacerbate this phenomenon. To better understand mechanisms involved, various studies were carried out during military expeditions in the extreme cold of Greenland between 2019 and 2024 on French soldiers (n = 46). The aim of these studies was to understand the effects of this environment on the components of energy intake (EI) and to identify an effective strategy for combating the effects of a negative energy balance.

Using the data gathered during these previous studies (Resting metabolic rate (RMR), EI, BML), the objective was to develop and verify the accuracy of an equation predicting individual energy requirement during this kind of expedition in order to conceive customized rations for each participant and theoretically avoid major BML.

METHODS: Total EE is dependent on two factors which are the RMR and the physical activity related EE (PAEE). The RMR was calculated using the FAO/WHO/UNU equation. The overall EE was determined observing the BML (of previous studies) in regards on EI during the expeditions, using the equation: EE=EI+(BML*6,18). To convert BML (g) into Kcal we used the coefficient 6,18 (Charlot, 2021) where the BML is explain by 40% of lean body mass (LBM) (1g represent 1,19Kcal) and 60% fat mass (1g represent 9,5 Kcal). Therefore, in mean, 1g of BML represent 6,18 Kcal.

RESULTS: In the previous studies and this one, the EI was meticulously measured, energy density and weight of each meal were assumed. To individualize the amount of EE of each participants we use an equation linking the RMR with the EE : Coef=EE/RMR . Using the previous study, the coefficient mean was 2,36 (± 14%). With this coefficient, we would anticipate the EI required to keep a neutral energy balance during an extreme cold expedition using the following equation EI=RMR*Coef. Following this method, the only measurement needed to anticipate the EI is the RMR.

CONCLUSION: In the context of an extreme cold expedition, this realistic and simple method would help nutritionists to quantify the energy requirements needed to avoid BML. Future expedition will serve to test and confirm the accuracy of this approach.

**PRE-COMPETITION RMSSD PREDICTS ARCHERY SHOOTING PERFORMANCE**

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INTRODUCTION: Research demonstrates that heart rate (HR) and heart rate variability (HRV) can reflect an athlete's adaptation to competitive stress (1,2). Archery is a unique sport that requires fine perceptual and motor control, which can be impaired by excessive sympathetic activation. While most studies analyzed single-session electrocardiography (ECG) data in resting states before competition, little is known about the relationship between performance and HR as well as HRV during competition. Therefore, this study aimed to examine these relationships.

METHODS: We recruited 8 skilled collegiate recurve archers (4 females; 18.6-21.2 years; 5.5-11.2 years of experience; weekly training 15-25 hours; personal best: 625-662) to participate in a simulated competition consisting of 10 sessions in 10 separate days. Each session included 2 runs, with each run involving the shooting of 6 ends of 6 arrows at a 122-cm target face from 70m, resulting in 720 arrows per archer. ECG recordings were obtained in a sitting posture with eyes open for 3 min before each session as resting-state data, as well as during each run (13-15 min) to capture in-competition physiological responses. This resulted in 10 resting-state and 20 in-competition ECG datasets per archer. The ECG signals were converted into R-R intervals time series to calculate heart rate (HR) and different HRV measures reflecting cardio vagal activity. The analyzed HRV indices included root mean square roots of successive differences (RMSSD), absolute power of high frequency (HF, 0.15–0.4 Hz) components, and standard-deviation of the Poincare plot Crosswise (SD1) as time-, frequency-, and non-linear measures, respectively. To examine which index at which measurement condition could best predict the shooting scores, we employed 8 (2 measurement conditions x 4 indices) separate generalized estimation equation (GEE) models to analyze the data. Alpha was set at .0125 for multiple-comparison correction.

RESULTS: All GEE models had good model fit, with QIC values ranging from 27.644 to 57.934. Among all models, only RMSSD at the resting state could significantly negatively predict the score (beta=-.002, p<.001). In contrast, none of the other indices, whether measured at resting state or during competition, show a significant relationship with performance.

CONCLUSION: These findings demonstrated that even a single 3-min pre-competition ECG recording could effectively predict performance outcomes, while in-competition recording may be less reliable, possibly due to movement artifacts. Interestingly, lower HRV, linked to lower vagal regulation due to higher stress, appeared to enhance shooting performance, highlighting a potential adaptive role of stress in precision sports such as archery.

**INDIVIDUALISED AND MOTIVATIONAL PRESCRIPTION OF VIRTUAL EXERCISE (IMPROVE) FOR PATIENTS AWAITING JOINT ARTHROPLASTY: AN EVIDENCE-BASED PREHABILITATION SERVICE**

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INTRODUCTION: The annual cost for surgical procedures in the UK is approximately £10.9 billion and a significant amount concerns orthopaedic procedures such as hip and knee arthroplasties [1]. Prehabilitation is the systematic process of improving patients physical, emotional, and nutritional status between diagnosis and surgery [2]. Home based prehabilitation seem to improve pain symptoms and function before hip and knee arthroplasty [3]. The aim of this project was to develop and remotely deliver a multimodal intervention to patients waiting for a hip or knee arthroplasty and assess key outcomes such as functional, health status, sedentary behaviour as well as safety and feasibility.

METHODS: In this opt-in service, eligible patients were identified through hospital waiting lists and were sent a leaflet. The intervention was delivered online by two Clinical Exercise Physiologists (CEPs) through MS Teams. The intervention consisted of one-to-one instructed exercise sessions, physical activity prescription, dietary advice, behavioral and emotional support for a period of 24 weeks. Each patient could receive up to 20 sessions. Outcome measures included: Western Ontario and McMaster Universities (WOMAC) index, 30 seconds sit-to-stand (StS) repetitions, time during a single leg stance, International Physical activity Questionnaire (IPAQ), Self-Efficacy for managing chronic disease scale (SEMCD), Self-Reported health status and Quality of Life (EQ5D5L). In addition, patient satisfaction was measured through a customized survey. Paired samples t-tests were used with significance level $p<0.05$ on SPSSv26 for the analysis.

RESULTS: In total, 750 leaflets were posted and there were 154 responses which results to a 20% response rate. Due to exclusions and drop-outs, 96 patients were finally recruited. The overall WOMAC score reduced significantly after the intervention (-8%, $p<.05$). The StS performance improved by 43% ($p<.05$), time on single leg stance improved by 70% ($p<.05$), and the overall sedentary time decreased significantly (-21%, $p<.05$). Similarly, there was a statistically significant improvement in the patients' self-efficacy (+9%, $p<.05$) and a significant improvement of the self-reported health status (EQ5D5L, +7.5%, $p<.05$). The overall patient satisfaction and feedback was overwhelmingly positive and no accidents or adverse events were recorded.

CONCLUSION: The results show that it is safe and feasible to remotely deliver individualized exercise interventions to orthopaedic patients. The intervention was delivered as intended according to current evidence and international guidelines. Functional outcomes, self-reported health status as well as self-efficacy were significantly improved, and sedentary behavior significantly reduced after the intervention. These results can inform the design and implementation of future services and implementation research.

1 Abbott et al. 2017, BJA, 119(2) 249–257

2 Bolshinsky et al. 2018 DC&R 61(1)124-138

3 De Klerk et al. 2023 Bone Jt Open, 4(5):315-328

## Conventional Print Poster Presentations

### CP-MH21 Physical Activity Promotion III

**EFFECTS OF BREAKING UP SITTING TIME WITH ISOMETRIC WALL SQUAT EXERCISE ON VASCULAR FUNCTION, BLOOD PRESSURE, AND CARDIAC AUTONOMIC MODULATION IN SEDENTARY ADULTS: A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Prolonged uninterrupted sitting has been associated with impaired vascular function, increased blood pressure, and cardiac autonomic dysfunction, highlighting the need to break up sitting time throughout the day, especially during work. Isometric wall squat exercise (IWSE) has proven effective in improving cardiovascular parameters in both normotensive and hypertensive individuals. However, whether this exercise is effective as a strategy to break up sitting time remains unknown. Thus, the aim of this study was to analyze the effects of breaking up sitting time with IWSE on vascular function, blood pressure, and cardiac autonomic modulation in sedentary adults.

METHODS: This randomized controlled trial (#RBR-10k2wxrg) included 40 participants without known cardiovascular diseases (35±11 y.o. and 61% women) with high sedentary behavior (≥ 6 hours/day). Participants were randomly assigned to the IWSE group (2-minute breaks during occupational activities, incorporating IWSE while maintaining their knees at the angle determined by the incremental test every 60 minutes of sitting) or to the SHAM group (standing for 2 minutes every

60 minutes of sitting during occupational activities). Popliteal artery vascular function, ambulatory and clinic blood pressure, and cardiac autonomic modulation (assessed by heart rate variability) were evaluated at baseline and after 12 weeks. To compare the effects of the interventions (IWSE or SHAM) on cardiovascular parameters, Generalized Estimating Equations were used, followed by a post hoc pairwise comparison. An intention-to-treat analysis was conducted to estimate overall effects, including all randomized patients regardless of dropouts. The predicted mean matching method was used for this purpose. The significance level was set at $P < 0.05$ for all analysis.

RESULTS: Per-protocol analysis showed that breaking up sitting time with IWSE increased the maximum diameter of the popliteal artery (IWSE: 5.2±0.2 vs. 5.7±0.3 mm; SHAM: 5.6±0.2 vs. 5.3±0.2 mm, P=0.011), while the intention-to-treat analysis indicated that the SHAM group reduced the baseline diameter of the popliteal artery (IWSE: 4.9±0.2 vs. 5.3±023 mm; SHAM: 5.3±0.2 vs. 5.1±0.2, P= 0.008). No effects of the interventions were observed on other vascular indicators, ambulatory and clinical blood pressure, or cardiac autonomic modulation (P>0.05 for all).

CONCLUSION: Breaking up sitting time with IWSE during occupational activities did not improve blood pressure, cardiac autonomic modulation, or vascular function but altered vascular structure by increasing the arterial diameter of the popliteal artery in sedentary adults.

This study was supported by CNPQ (#408860/2023-5) and FACEPE (#APQ-1142-4.09/21)

**DOES PROSTHETIC WALKING PRACTICE COMBINED WITH VIRTUAL REALITY ACUTELY IMPROVE BALANCE ABILITY? A PRELIMINARY STUDY USING A SIMULATED PROSTHESIS**

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INTRODUCTION: Lower-limb amputees need prosthesis walking to maintain their physical activity level and improve quality of life [1]. However, acquiring a prosthetic walking is difficult, potentially leading to reduced physical activity. Recently, the combination of virtual reality (VR) with prosthetic walking practice has been attracting attention as a tool to enhance its efficiency [2]. Despite this interest, few studies have investigated the effects of VR on static and dynamic balance abilities, which are important for prosthetic walking. This study aimed to confirm the acute effects of prosthetic walking practice combined with VR on balance ability in healthy adults wearing a simulated prosthesis as a preliminary study.

METHODS: The participants were 14 healthy adults with no experience wearing a simulated prosthesis. The simulated prosthesis was a trans-femoral prosthesis with a 3R60 knee joint (OttoBock, Ltd, Japan). Participants were randomly divided into two groups: VR group, which practiced prosthetic walking with VR video showed a first-person perspective walking motion, and control group, which practiced without VR video. The prosthetic walking practice consisted of a 5-minute in-situ foot stamping in the parallel bars [3]. Dynamic balance ability was assessed using the Timed up and Go test (TUG test). Static standing balance was measured using the Zebris PDM-S system (Zebris Medical GmbH, Germany) for 30 seconds in the closed-eye, closed-leg standing posture. The measured parameters were center of pressure (COP) sway area, COP path length, and average COP sway speed. The improvement rate in balance ability before and after practice was calculated. Statistical analysis was performed using a t-test between groups for each improvement rate. The significance level was set at 5%.

RESULTS: The improvement rates of the VR group (TUG test: 17.8 ± 4.8%, COP sway area: 32.2 ± 15.9%, COP path length: 23.8 ± 8.8%, COP sway speed: 23.6 ± 9.0%) were significantly higher than those in the control group (12.1 ± 2.6%, 1.9 ± 27.4%, 6.2 ± 15.4%, 6.2 ± 15.3%) ($p<0.05$, respectively).

CONCLUSION: Performing in-situ foot stamping movements with VR video of walking motion gives the sensation as if the person is walking forward. This characteristic of VR effectively increased the load on the prosthetic side, and balance ability was significantly improved compared to the control group. The results of this study suggest that VR can be used in the rehabilitation of lower limb amputees, with the advantage of being safer and more flexible in terms of location. Further studies with lower-limb amputees and biomechanical studies focusing on walking should be conducted in the future to clarify the effects of VR in combination with prosthetic walking practice.

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**THE EFFECTS OF EXERCISE AT DIFFERENT TIMES OF DAY ON PHYSICAL ACTIVITY BEHAVIOUR IN INACTIVE ADULTS**

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INTRODUCTION: Prescribed moderate-intensity aerobic exercise on health issues has been extensively investigated but additional exercise interventions may lead to behavioural compensation (e.g., reducing physical activity at other times). However, it is still unclear whether the timing of exercise can affect physical activity behaviours. This study was to examine the effect of exercise at different times of day on physical activity behaviours over a 72-hour period across exercise and non-exercise days.

METHODS: 22 (20 females) young healthy physically inactive adults (age: 24 ± 5 yr; BMI: 21.8 ± 2.2 kg/m2) were recruited in a randomized crossover study with either 45-min brisk walking in the morning (8:00 ~ 11:00, Mwalk) or in the evening

(18:00 ~ 21:00, Ewalk). Heart rate (HR) and rating of perceived exertion (RPE) were measured during exercise. Physical activity levels (i.e., step counts), physical activity intensity, and sedentary behaviours were recorded via a pedometer and an accelerometer over a 72 hours period (the exercise day for 24 hours, EX day; non-exercise day, 24 hours before and after EX day). The habitual physical activity levels were recorded over a period of 7 consecutive days.

RESULTS: There were no differences in HR (120 ± 25 vs. 119 ± 23 bpm, $p = 0.603$) and RPE (11 ± 2 vs. 11 ± 2, $p = 0.538$) during exercise between Mwalk and Ewalk. Compared to habitual physical activity (5406 ± 1306 steps), both Mwalk (12797 ± 3226 steps) and Ewalk (13580 ± 3903 steps) increased physical activity levels on the EX day ($p < 0.0001$) and there was no difference between 2 trials ($p = 0.437$). Nonetheless, we did not observe any of behavioural compensation in physical activity levels, physical activity intensity, and sedentary behaviours, as no significant differences were found between Mwalk and Ewalk, regardless of whether it was an exercise day or a non-exercise day (all, $p > 0.05$).

CONCLUSION: A 45-min of brisk walk prescribed either in the morning or evening can enhance physical activity levels in physically inactive adults. The timing of brisk walking does not appear to induce behavioural compensation (i.e., reduction of physical activity and/or changes in the pattern of physical activity intensity) across exercise and non-exercise days.

**ASSOCIATION BETWEEN PARENTS AND PRESCHOOLERS ACCELEROMETER-MEASURED PHYSICAL ACTIVITY**

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INTRODUCTION: The World Health Organization guidelines on physical activity for children under five recommend at least 180 minutes of daily total physical activity for children aged 3-4 years. Parents play a crucial role in promoting children's physical activity. Higher levels of parental moderate-to-vigorous physical activity (MVPA) are associated with greater child MVPA However, few studies have directly measured physical activity, and even fewer have focused on preschoolers. The aim of this study is to investigate the association between parents' and preschoolers' accelerometer-measured physical activity in Japan.

METHODS: The sample comprised data from 32 preschoolers and their parents (28 mothers and 27 fathers) from Japan. Preschoolers wore the thigh-worn activPAL accelerometer and parents wore the waist-worn ActiGraph GT3X accelerometer for 6 consecutive days including two-day weekend. They must meet a minimum wear time criterion of at least 480 minutes per day for a minimum of three days ensuring that at least one of these days on a weekend. In preschoolers, the mean daily step count was calculated and categorized as meeting the total physical activity guideline according to achievement of ≥ 11,500 steps per day. In parents, the MVPA was estimated by acceleration counts ≥ 2,020 counts/min and categorized as meeting the physical activity guideline of 150 min of MVPA per week.

RESULTS: The mean daily step counts for preschoolers was 11,909 ± 2,183 steps. Approximately half of the sample met the TPA guideline (48.5%, 95%CI, 30.3-66.7). The weekly spent time in MVPA for mothers was 110.4 ± 54.4 min and for fathers was 228.1 ± 175.8 min. The daily step counts for preschoolers was significantly correlated with the weekly spent time in MVPA for fathers ($r = 0.414$, $p = 0.032$), but not with that of mothers ($r = 0.318$, $p = 0.099$). Paternal adherence of physical activity guideline was positively associated with children meeting the total physical activity recommendation (OR = 7.222, 95%CI, 1.440-36.224).

CONCLUSION: The higher level of paternal MVPA was correlated with greater total PA in children. In addition, meeting the physical activity guidelines in fathers was associated with meeting the total physical activity guideline in preschoolers. The findings suggest that paternal physical activity plays an important role in supporting preschoolers in meeting the total physical activity guideline.

**THE NEW WAY TO TRAIN: SOCIAL ANXIETY RELATED TO EXERCISE, ONLINE FITNESS PROGRAMS, AND THE MOTIVATORS AND BARRIERS TO EXERCISE IN COLLEGE STUDENTS**

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INTRODUCTION: Exercise's positive impacts on anxiety are well established (e.g., DeWolfe et al., 2023). However, in an interesting contrast, those with higher anxiety exercise less than the general population (Lantz et al.,1997), suggesting that anxiety may act as a barrier to exercising. This barrier might be particularly relevant in the context of gym-based exercise, where social and environmental factors could exacerbate anxiety. The purpose of this study was, therefore to evaluate whether college students who do not exercise at a gym have higher anxiety and exercise-specific anxiety than those who do.

METHODS: The present study included 333 students from a private liberal arts institution (263 females; 66 males; 1 nonbinary/third gender). On average, participants were 19.5 years old (SD=1.55; Range=18-34). Participants completed a survey that measured their exercise habits and exercise-based and general anxiety. Exercise anxiety was measured using the Social Exercise and Anxiety Measure (SEAM; Barbara, 2006), which yields three subscales: Self-Efficacy (SES), one's belief in their ability to complete exercises, Gym Avoidance (GA), hesitancy to attend a gym, and Exercise Importance (EI), personal significance of physical activity. They also completed the Generalized Anxiety Disorder 7 (GAD; Spitzer et al., 2006) to measure overall anxiety.

RESULTS: Participants were categorized into two groups: "exercisers" consisted of those who reported exercising at the gym within the past week (n=212) and "non-exercisers" those who had not exercised at the gym in the past week (n=121).

Non-exercisers exhibited less confidence in their ability to perform exercise-related tasks (M=64.15, SD=19.20) than exercisers (M=78.92, SD=19.76; t(325)=4.78, p<.001). In addition, non-exercisers considered exercise less important to their day-to-day lives (M=4.64, SD=1.98) compared to exercisers (M=5.84, SD=1.84; t(330)=3.37, p<.001). Finally, non-exercisers were more likely to avoid attending the gym (M=4.01, SD=1.06) relative to exercisers (M=2.55, SD=1.07; t(329)=8.64, p<.001). Further, those with higher rates of general anxiety were more likely to report reduced confidence in exercising and a reluctance to attend a gym (ps <.001). Interestingly, anxiety did not predict exercise importance.

CONCLUSION: Overall, the results indicate an underlying difference between those who exercise at a gym and those who do not. Namely, individuals who were reluctant to attend a gym had higher rates of anxiety overall. Furthermore, lower social efficacy scores of the non-exercisers may reflect a reluctance to go to the gym. Additionally, the lower exercise importance scores of non-exercisers may suggest a lack of perceived value in exercise. Not surprisingly, non-exercisers were more likely to express gym avoidance, which would be expected in individuals who do not see the value in going to the gym and lack confidence in their ability to exercise in a public venue. Overall, the role of anxiety in exercise is nuanced.

**ACCELEROMETER-DETERMINED ADHERENCE TO THE 2020 WHO GUIDELINES ON PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR BY FIRST-YEAR STUDENTS AT A SMALL RESIDENTIAL COLLEGE.**

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INTRODUCTION: Studies examining physical activity (PA) in college and university students often report mixed results when compared to various national and international guidelines. In some cases, less than half of the participants meet recommendations for PA (1-3), while others have found that nearly all students meet PA guidelines (4,5). Some of these mixed results may be due to studies utilizing self-report instruments when examining PA (1) or comparing results to guidelines requiring PA to be completed in at least 10-min bouts (2,3). The 2020 WHO Guidelines On Physical Activity And Sedentary Behaviour (6) suggest that adults accumulate at least 150 min/week of moderate-intensity PA (MPA) or 75 min/week of vigorous-intensity PA (VPA), or an equivalent combination of moderate and vigorous-intensity PA (MVPA), with no requirement that PA be in at least 10-min bouts. Our aims were to use hip-worn accelerometers to assess min/week of MVPA of first-year students at a small residential college, determine the percentage of students meeting the WHO recommendation for MVPA, and to determine differences, if any, in PA between female and male students.

METHODS: A total of 2,477 first-year college students were invited to participate in the study in 2018, 2019, 2021, 2023, and 2024. Nearly 400 students were excluded due to participation on a National Collegiate Athletic Association (NCAA) sponsored team. PA was assessed in 131 student volunteers by waist-worn accelerometry for all waking hours over seven consecutive days. Validated wear time of at least 600 min/day for four weekdays and one weekend day of the 7-day wear period was required for inclusion in data analysis. Intensity and duration of PA was determined, and minutes of MVPA calculated for those who met the wear time criteria.

RESULTS: Data for 109 students (71 females, 38 males) who met the wear time criteria resulted in a mean + standard deviation of 522 ± 181 min of MVPA over the 7-days. All participants accumulated at least 150 min of MVPA for the week, with a range of 179 to 1,135 min/week. Independent t-tests showed no significant difference between females and males for minutes/week of MVPA (p = 0.112; 502 ± 163 and 560 ± 205 min/week, respectively) or MPA (p = 0.292; 465 ± 138 and 497 ± 173 min/week, respectively). However, there was a significant difference in min/week of VPA between females and males (p = 0.009; 37 ± 40 and 63 ± 59 min/week, respectively).

CONCLUSION: The first-year college students examined here demonstrated 100% compliance with the 2020 WHO Guidelines On Physical Activity And Sedentary Behaviour. There was no significant difference in MVPA or MPA between females and males, however, males participated in significantly more min/week of VPA than females.

**CLINICAL EXERCISE PHYSIOLOGISTS: AN UPDATE ON THE CURRENT SITUATION IN AUSTRIA**

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INTRODUCTION: It is becoming increasingly aware that regular exercise is vital for preventing and managing long-term health conditions (1). For this reason, exercise therapy—recognized as a highly cost-efficient intervention—has been progressively implemented in guidelines (e.g. 2) and may be as effective as established pharmacological therapies for a wide range of non-communicable diseases (3, 4).

A growing body of research calls for a personalized approach (5) and the necessity of individualized exercise prescriptions, while also highlighting the inadequacy of a one-size-fits-all approach (6). Therefore, an increasing number of countries have been incorporating clinical exercise physiologists (CEPs), who are university graduates specialized in sports and exercise science as well as health and therapy issues, into their healthcare systems (7).

METHODS: CEPs are experts in the tailored exercise prescriptions for both healthy and diseased individuals. They work with individuals experiencing chronic and complex medical conditions, injuries, and disabilities, assisting in restoring optimal physical function or health. CEPs work across a range of health settings including health and rehabilitation centres or public and private hospitals.

Recently, Carrard et al. (8) and Zhou et al. (7) compared the Australian with Swiss and Chinese healthcare systems, which has shed light on the varying international roles of CEPs. However, more countries (e.g. the UK, New Zealand, Canada, and Hong Kong) are integrating CEPs into their healthcare systems.

RESULTS: In Austria, exercise scientists were legalized as CEPs by the Austrian government in 2012, when they were formally accredited as health professionals under the designation of Training Therapists (TTs), which is recognized as an allied healthcare profession. However, TTs were initially only allowed to work as salaried employees. By January 1st, 2025, the restriction to work only in a salaried but not in a self-employed position has now been amended by legislation. Currently, TTs may offer Training Therapy in an outpatient setting; only medical referral from a qualified physician is mandatory. They must comply with the same requirements as other healthcare professions (e.g., mandatory documentation, first aid measures).

CONCLUSION: Although self-employed work is now permitted, health insurance companies have yet to introduce—unlike other healthcare professions—reimbursement for these services. Consequently, this means that this necessary type of therapy remains inaccessible to some segments of the Austrian population who cannot afford it.

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**CHANGES IN CARDIOMETABOLIC RISK FACTORS IN MIDDLE AGED ADULTS FOLLOWING A 12-WEEK COMMUNITY-BASED LIFESTYLE INTERVENTION.**

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INTRODUCTION: Increased prevalence of obesity and physical inactivity within individuals has been linked to increased risk of developing cardiometabolic diseases (CMD), such as cardiovascular disease (CVD) and type 2 diabetes (T2DM) [1]. Alternative modified sports, such as walking rugby, have been suggested to engage at risk individuals in regular physical activity [2]. Community-based lifestyle programmes have been successfully used to reduce CMD through education and behaviour change [3]. Therefore, the aim of this study was to determine whether a 12-week community-based programme, using walking rugby, could impact CMD risk in middle-aged adults

METHODS: N=16 individuals (14M, 2F) (age = 54.1±9.0yrs, BMI = 31.5 (5.8) kg/m2) were recruited to one walking rugby club in South Wales and completed a 12-week community-based lifestyle intervention. The intervention comprised weekly sessions (attendance = 60.4%) which included 45-minute health education and 45-minute walking rugby training, and a pedometer-based programme (increasing average daily step count by 10%). Anthropometry, blood pressure, bioelectrical impedance analysis, fasted lipid and glucose profiles, incremental shuttle walk test (ISWT) and International Physical Activity Questionnaire (IPAQ) were assessed at baseline and 12-week follow-up. 10-year CVD and T2DM risk was assessed using QRISK3 and QDiabetes algorithms. Data was analysed using repeated measures MANOVA for metabolic syndrome variables (glucose, waist circumference, blood pressure, triglycerides, HDL cholesterol) with post-hoc pairwise comparison. Paired t-tests (parametric) and Wilcoxon signed rank tests (non-parametric) with Bonferroni-Holm correction were performed for other variables.

RESULTS: At baseline, 69% participants presented with elevated BMI (>30kg/m²), 75% elevated waist circumference (WC) and 43% elevated QRISK3 score (>10%). At 12 weeks, significant improvements were seen in HDL cholesterol (21.1%, p=0.01) and, WC (-2.43%, p=0.007). However, HbA1c also increased (6.67%, p=0.004). ISWT walk distance and time to completion improved by 8.1% (p=0.035) and 9.8% (p=0.04) respectively. Weekly step count and IPAQ score improved from baseline; however, these changes were not significant (p>0.05).

CONCLUSION: Walking rugby-based lifestyle programme has potential to improve CMD risk factors and cardiorespiratory fitness in at risk adults. Future research with a larger population sample would benefit the efficacy of similar programmes to impact CMD risk.

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**PELVIC FLOOR MUSCULATURE VS UPPER AND LOWER LIMBS STRENGTH: PRELIMINARY RESULTS OF CHANGES AND ASSOCIATIONS FOLLOWING A MULTIDISCIPLINARY APPROACH TO FEMALE URINARY INCONTINENCE**

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INTRODUCTION: Urinary incontinence (UI) is a common condition in women that worsens with age. Although its pathogenesis is multifactorial, reduced pelvic floor muscle (PFM) strength is a primary contributing factor [2]. The 5-sit-to-stand (5STS) test has emerged as a key indicator of health in older adults. Given the biomechanical connection between 5STS performance and PFM activation, the present study analyses the neuromuscular impact of a PFM short multidisciplinary intervention (MI; 8 weeks of specific physical exercise & 6 educational sessions) in a group of healthy older women.

METHODS: 12 healthy elderly women [65,83 (5,64) years; 67,17 (8,94) Kg] were assessed of their PFM according to the PERFECT's guidelines (Power, Endurance, Repetitions and Fast) before and after MI. Upper (handgrip) [3] and lower limb strength [5-sit-to-stand -time & relative power, RP- [4] were also assessed. After normality test, Wilcoxon and Spearman was applied to elucidate improvements and associations.

RESULTS: Only the four types of strength from PFM improved ($p<0.05$). At baseline, PowerPFM showed a moderate negative association with Time5STS ($r=-0.639$; $p= 0.025$) which increased after specific training ($r=-0.889$; $p=0.001$). Additionally, new associations emerged between PowerPFM and RP5STS ($r= 0.645$; $p= 0.024$) and RepetitionsPFM and RP5STS (PRE: $r=-0.615$; $p= 0.033$; POST: r: 0.628; $p= 0.029$). Moreover, after MI, RepetitionsPFM also became associated with Time5STS (r: -0.831; $p=0.001$). FastPFM showed a moderate positive association with RP after MI ($r= 0.670$; $p=0.01$).

CONCLUSION: Eight weeks of MI were enough to improve PFM [5], but the specificity of training did not ensure improvements on upper and lower limbs strength. The few associations prior to the study suggest that each neuromuscular system follows a different aging process and should be specifically trained [6], though associations post changes point to some synergic improvements in lower limb strength. Noteworthy, new studies should thus confirm that introducing the 5STS may be valuable to avoid the use of a perineometer or facilitate the inclusion criteria in multidisciplinary pelvic floor programs, as suggested by our post-training associations.

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**BREAKING BARRIERS: THE ROLE OF SPORTS IN ENHANCING HEALTH AND INCLUSION FOR CHILDREN WITH CHRONIC DISEASES**

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INTRODUCTION: Children and adolescents (CaA) with chronic diseases face significant barriers to physical activity, limiting their physical, psychological, and social well-being. Despite the well-documented benefits of sports participation, accessibility, adherence, and inclusion remain major challenges. This systematic review evaluates the impact of sports-based interventions on CaA with chronic conditions, identifying key outcomes and intervention characteristics that promote holistic health improvements.

METHODS: A systematic review of sport-based interventions for CaA with chronic diseases was conducted following PRISMA guidelines. Eight databases were searched, including randomized controlled trials and observational studies assessing physical and psychosocial outcomes. The review included interventions targeting conditions such as autism spectrum disorders (ASD), cerebral palsy, obesity, ADHD, and cancer, among others.

RESULTS: From an initial pool of 10,123 records, 52 studies were included, involving 2,352 participants aged 3-18 years. Findings revealed that sport-based interventions significantly improved motor performance, physical fitness, and social competencies. Notably, children with ASD showed enhanced social interactions through structured team sports, while those with obesity benefited from increased physical activity levels and improved self-perception. Additionally, ADHD participants exhibited better attention control and emotional regulation. Importantly, adherence rates were high, demonstrating the feasibility of such interventions.

CONCLUSION: This review highlights the transformative potential of sports participation for CaA with chronic diseases. Beyond physical benefits, engagement in structured sports fosters social integration, psychological resilience, and im-

proved quality of life. The findings advocate for the inclusion of tailored, accessible sports programs within healthcare and educational settings to optimize well-being in this vulnerable population. Future research should focus on long-term adherence strategies and policy-level implementation to maximize impact.

## Conventional Print Poster Presentations

### CP-MH22 Training Vuscular and Cardiometabolic Health

**THE ACUTE EFFECT OF AEROBIC, RESISTANCE, AND CONCURRENT EXERCISE ON DYNAMIC CEREBRAL AUTOREGULATION IN HEALTHY YOUNG ADULTS**

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INTRODUCTION: The acute effects of resistance (RES), moderate-intensity continuous (MICE), and concurrent (CONE) exercise on dynamic cerebral autoregulation (dCA), as well as potential sex differences in dCA post exercise remains unexplored. This forms an important area of investigation given exercise poses a challenge to dCA and evidence suggests that females have impaired resting dCA compared to males (Labrecque et al., 2019). However, whether this impairment extends post exercise remains unknown. This study aimed to investigate the acute effects of these exercise modalities on dCA in healthy young adults, and to explore potential sex differences therein.

METHODS: 12 males (mean±SD, 24±3.6 years) and 14 females (23±2.1 years) volunteered to take part in this study. Participants completed two preliminary and four experimental visits. On visits one and two, participants completed a ramp incremental cycling test to exhaustion and 1 repetition maximum (1RM) test, respectively. Participants then completed four separate experimental trials that were matched for time (30 minutes): sedentary control day (CONT), RES exercise at 70% 1RM, MICE at 90% gas exchange threshold (GET), CONE consisting of RES and MICE. dCA was assessed pre, and 10 minutes post experimental trials using a single sit-to-stand manoeuvre. Middle cerebral artery blood flow velocity (MCAv) was measured via transcranial Doppler ultrasonography and mean arterial pressure (MAP) was measured via finger plethysmography. Baseline MCAv was taken as the last 60 seconds of seated rest. dCA was quantified as the percentage fall in MCAv relative to the percentage fall in MAP upon standing (Δ%MCAv/Δ%MAP). dCA responses were analysed using a mixed model ANOVA.

RESULTS: Baseline MCAv remained unaffected by condition or time ($P>0.05$). Females exhibited higher baseline MCAv compared to males ($P=0.01$). However, there were no significant interactions between condition, time, and sex ($P>0.05$). The fall in MCAv upon standing was not significantly different 10 minutes post any experimental condition in comparison to pre, except for the RES trial, where the fall in MCAv in both absolute (10.37±4.20 vs 12.89±3.27 cm/s, $P=0.01$) and relative (16.16±6.11 vs 20.38±5.20%, $P=0.01$) terms was greater 10 minutes post. For the fall in MAP, there was no main effect of condition or time ($P>0.05$). No sex differences were reported for the fall in MCAv or MAP ($P>0.05$). dCA remained unchanged following all experimental conditions ($P=0.61$). No sex differences in dCA were found pre or 10 minutes post any experimental trial ($P=0.17$).

CONCLUSION: These findings suggest that: (1) dCA remains intact 10 minutes post-RES, MICE, and CONE, suggesting that acute exercise does not alter dCA responses in healthy young adults; and (2) provides evidence of no sex differences in dCA, highlighting that both males and females exhibit similar dCA both before, and 10 minutes post these exercise conditions.

**VASCULAR AND CARDIOMETABOLIC HEALTH IN POSTMENOPAUSAL WOMEN FOLLOWING RESISTANCE TRAINING PROGRAMMES DIFFERING IN SET CONFIGURATIONS: PRELIMINARY RESULTS FROM CARE PROJECT**

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INTRODUCTION: Hormonal changes of menopause impact on womens health (1). Resistance training is recommended on reducing the risk of cardiovascular disease (2) and improving cardiometabolic health in postmenopausal women (3). Set configuration has been demonstrated to influence various physiological responses and adaptations (4,5). The aim of this study was to explore the blood pressure, arterial stiffness, and lipid profile changes in postmenopausal women following resistance training protocols differing in set configuration.

METHODS: 16 physically active postmenopausal women participated in a study funded by the Spanish Ministry of Science, Innovation and University (PID2021-124277OB). After medical evaluation and familiarization, participants were assigned to control (CON) and experimental groups: 9 sets of 4 repetitions with 45s rest (4S), or 4 sets of 9 repetitions with 120s rest (9S). Target variables were assessed before, after 12-weeks of training and after 8-weeks of follow-up. Systolic (sBP), diastolic (dBP), and mean arterial pressure (MAP) were evaluated at rest for 10min using Task Force System. Arterial stiffness was evaluated via Popmetre, measuring finger-to-toe pulse wave velocity (ft-PWV) and ankle-brachial index (ABI). Lipid profile analysis included total cholesterol (CHOL), HDL, LDL, triglycerides (TGL), and CHOL ratio.

RESULTS: ANOVA did not detect a main effect of group, time, and group×time interaction (p>0.05) for sBP, dBP and MAP. Compared to pretest lower descriptive values of sBP were found in follow-up for 4S (109.96 to 99.08mmHg). Moreover, compared to pretest, lower descriptive values of dBP (70.27 to 63.72mmHg) and MAP (87.32 to 79.09mmHg) were found in follow-up for 4S. Main group effect was detected for ft-PWV, being overall values higher in 9S (17.51±0.88m/s) compared to CON (13.61±1.08m/s). Main time effect showed lower ABI in follow-up compared to pre and postest for 4S (2.09±0.04 to 1.10±0.10) and 9S (2.02±0.04 to 0.90±0.30). ANOVA did not detect a main effect of group, time, and group×time interaction (p>0.05) for LDL, TGL and CHOL ratio. Lower overall CHOL and HDL were observed in follow-up compared to pre and postest (p<0.011) for 9S and 4S. Descriptive data found lower TGL in follow-up for 9S (87.30±15.10mg/dL) compared to pre (105.50±22.40mg/dL) and postest (109.80±43.30mg/dL).

CONCLUSION: Preliminary results showed that none of the variables analyzed were modulated by set configuration after middle-term programmes. However, descriptive data raises a tendency to lower sBP, dBP and MAP after intervention and follow-up for 4S. Experimental groups improve vascular health in follow-up presenting ABI values lower than 1.1. Finally, a tendency towards a better lipid profile was observed for experimental groups.

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**ACUTE EFFECTS OF HIGH-INTENSITY AEROBIC EXERCISE ON COGNITIVE FUNCTION IN REGULARLY ACTIVE YOUNG ADULTS: A CROSSOVER STUDY**

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INTRODUCTION: Aerobic exercise is recognized for its positive impact on cognitive functions, primarily through increased brain-derived neurotrophic factor (BDNF) and improved cerebral blood flow(1). Short-term cognitive improvements are particularly valuable in real-life scenarios that demand focus and quick decision-making, such as exams or competitions(2). Despite these benefits, the acute effects of high-intensity aerobic exercise on cognitive functions in regularly active individuals remain underexplored. Investigating these short-term effects can provide insight into the role of exercise in enhancing immediate cognitive performance.

METHODS: Twenty regularly active young adults participated in a randomized crossover study. Each participant completed two sessions (exercise and control) separated by a one-week washout period. A 20-minute high-intensity aerobic exercise session was performed. Cognitive performance, including reaction time, aim accuracy, and visual memory, was assessed at three time points: before exercise (T0), 30 minutes after (T1), and 60 minutes after (T2).

RESULTS: The exercise group showed significant improvement in reaction time at T1 ($p = 0.031$, $\eta^2p = 0.138$) and T2 ($p = 0.036$, $\eta^2p = 0.194$), with large effect sizes (Cohen`s $d = 1.265$, $d = 0.979$). Visual memory improved at T1 ($p = 0.070$, $\eta^2p = 0.148$), but the effect diminished by T2 ($p = 0.501$, $\eta^2p = 0.028$). Although aim accuracy showed improvement, the group-by-time interaction was not significant ($p = 0.245$, $\eta^2p = 0.089$). No sequence effect was observed ($p > 0.1$).

CONCLUSION: This study shows that high-intensity aerobic exercise can significantly improve reaction time and visual memory in regularly active young adults, especially within the first 30 minutes after exercise. However, these improvements decrease by 60 minutes, highlighting the short-term nature of the effects. Although aim accuracy showed some improvement, it was not statistically significant. These findings suggest that short bursts of aerobic exercise may be useful for boosting cognitive functions in time-sensitive tasks such as exams or decision-making under pressure.

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**SIX-WEEK PASSIVE STATIC STRETCHING OF THE LOWER LIMBS REDUCES SYSTOLIC BLOOD PRESSURE IN INDIVIDUALS WITH ESSENTIAL HYPERTENSION**

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INTRODUCTION: Passive static stretching (PS) improves endothelial function and reduces arterial stiffness in healthy and pathological subjects [1]. Recent evidence suggests that stretching a limited number of muscles elicits systemic cardiovascular adaptations in young participants [2]. Thus, local PS could improve cardiovascular health in hypertensive subjects (HS), characterized by elevated blood pressure and possible low exercise tolerance [3]. We hypothesize that systemic

endothelial function, central arterial stiffness, and blood pressure will improve after a six-week PS intervention for the lower limbs in HS.

METHODS: 24 HS participated in this longitudinal non-randomized crossover study. Blood pressure was recorded with a sphygmomanometer. Carotid-to-femoral Pulse Wave Velocity (PWVcf) was measured with the Complior system as an index of central arterial stiffness. Flow-mediated dilation (FMD) and nitrate-mediated dilation (NMD) were assessed in the brachial artery via ultrasound to evaluate systemic vasomotor control. Assessments were conducted at baseline (T0) and after a 6-week control period (T1), followed by a 6-week PS intervention (20 min/day, 5 days/week) (T2), and a final session after a 6-week follow-up (T3).

RESULTS: No changes were observed in T1 for all variables (all $P \geq 0.06$). In T2, systolic blood pressure (SBP) decreased from 126±11 to 122±11 mmHg ($P<0.013$). No changes were found in diastolic blood pressure (P=0.126), pulse pressure (P=0.172), mean arterial pressure (P=0.071), PWVcf (P=0.515), brachial artery diameter (P=0.615), FMD% (P=0.167), and NMD% (P=0.800). In T3, SBP returned to pre-intervention values (P=0.042 vs. T2; P=0.534 vs. T1).

CONCLUSION: A six-week PS protocol for the lower limbs reduced SBP in HS, but effects were reversed after the follow-up, highlighting the need for continuous stimulus to sustain the training benefits. The absence of central and systemic adaptations suggests SBP reduction resulted from decreased stiffness in involved and non-tested vessels or other unevaluated mechanisms (e.g., reduced sympathetic overdrive, renin-angiotensin system activation).

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**TELEHEALTH EXERCISE TRAINING IN PERIPHERAL ARTERIAL DISEASE (TEXTPAD) STUDY: A PILOT RANDOMIZED CONTROLLED TRIAL IN SOCIOECONOMICALLY DISADVANTAGED POPULATIONS**

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INTRODUCTION: Peripheral arterial disease (PAD) is a common condition among older adults, particularly those in socioeconomically disadvantaged populations. Supervised exercise is a key treatment for PAD-related claudication, but access to such programs is limited, especially following the COVID-19 pandemic. Telehealth interventions offer a promising alternative, but their feasibility and effectiveness in these populations remain unclear. This study aimed to assess the feasibility and preliminary effectiveness of a home-based telehealth intervention combining exercise and behaviour change counselling for patients with PAD from socioeconomically deprived areas of the UK.

METHODS: A pilot randomised controlled trial was conducted with PAD patients recruited from the Vascular Unit of Freeman Hospital in Newcastle and resided in the lowest 30% of socioeconomically deprived areas. Participants were randomised into a telehealth intervention or usual care group. The intervention involved weekly behaviour change sessions targeting main PAD risk factors, plus supervised exercise sessions via videoconference. Usual care included general advice on physical activity (e.g., unsupervised walking). Feasibility was assessed through recruitment, adherence, and retention. Secondary outcomes included the 6-minute walk test (6MWT), Walking Impairment Questionnaire (WIQ), Vascular Quality of Life Questionnaire (VascQoL-6), and risk factors (smoking and alcohol), measured at baseline and 12 weeks. We compared delta values (post-pre values) using an independent t-test, with $P > 0.05$ as significant.

RESULTS: Of 99 patients screened, 36 were enrolled and randomised (19 intervention, 17 control). By 12 weeks, 25 participants completed the study (13 intervention, 12 control). In the intervention group, the median attendance was 20 of 24 possible exercise sessions and 11 of 12 behavioural counselling sessions. Changes in the 6MWT were not significantly different between groups ($p>0.05$). However, WIQ speed improved in the intervention group (mean change +22.2±4.6) than the control group (+5.5±4.9; p=0.002), as WIQ stair-climbing (+20.0±7.0 vs. −5.6±5.3; p=0.001). The intervention group also experienced a greater increase in disease-specific quality of life (VascQoL-6: +3.7±0.81 vs. +0.41±0.95; p=0.01). Notably, 3 of 6 baseline smokers (50%) in the intervention group quit smoking compared to 0 in the control group, whereas minimal changes in alcohol intake were observed in both groups.

CONCLUSION: Despite the recruitment challenges, this home-based telehealth intervention proved feasible and showed preliminary effectiveness in enhancing subjective functional capacity, quality of life, and smoking cessation among PAD patients from socioeconomically disadvantaged backgrounds. These findings indicate that telehealth could represent a valuable alternative to traditional supervised exercise programmes for managing PAD, with further research required to refine the intervention and evaluate its long-term clinical impact.

**ACUTE CARDIOVASCULAR RESPONSES TO A SHORT SPRINT INTERVAL TRAINING SESSION IN NORMOTENSIVE VS. HYPERTENSIVE INDIVIDUALS**

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INTRODUCTION: The current evidence suggests a significant but limited efficacy of high-intensity interval training (HIIT) for the chronic reduction of blood pressure (BP) in hypertensive individuals. Interestingly, despite its time efficiency, there is very limited data on the safety of HIIT protocols with hypertensive individuals. Given the cardiovascular risk associated with elevated BP and HR responses during HIIT protocols, more information is warranted for the safe use of these protocols for the treatment of hypertension. In this regard, short Sprint Interval Training (sSIT), a HIIT modality which consists of repeated short (≤10 s) sprinting bouts, has shown its effectiveness to improve both aerobic and anaerobic fitness indices with a reduced cardiovascular strain and better affective responses than other HIIT protocols. However, there is no data on the acute responses of sSIT protocols with hypertensive individuals.

METHODS: Ten normotensive (42.3±13.1 years, 25.9±2.1 kg/m2) and 10 hypertensive individuals (47.3±7.15 years, 28.4±3 kg/m2) volunteered for participation in this study. After the clinical examination and completing an incremental cycling test after exhaustion, participants underwent two sSIT sessions with, at least, 48h in-between. The protocols consisted of 10 sprints of 5s with 80% of the aerobic power recorded in the incremental test, with 50s of active recovery at 25W. Heart rate (HR), systolic (SBP) and rate pressure product (RPP) were recorded before, during (5th and 10th sprints), and after the protocols with the auscultatory method.

RESULTS: Hypertensive individuals exhibited a lower HR after the 10th sprint during the second sSIT session when compared to the first sSIT session ($p<0.001$), with no significant differences observed between groups. Moreover, hypertensive individuals exhibited higher SBP values than normotensive controls in most moments ($p=0.006$), with similar SBP values observed between groups after the 10th sprint in the second session ($p=0.323$). In addition, hypertensive individuals showed safe mean RPP values during both sessions (<25,000 mmHg*bmp) with only significant differences observed between groups after the 5th sprint during the second session ($p=0.014$).

CONCLUSION: The sSIT protocol used in the current study demonstrated to be safe for hypertensive individuals when considering RPP values. Further, hypertensive individuals exhibited higher cardiovascular responses when compared to the normotensive control group who showed a progressive increase in cardiovascular strain during the protocol. A first bout of a sSIT session may reduce the cardiovascular strain in a second sSIT session in hypertensive individuals, which was not observed in the normotensive control group. Further studies should elaborate on the comparison of this and other sSIT protocols with other HIIT formats.

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## Conventional Print Poster Presentations

### CP-MH23 Training in Older Adults

**EFFECTS OF A COMMUNITY-BASED MULTIMODAL EXERCISE PROGRAM ON PHYSICAL AND COGNITIVE FUNCTION OF OLDER ADULTS: A PILOT PRE-POST STUDY**

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INTRODUCTION: Aging is associated with an increased risk of chronic disease and loss of function, profoundly affecting independence and quality of life. Physical activity, particularly exercise training, has been highly recommended for older adults. Community-based exercise programs for older adults play an important role in encouraging, enabling, and engaging older adults to participate in regular, appropriate, and health-promoting exercise; therefore, helping to mitigate the decline in both physical and cognitive outcomes that commonly occurs with advancing age [1]. This study examined the effects of a 16-week community-based multimodal exercise program (CBMEP) on physical and cognitive function of older adults.

METHODS: This pilot pre-post study included and enrolled eight older adults (Age: 76.87±3.22 years; 50% women). The 16-week program consisted of Monday through Friday, 60-minute fitness classes at a recreational center, with participants attending at least three days per week. The exercise program incorporated stretch, balance, resistance, aerobics, yoga, and tai-chi, and it was delivered by trained students majoring in Kinesiology and supervised by an experienced graduate student. Participants were assessed pre- and post-16 weeks of intervention on measures of lower extremity function (Short Physical Performance Battery; SPPB), functional mobility (Timed Up and Go; TUG), functional muscle power (Stair Climbing Power Test; SCPT), walking endurance (2-Minute Walking Test; 2MWT) and global cognition (Montreal Cognitive Assessment; MOCA). Data were analyzed using paired t test with a significance set at $P<0.05$, and percentage improvement (PEI), which was calculated using the following: PEI = (Pre – Post)/Pre) x 100.

RESULTS: After 16 weeks of a multimodal exercise program, a trend toward improved functional muscle power from pre- to post-intervention was observed (SCPT; Pre: 4.32±0.59s vs. Post: 3.89±0.89s; P=0.05; PEI = 9.95%). No significant improvements were found for lower extremity function (SPPB; Pre: 11.38±0.74 vs. Post: 11.75±0.46; P=0.29; PEI = 3.25%), functional mobility (TUG; Pre: 6.05±0.61s vs. Post: 5.73±0.79s; P=0.19; PEI = 5.29%), walking endurance (2MWT; Pre: 640.63±65.79ft vs. Post: 669.93±81.32ft; P=0.21; PEI = 4.57%), or global cognition (MOCA; Pre: 27.67±2.58 vs. Post: 28.00±2.00; P=0.47; PEI = 1.19%).

CONCLUSION: Our findings suggest that 16 weeks of CBMEP did not significantly improve the selected outcomes. However, the results indicated a trend toward improved functional muscle power. Although the selected physical and cognitive function outcomes did not show significant effects, the observed maintenance of these functions over time could be viewed as positive, given the normal declines associated with aging.

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**EFFECTS OF INTEGRATED LOWER LIMB POWER TRAINING WITH VISUAL FEEDBACK ON HEALTH AND PERFORMANCE IN COMMUNITY-DWELLING ELDERLY**

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INTRODUCTION: Lower extremity muscle power critically impacts mobility and quality of life in older adults. Aging leads to declines in Type II muscle fibers and strength, linked to reduced mobility, higher disability risk, and cognitive impairment, affecting daily living activities[1]. Muscle power training uses progressive, high-intensity exercises with rapid movements to quickly enhance force generation, unlike endurance training, which focuses on sustained effort[2]. The study examined lower extremity power training with visual feedback to improve health performance in community-dwelling elderly individuals.

METHODS: Twenty-five elders from two centers were recruited: one was assigned to the intervention group (n=11) and the other to the control group (n=14). The intervention group participated in a 12-week progressive resistance training program with two sessions per week, while the control group continued their usual activities. Outcome variables included body composition, muscle strength, physical performance, Heart Rate Variability (HRV), and the Montreal Cognitive Assessment (MoCA), measured at baseline, mid-intervention, and post-intervention, except HRV and MoCA, which were assessed only at baseline and post-intervention. Repeated-measures ANOVA and generalized estimating equations were used for statistical analyses, with $p<0.05$ deemed significant.

RESULTS: Our results revealed muscle strength improved in both groups. The control group showed significantly increased strength in the left quadriceps and bilateral hamstrings from baseline to mid-phase. The intervention group improved in quadriceps, hamstrings, and right-hand grip strength from mid to post-phase, while no further changes occurred in the control group. Diastolic blood pressure ($\eta^2=3.936$, $p=0.047$) and HRV, measured by the root mean square of successive differences ($\eta^2=5.10$, $p=0.024$), showed significant interaction effects, increasing in the intervention group. Gait speed improved significantly in the intervention group ($p=0.004$), along with overall Short Physical Performance Battery (SPPB) scores. Regarding cognitive function, orientation ability and total score showed significant differences between groups ($p=0.003$; $p=0.04$), with the control group experiencing a significant decline in orientation ability. Systolic blood pressure and oxygen levels increased in both groups without between-group differences, while the body mass remained unchanged.

CONCLUSION: The control group showed early strength gains, likely due to higher activity levels, while the intervention group, following progressive overload, achieved greater long-term improvements. Power training improved parasympathetic activity and cardiac regulation, enhancing physical performance and cognitive function.

**EFFECTS OF A PRAGMATIC, COMMUNITY-BASED, 6-WEEK MINI-TRAMPOLINE EXERCISE PROGRAMME ON FUNCTIONAL ABILITY, POSTURAL CONTROL AND BALANCE CONFIDENCE OF OLDER ADULTS**

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INTRODUCTION: Physical activity (PA) increases functional ability and balance in older individuals, but engagement is low [1]. Improving engagement with PA in the community, requires a range of programmes on offer [2]. Trampoline-based exercise increased power in older individuals in the laboratory [3]. The present study explored the effect of a pragmatic, community-based 6-week trampoline exercise programme on functional ability and postural control in older adults.

METHODS: Forty-six older adults (>60 years) were randomly allocated to a mini-trampoline (EXP, n=25) or a usual (CON, n=21) exercise group. EXP exercised on individual mini-trampolines while CON with standard exercise class activities. Both groups exercised at a community centre for 6 weeks, for 30 minutes, twice a week; participants completing <70% (i.e. <9) sessions were excluded from the analysis [4]. Functional ability (timed-up and go (TUG) time), leg power (sit to stand time (STS) and power (STS-P)), postural control (single leg stance path (SL-P) and velocity (SL-V)) and performing ambulatory activities confidence (Activities-specific Balance Confidence (ABC) scale) were measured before (PRE) and after (POST) the

6-weeks. Age, height, body mass and sex between groups was compared was baseline. A generalised linear mixed-effects model was used to examine for differences in all variables between EXP and CON.

RESULTS: A total of 29 participants attended ≥9 sessions (EXP: n=16, 64.5±3.8 years; CON: n= 13, 64.1 ± 2.7 years). There were no differences in age, height, body mass or sex between groups. No adverse effects were reported by any participant. No significant interaction or group main effect existed for TUG, STS and ABC but there was a significant PRE-POST main effect, with performance improvement at POST (TUG: PRE = 9.35 ± 1.23 s, POST = 8.68 ± 1.22 s, P = 0.001, g = 0.547; STS: PRE = 17.5 ± 3.33 s, POST = 15.3 ± 4.52 s, P = 0.182, g = 0.554; ABC: PRE = 93.8 ± 8.12%, POST = 96.2 ± 4.60%, P = 0.001, g = 0.34). SL-P and SL-V showed no significant interaction or main effects.

CONCLUSION: Whilst there was no difference between interventions for any outcome, both EXP and CON groups improved functional ability, leg power and balance confidence but not postural control. A notable outcome of the study is the comparable adherence rate above the specified 70% attendance and the lack of adverse events in both groups. These results support that a pragmatic, community-based mini-trampoline exercise programme may be an effective exercise option for older adults to support promotion of PA in this population and merits further investigation.

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**ACCEPTANCE AND FEASIBILITY OF A NOVEL TRAINING ALGORITHM IN A NURSING HOME ENVIRONMENT**

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INTRODUCTION: Sarcopenia is a rising problem worldwide, mainly due to the steady increase in life expectancy. It is scientifically well-established that strength training is the most important measure to counteract sarcopenia. However, the implementation of strength training in nursing homes with a particularly large number of people affected is often prevented by a number of barriers. Such barriers often have an influence on the acceptance and feasibility of an intervention. However, these two aspects are as important as the effectiveness of a training. Thus, the aim of this study was to investigate acceptance and feasibility of a recently proposed training algorithm in nursing homes.

METHODS: The staff of 5 nursing homes were trained in the KNIMS algorithm stage B (Weber et al., 2024) and exercised over 4 weeks (5 times a week, Monday till Friday) with 28 residents. Each training session was documented, the performance of the individual exercises was recorded, the subjective assessment of the exercise intensity of the residents was surveyed and the motivation of the residents was assessed by the nursing staff. For the analysis, we divided acceptance and feasibility as follows: combined acceptance and feasibility (cAF) quantifying the adherence of the residents to the training, operational feasibility (opF) describing the integration of the training in the daily activities of a nursing home, and exercise performance feasibility (EPF) as applicability of the exercises to the residents.

RESULTS: The cAF was at least 54%, the opF was 91% and the EPF ranged from 88% to 94.2% depending on the kind of exercise. The opF was higher than 100% in two facilities, as training sessions were also offered at weekends in addition to the planned training sessions from Monday to Friday. In contrast, the number of weekly training sessions at one facility was reduced due to a lack of staff as a result of a COVID-19 outbreak. Finally, it turned out that the training motivation was higher for training in a group ($P = 0.007$), but the training intensity was higher during individual training ($P < 0.001$).

CONCLUSION: The study demonstrates that the training algorithm is both accepted (by the instructing staff and the residents) and feasible/implementable in a nursing home environment. It has been shown that, contrary to our previous assumption, training is also possible at weekends. It was also shown that the exercises of the algorithm consisting of squat, lunge and one-leg stand can be performed by the majority of residents. The biggest barrier to carrying out the training, thus influencing acceptance as well as feasibility, is the availability of staff as obtained in the facility with the COVID-19 outbreak. The efficacy of the algorithm needs to be proven in the future.

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**THE APPETITE PROJECT: EFFECTS OF NUTRITIONAL AND EXERCISE INTERVENTIONS ON PHYSICAL FUNCTION, BLOOD BIOMARKERS, AND BODY COMPOSITION IN A GROUP OF OLDER ADULTS**

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INTRODUCTION: Age-related muscle function decline can significantly impair health and quality of life. Loss of appetite and inadequate macronutrient intake, especially protein, can contribute to this decline. This study was part of a multi-country randomised controlled trial (APPETITE project) aimed at evaluating the effects of plant protein and fibre (PPF) supplements

incorporated within a personalised diet (PD), a physical activity (PA) program, or their combination (Horner et al., 2024). Our aim was to assess the effects of such interventions on functional, anthropometric and blood-based markers.

METHODS: Fifty-two older adults (M=9, age 72.1±5.0 y, height 1.6±0.1 m, body mass 65.6±11.1 kg) were randomly distributed into 4 groups: PD, PA, personalised diet and physical activity (PD+PA), and control (CTRL). Participants were tested before and after a 12-week intervention, regardless of group assignment. The PD intervention consisted of dietary counselling and daily consumption of PPF (25g twice a day); the PA group received supervised exercise classes in a group setting (one hour, twice a week); the PD+PA group incorporated both PD and PA interventions whereas participants allocated in CTRL group were only required to perform testing sessions while maintaining their habitual diet and physical activity level. We assessed body composition through dual-energy x-ray absorptiometry (DXA); physical function through chair stand test, gait speed test, 400 meters walking test, handgrip dynamometry, and maximal isometric voluntary torque (MVT); blood biomarkers of neuromuscular system function such as the C-terminal agrin fragment (CAF) and the brain-derived neurotrophic factor (BDNF). A two-way repeated measures ANOVA was performed to detect differences across groups and time points.

RESULTS: Of all the measurements, we found significant time effects on DXA lean mass ($p<0.05$), chair stand test ($p<0.05$), gait speed ($p<0.05$), and MVT ($p<0.001$). However, no between-group differences or time-group interactions were detected.

CONCLUSION: Despite some changes in functional and body composition outcomes, the analysis did not highlight differences in either the physical activity or the personalised diet interventions. However, this analysis was carried out in a subgroup of a broader project, therefore with a reduced sample size. It will be essential to reconsider the results when the complete data set from the other study centres will be available. The study was funded under the European Joint Programming Initiative 'A Healthy Diet for a Healthy Life'.

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**EFFECT OF SET CONFIGURATION OF RESISTANCE TRAINING ON CARDIOVASCULAR AUTONOMIC MODULATION AND BAROREFLEX SENSITIVITY ADAPTATIONS IN POSTMENOPAUSAL WOMEN: PRELIMINARY FINDINGS OF THE CARE STUDY**

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INTRODUCTION: Menopause has been identified as a cardiovascular sex-specific risk factor for women (1), due to the hormonal changes that increase the risk of dysfunction in cardiovascular autonomic modulation, leading to a higher prevalence of cardiovascular diseases (2). Resistance training (RT) is recommended to counteract, or even reverse, some adverse effects of menopause (3). Set configuration has been demonstrated to modulate cardiovascular responses to RT (4). However, no evidence exists regarding cardiovascular adaptations in postmenopausal women. Therefore, the aim of this study was to explore adaptations in cardiac autonomic modulation and baroreflex sensitivity following two resistance training interventions that differed in set configuration in postmenopausal women.

METHODS: Preliminary results from CARE study, funded by the Spanish Ministry of Science Innovation and University (PID2021-124277OB), involved 16 physically active, normotensive postmenopausal women. Following a medical examination and familiarisation and testing sessions, participants were randomly assigned to one of three groups: long set configuration (9S), short set configuration (4S), or a control group. Both RT groups exercised at a moderate intensity (12RM load), 2 days per week for 12 weeks, but differed in set configuration. The 9S group performed 4 sets of 9 repetitions with 120s rest, while the 4S executed 9 sets of 4 repetitions with 45s rest. Before, after intervention and in a follow-up assessment, cardiac autonomic modulation [root mean square of differences between adjacent pulse interval (RMSSD), heart rate (HR), high frequency power (HF)], baroreflex sensitivity (BRS) and its effectiveness (BEI) were evaluated at rest.

RESULTS: No significant main effects of time, group, or interaction were detected for any parameter ($p\geq0.112$), except for HR, where 9S group showed globally lower values compared to the 4S group ($p=0.048$). Furthermore, a main effect of time was observed for BRS ($p=0.047$), with overall improvements being evident following the post-test evaluation.

CONCLUSION: After 12 weeks of RT intervention, no cardiovascular adaptations were observed in postmenopausal women, regardless of the set configuration. These preliminary results suggest that physically active postmenopausal women may experience lesser benefits from incorporating RT routines compared to sedentary women with cardiometabolic risk (5), with an active lifestyle being the key factor for improving cardiovascular health in postmenopausal women (2).

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**METABOLIC REHABILITATION IN CARDIOVASCULAR PATIENTS ASSESSED BY CPET-BASED ANALYSIS OF FAT OXIDATION**

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INTRODUCTION: Cardiac rehabilitation (CR) is a comprehensive intervention addressing the physical and psychological challenges of coronary artery disease (CAD). While the overall effects of exercise-based CR on cardiopulmonary fitness are well documented, the metabolic CR effects are underreported. This study investigated fat oxidation (FatOx) during exercise as a function of mitochondrial capacity and evaluated the effects of CR on FatOx improvement in patients with CAD.

METHODS: 256 CAD patients (21% female, 56.6±6.7 years; 79% male, 55.2±7.5 years) after myocardial infarction (MI) and/or reperfusion via percutaneous transluminal coronary angioplasty referred to 3-4 weeks of exercise-based CR underwent full-clinical assessment including cardiopulmonary exercise testing (CPET) at admission (pre) and before discharge (post). Breath-by-breath spirometric data was used to calculate substrate oxidation rates including FatOx using a stoichiometric approach. Data was then plotted as percentage of peak VO2. Responder analysis was performed for submaximal and peak exercise capacity based on VO2 at ventilatory threshold 1 (VT1) and VO2peak as well as for maximal fat oxidation (MFO) using the typical error method. MFO was compared to published data from healthy controls. Mean area under the curve (AUC) for relative FatOx values was calculated with 95% confidence interval.

RESULTS: At the start of CR, patients exhibited significant limitation in physical exercise capacity at submaximal (12.4±3.3 ml/min/kg; 50.2±12.6% predicted reference) and peak exercise (18.5±4.6 ml/min/kg; 73.8±15.5% predicted reference). FatOx capacity was significantly impaired in CAD patients (MFO: 0.31±0.14 g/min; AUCpre: 11.1[10.6-11.7]) compared to healthy controls (MFO: 0.46±0.17 g/min; p<0.001). Stratification by age and sex revealed that limited FatOx was more pronounced in female and older patients (AUC: 8.1[7.7-8.5] and 9.2[8.8-9.7]). No evidence of reduced FatOx linked to number of affected coronary vessels or previous MI was observed. During rehabilitation, overall FatOx improved significantly (+20.7%, AUCpost: 13.4[12.8-13.9]; p<0.001), while females showed only minimal improvement (+2.5%) compared to males (+24.4%). The responder analyses revealed that 35% of patients showed a response in VO2@VT1, while 43%improved in VO2peak. The responder analysis also identified a subgroup of patients (11%) who showed no improvement in VO2 at submaximal or peak exercise but exhibited a significant improvement in MFO (AUCpre: 10.2 [9.7–10.7], AUCpost: 17.5 [16.9–18.2]; +72.3%).

CONCLUSION: CAD patients demonstrated improved FatOx capacity in response to CR which appears limited in females with CAD. MFO may identify responders to CR in terms of beneficial metabolic adaptations, potentially linked to restored mitochondrial function, in addition to traditional outcome assessments based on VO2 uptake.

**SPPB IN OLDER ADULTS: NOT ALWAYS A GOOD CHOICE**

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INTRODUCTION: Despite its wide use in Primary Care (1), the Short Physical Performance Battery (SPPB) presents limitations. A score below 10 pts is associated with increased all-cause mortality (2), but it's been suggested a ceiling effect in non-frail individuals as well as limited applicability to track performance changes over time (3). This study analyses this applicability compared to the gait speed in the 200-meter walking test (GS200), in a sample of old patients referred from Primary Care who were assigned to two different short physical interventions of 8-weeks, according to their fitness level.

METHODS: One hundred and two adults >60 years were assigned to Gesmed-Marcha (GM; N=53, 37 women; Nordic walking plus inspiratory muscle training) or Gesmed-ViuActiu (GVA; N=49, 37 women; multicomponent exercise). Changes in body mass index (BMI), SPPB (Total: SPPBT, balance: SPPBB, 5STS test, and 4-meter gait speed), and GS200, were analysed by means of a General Linear Model (repeated measures in pre-post training; sex and PEI as factors), and the Mann Whitney or Wilcoxon test as non-parametric alternative.

RESULTS: At baseline, BMI and % fat mass were significantly worse (p< 0.05) in GVA compared to GM in men [31.36 (1.67) vs 27.59 (0.70) kg/m2; 32.03 (1.39) vs. 27.01 (0.92) % fat mass] and women [29.26 (0.78) vs. 27.34 (0.66) kg/m2; 40.35 (0.95) vs. 35.28 (0.90) % fat mass]. SPPBT and GS200 also reflected a significantly lower functional capacity in GVA individuals (p< 0.05). Following training, GVA showed significant improvements in SPPBT [ Men, pre: 10.60 (0.37) vs. post 11.88 (0.31) pts., p= 0.004; Women: pre 10.39 (0.22) vs, post 11.50 (0.19) pts., p < 0.001] and its subscales except for balance; as well as in GS200 [Men pre 1.36 (0.07) vs post 1.66 (0.08) m/s, p < 0.001; Women pre 1.38 (0.04) vs post 1.51 (0.05), p < 0.001) m/s]. Conversely, no significant improvements were found in SPPBT or its subscales in GM except for 4Vel in women, whilst there were always significant improvements in GS200 [Men: pre 1.86 (0.07) vs post 1.95 (0.07) m/s, p= 0.011; Women: pre 1.64 (0.04) vs. post 1.69 (0.04) m/s, p= 0.019). Noteworthy, whatever the PEI, all subgroups had baseline balance median scores of 4 points, a maximum score with no option for improvements.

CONCLUSION: Despite its short duration, both Gesmed PEI showed to be effective in improving functionality and live expectancy through improvements in Gait Speed. However, SPPB confirmed its ceiling effect, mostly in balance, and lack of capacity to track performance changes in fitter older adults. This limits its applicability to analyse PEI effects in Primary Care. Alternatively, GS200 confirms to be sensitive and a powerful alternative in these interventions.

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**TWELVE WEEKS OF STEP-BOX GROUP AEROBIC EXERCISE DOES NOT IMPROVE PULMONARY AND AUTONOMIC NERVE FUNCTION IN POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Menopause causes a rapid decline in the female hormone estrogen, which leads to decreased pulmonary function and autonomic nerve imbalance. Regular aerobic exercise is a well-known behavioral intervention to improve pulmonary and autonomic nerve function. Step-box group exercise training is a practical and effective moderate-to-high intensity aerobic exercise that improve cardiorespiratory fitness and lower body muscle strength by performing rhythmic repetitive movements accompanied by music. However, research studies investigating the effects of step-box exercise on pulmonary function or autonomic nerve balance in postmenopausal women are rare. This study aimed to evaluate the effect of a long-term step-box group training on pulmonary and autonomic nerve function in postmenopausal women.

METHODS: Twenty-four postmenopausal women participated in the study and were randomly assigned to step-box group training (SBT) or control group (CON). The SBT group performed 50 minutes of step-box aerobic exercises, three times per week for 12 weeks at 60–80% of age-predicted maximal heart rate. To assess pulmonary function, forced vital capacity (FVC), forced expiratory volume in one second (FEV1) were measured and FEV1/FVC ratio was calculated using a COSMED PFT system. Heart rate variability indices including the standard deviation of NN intervals (SDNN) and the root mean square of successive differences (RMSSD) were analyzed to evaluate autonomic nerve function.

RESULTS: There was no significant group by time interaction in pulmonary function parameters (FVC, FEV1, and FEV1/FVC, $p \geq 0.28$) between SBT and CON group. Heart rate variability parameters also did not change in either group (SDNN and RMSSD, $p \geq 0.40$).

CONCLUSION: This study results suggest that 12 weeks of step-box group training were not sufficient to induce measurable changes in pulmonary and autonomic nerve function in postmenopausal women. Further research studies are needed to determine the proper frequency, intensity, session time, and minimum training duration of step-box group training that can positive affect pulmonary and autonomic nerve function in postmenopausal women.

## Conventional Print Poster Presentations

### CP-MH24 Injuries in Young Athletes

**MEDIAL TIBIAL STRESS SYNDROME IN YOUNG FEMALE GYMNASTS –PREVALENCE AND CORRELATIONS WITH PUBERTAL STAGE, BONE PROPERTIES, AND ANATOMICAL FEATURES**

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INTRODUCTION: Artistic, acrobatic, and rhythmic gymnastics are physically demanding sports characterized by high-volume and high-intensity training, which during pubertal growth, co-occurs with rapid skeletal growth and hormonal changes that may affect soft tissue properties. This training regime, combined with the pressure to maintain a lean physique, can lead to low energy availability, hormonal disruptions, late menarche, and low bone density increases the risk of musculoskeletal injuries, particularly in lower leg injuries like Medial Tibial Stress Syndrome (MTSS). The aim of the present study was to evaluate the prevalence of MTSS and to assess demographic, pubertal stage, bone properties, and anatomical features associated with the diagnosis of MTSS in young gymnasts.

METHODS: A total of 274 young female competitive gymnasts from three disciplines of gymnastics (rhythmic, acrobatic, and artistic) were included in this study. They all trained at the same professional level from different specialized clubs and were clinically evaluated for the presence of MTSS. Data collected included demographic information, training characteristics, pubertal status, anthropometric features, muscle strength, joint range of motion, and bone strength.

RESULTS: MTSS was found in 70 (25.6%) out of 274 young female gymnasts assessed, who had an average age of 11.8±1.9 years. There was a higher prevalence among artistic gymnasts 23/60 (38.3%) compared to rhythmic gymnasts with 33/154 (21.4%), and acrobatic gymnasts with 15/60 (25.0%) ($p=0.040$). Logistic regression showed that rhythmic gymnasts with MTSS versus those without MTSS had lower ankle plantar-flexor strength ($p>0.001$) and lower tibial bone strength ($p=0.004$); acrobatic gymnasts with MTSS versus those without MTSS had lower tibial bone strength ($p=0.022$) lower fat percent ($p=0.017$) and trained more hours per week ($p=0.032$); and artistic gymnasts with MTSS versus those without MTSS had lower ankle plantar-flexors and dorsi-flexors strength ($p=0.003$; $p=0.006$., respectively), higher hip flexor strength ($p=0.012$) and lower tibial bone strength ($p=0.014$).

CONCLUSION: The main findings of the current study indicate that one out of every four female gymnasts experienced MTSS during the training period. Artistic gymnasts showed the highest prevalence of MTSS compared with acrobatic and rhythmic gymnasts. Reduced tibial bone strength, reduced plantar flexor muscle strength, and increased hours of training were associated with MTSS in young competitive gymnasts. These findings will enable better screening and monitoring throughout training seasons, as well as designing injury-prevention programs and providing valuable data that can guide clinicians, trainers, and medical teams treating young female gymnasts in preventing bone stress injuries such as MTSS.

**ARE PREVIOUS ANKLE SPRAINS IN ADOLESCENT FEMALE SOCCER PLAYERS RELATED TO STATIC AND DYNAMIC BALANCE AND ONE-LEGGED JUMPS?**

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INTRODUCTION: The incidence of ankle sprains is high in adolescent female soccer players. The highest risk factor for ankle sprains is having a preexisting ankle injury, as athletes with prior sprains have a higher risk of recurrence. This study investigated the results of the static and dynamic balance tests and one-leg jump tests in adolescent female soccer players with and without a history of ankle sprains to develop measures for the prevention of ankle sprain injuries.

METHODS: The study included a total of 217 female soccer players aged 13.2 ± 0.9 years with 6.8 ± 2.3 years of soccer experience. A survey was conducted to determine whether the players had a history of ankle sprains, whether the injury occurred within 1 year, the injured side, etc. The Y-balance test (YBT), closed-eye single-leg balance test (SLBT), and single-leg hop test (SHT) were executed. In all participants, the results of each test were compared between the left and right lower extremities with and without a history of an ankle sprain and with and without injury within 1 year. Statistical analysis was performed using the t-test for independent samples, t-test for corresponding samples, and $\chi 2$ goodness-of-fit test, with a 5% significance level. This study was conducted after obtaining approval from the Konan Women's University Research Ethics Review Committee (Approval No. 2024005).

RESULTS: In this study, 82 (31%) and 63 (24%) participants had a history of ankle sprain in the right and left lower extremities, and 52 (20%) and 37 (14%) had it in the right and left lower extremities within 1 year, respectively. Overall, the YBT result was significantly lower only in the posterior lateral reach of the left lower extremity ($p < 0.05$). Participants with a history of left ankle sprain had significantly more positive results in the closed-eye SLBT ($p < 0.05$). The YBT result was significantly lower in participants with a history of left ankle sprain within 1 year ($p < 0.05$) as was the right anterolateral lower extremity reach on the YBT ($p < 0.05$). The SHT results were not significantly different between the right and left extremities for all participants or those with or without a history of an ankle sprain.

CONCLUSION: Participants with a history of left ankle sprains showed asymmetry between the left and right lower extremities in the closed-eye SLBT and YBT. Soccer requires asymmetrical performance between the left and right lower extremities. Therefore, asymmetry in single-leg postural control has been reported to increase the risk of sports injuries. The results of this study indicate the need for interventions, which consider the results of this study, to prevent recurrent ankle sprains. Therefore, interventions to prevent ankle sprain recurrence must consider the injured side and timing of the injury.

**THE RELATIONSHIP BETWEEN INTRINSIC FOOT MUSCLES AND TOE GRIP STRENGTH DURING JUMP LANDING IN ADOLESCENT ATHLETES, AND THE SEX DIFFERENCES**

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INTRODUCTION: We previously investigated the relationship between jump landing ability, intrinsic foot muscles, and toe grip strength in adolescent athletes, and no correlations were found between these variables [1]. However, it was reported that sex differences in foot arch and function exist during adolescence [2], suggesting that the foot-related factors contributing to balance ability may differ between males and females. This study aimed to examine the relationship between intrinsic foot muscle morphology, toe grip strength, and jump landing ability in adolescent athletes, separately for males and females.

METHODS: The study focused on the left foot of 104 males and 67 females. The cross-sectional areas of the abductor hallucis (AbH), flexor hallucis brevis (FHB), and flexor digitorum brevis (FDB) were measured using an ultrasonography. Toe grip strength was assessed with a toe grip dynamometer. The arch height ratio was calculated to represent foot morphology. The stability of the single-leg forward jump landing was evaluated using the Dynamic Postural Stability Index (DPSI), which is derived from composite ground reaction forces in the anterior-posterior (APSI), medial-lateral (MLSI), and vertical (VSI) directions. Sex differences in each measurement item were examined using an unpaired t-test. Correlation coefficients between the muscle cross-sectional areas of each intrinsic foot muscle, toe grip strength, and jump landing ability were calculated separately for males and females to explore the relationships.

RESULTS: All the cross-sectional areas of the intrinsic foot muscles, toe grip strength, and arch height ratio were significantly higher in males than females ($p<0.05$), but there was no difference in DPSI. In males, the cross-sectional area of the FHB showed a significant negative correlation with DPSI, MLSI, APSI, and VSI, and toe grip strength showed a significant positive correlation with DPSI and VSI ($p<0.05$). In females, the FHB showed a significant negative correlation with DPSI, MLSI, and VSI, while the FDB showed a significant positive correlation with APSI ($p<0.05$).

CONCLUSION: There were sex differences in the foot factors related to jump landing ability between adolescent athletes. In males, improving only toe grip strength may reduce jump landing ability. In females, it is important to consider both

conditions, as the development of FDB alone or a decrease in the foot arch height ratio may hinder the improvement of jump landing ability. It was also suggested that the development of FHB is important for improving jump landing ability in both sexes. The muscle morphology of FHB is involved in good jump landing ability in healthy adults [3], and active improvement of muscle function would be important in adolescent athletes.

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**COMPARING FUNCTIONAL PERFORMANCE ACROSS MALE AND FEMALE YOUTH BASKETBALL ATHLETES: INSIGHTS FROM PRESEASON SCREENING**

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INTRODUCTION: Understanding gender-specific functional characteristics in youth basketball is essential for developing targeted training and injury prevention strategies. Variations in balance, agility and jumping ability may be attributed to differences in biomechanical demands, neuromuscular adaptations and training responses between male and female athletes (Márquez et al. 2017). Basketball performance relies on agility, strength, balance and power, making these attributes critical for skill execution and injury prevention (Sattler et al. 2015).

This study aims to examine functional performance during preseason screening of male and female youth basketball players to conclude on gender specific injury prevention approaches.

METHODS: 55 male and female youth Basketball players (F: n 21, age 15.8 ± 1.7; BMI 20.9 ± 2.6; M: n 34, age 16.3 ± 1.7; BMI 21.6 ± 2.5) underwent a test battery with standardized functional performance tests assessing balance (Y-Balance Test), agility (T-Test) and jumping (Countermovement Jump, Hop for Distance, Side Hop Tests) (Scinicarelli et al. 2021). A one-way ANOVA ($p < .05$) was performed to compare the means of single-leg results (dominant, non-dominant and limb symmetry index) across two independent groups (male and female).

RESULTS: Preliminary analysis revealed gender differences. As to be expected, male athletes outperformed females in jumping-related tests (CMJ-Dom: $p < .001$; df, 1; F, 45,307; CMJ-NDom: $p < .001$; df, 1; F, 25.146; JFD-NDom: $p < .001$; df, 1; F, 15.337; SH-NDom: p .01; df, 1; F, 7.057), while female athletes demonstrated better balance performance (YBT-Dom: p .03; df, 1, F, 4.489). Agility measures showed results favouring male athletes (T: $p < .001$; df, 1; F, 32.912).

CONCLUSION: The observed gender differences highlight the need for gender specific training as well as injury prevention programs. To address performance gaps female athletes should focus on plyometric and strength training to enhance jumping and agility, while male athletes would benefit from balance, core stability, and proprioceptive exercises to improve postural control. These strategies may optimize performance, contribute to more effective training adaptations and reduced injury risk.

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**ANTERIOR TIBIOFIBULAR GAP WITH AND WITHOUT WEIGHT-BEARING IN ADOLESCENT ATHLETES: AN ULTRASOUND-BASED STUDY**

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INTRODUCTION: Anterior inferior tibiofibular ligament (AITFL) injuries commonly occur under weight-bearing conditions with forced ankle dorsiflexion and external rotation. Pediatric AITFL injuries may lead to future ankle instability if not properly treated [1]. We have investigated the ultrasonography (US) assessment of the anterior tibiofibular gap (ATFG) in healthy adults about AITFL injuries, considering weight-bearing and ankle angles [2]. However, the study has not been conducted in adolescents. The purpose of this study was to explore the feasibility of US assessment of ATFG in adolescent athletes considering weight bearing and ankle angles.

METHODS: Forty-nine adolescent athletes (32 men and 17 women, 98 feet) participated in this study. ATFG was assessed using US (GE Healthcare Inc., Japan) in the sitting and standing position. Three ankle angle conditions were set on the tilt table: neutral position (N); dorsiflexion, 20° (D20); and dorsiflexion, 20° with external rotation, 30 ° (D20ER30). The AITFL was imaged approximately 1 cm proximally from the thickest part of the ligament at the ankle using an anterior US approach [3]. The ATFG was eventually calculated in Image J software (National Institute of Health, Bethesda, USA). Two-way repeated-measures analysis of variance (ANOVA) was used to examine differences between the ATFG as the dependent variable and postures (sitting and standing position) and ankle angles (N, D20, and D20ER30) as the independent variables. The Bonferroni test was used as a post hoc test for the ankle angles. The significance level was set at $p < 0.05$.

RESULTS: The results of the two-way ANOVA indicated that there was no interaction effect between postures and ankle angles ($F = 0.06$, $p = 0.94$). Main effects were observed for measurement postures ($F = 11.09$, $p < 0.01$) and ankle angles ($F = 32.07$, $p < 0.01$). The post hoc test revealed significant differences between D20 and D20ER30 in the sitting position, N and D20ER30 in both the sitting and standing positions ($p < 0.05$ respectively).

CONCLUSION: Our finding was that the ATFG in adolescent athletes varies depending on weight-bearing and ankle angles. The fibular lateralization and decreased fibular external rotation that occur during growth result in changes to the anatomical characteristics of the syndesmosis anatomy, differing from the features in the adulthood [4]. Moreover, prevention of pediatric AITFL injuries is crucial in children, as the tibia and distal fibula are more prone to fractures due to the physis. This study, which demonstrates changes in the ATFG under weight-bearing conditions and ankle angles in the growing population, is expected to provide fundamental data for understanding pediatric AITFL injuries.

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**THE ASSOCIATION BETWEEN PERCEIVED ACUTE SPORTS INJURY AT THE TIME OF OCCURRENCE AND THE SEVERITY OF SPORTS INJURIES IN YOUNG JAPANESE NATIONAL CHAMPIONSHIP-LEVEL ATHLETES.**

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INTRODUCTION: Psychological studies have suggested that the strong stress responses likely reduce athletes decision-making capacities, leaving them vulnerable to errors, collisions, and compromised motor control, thereby increasing injury risk. [1]

Exploring athletes perceptions during acute sports injuries is essential to more thoroughly comprehend the mechanisms behind sports injury development, which may be linked to athletes' stress responses. This study aimed to understand how the perceptions of young athletes at the national championship level at the time of acute sports injury are related to the severity of the injury.

METHODS: 202 Japanese (Male=97 & Female=105) aged 18 to 24, who competed at the national championship level, completed an online survey. The survey inquired about their perceptions during injuries and their experiences with acute sports injuries. Participants responded to 20 questions about self-evaluated psychological and situational characteristics at the time of injury on 5-point Likert scale (e.g., being angry and feeling pressure). The severity of the sports injury was assessed in 7 categories of the time taken to return to play sports. It was hypothesized that "concerning the coach," "competing against rivals," "feeling impatient," and "feeling pressure" will link to the "severity" of the sports injury. Path analysis was employed to examine the effects of the variables on the severity of acute injuries. Multiple hypothesized models were tested exploratively and judged by goodness of fit indices.

RESULTS: A final model emerged after model changes and showed the highest goodness of fit indices ($\chi 2 = 0.475$, significance probability = 0.789, GFI = 0.998, AGFI = 0.988, CFI = 1, and RMSEA = 0.00). The final model revealed that "severity" was predicted by "feeling pressure" (path coefficient = 0.27, $p < 0.001$), which was nuanced by "concerning the coach" (path coefficient 0.28, $p < 0.001$) and "feeling impatient" (path coefficient 0.55, $p < 0.001$) as well as that "concerning the coach" was linked to "feeling pressure" (path coefficient 0.55, $p < 0.001$).

CONCLUSION: It has been suggested that the impatience and pressure perceived by athletes when they got injured may stem from their concerns about their coaches' evaluations. This anxiety could trigger stress responses, potentially leading to acute sports injuries.

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**THE ASSOCIATION BETWEEN TENDINOPATHY, TENDON STRUCTURE, AND MUSCLE STRENGTH IN YOUNG ELITE FEMALE GYMNASTS: A 12-MONTH FOLLOW-UP STUDY**

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INTRODUCTION: Engaging in gymnastics involves rigorous physical activities, including the repeated execution of extreme movements that exert high forces on the musculoskeletal system. These extensive and complex movements expose gymnasts to high physical stresses and loads, increasing the risk of lower-extremity injuries. Achilles and patellar tendinopathy are one of the most frequently diagnosed injuries in gymnasts, with a limited chance of recovery. The aim of the present study was to examine the relationships between clinical diagnoses of tendinopathy, tendon structure, and muscle strength in young elite female gymnasts over a 12-month training period.

METHODS: A total of 274 competitive female gymnasts (aged M=12.1±1.9yrs at baseline) at the same professional training level were assessed at baseline. Two-hundred and seven gymnasts (out of the 274) were assessed at both baseline and followed-up 12-months later for patellar-tendon and Achilles-tendon structure by Ultrasound Tissue Characterization (UTC), as well as for anthropometric measures and muscle strength (hip abductors, hip adductors, knee extensors, knee flexors, ankle plantar-flexors and ankle dorsiflexors). Additionally, all gymnasts were clinically diagnosed at the two time points by the same professional physical therapist for patellar and Achilles tendinopathy.

RESULTS: At baseline, patellar tendinopathy and Achilles tendinopathy were found in 26.6% and 31.4% of the 207 gymnasts, respectively. At the 12-month follow-up, 37.2% and 38.6% remained healthy; 9.7% and 15.5% had recovered; 36.2% and 30.0% had developed tendinopathy; and 16.9% and 15.9% remained with-tendinopathy, respectively. Using the Kruskal-Wallis test, the healthy and recovered from tendinopathy groups exhibited decreased prevalence of disorganized patellar tendon and Achilles tendon fibers from baseline to follow-up, whereas increased prevalence was seen in those who sustained or had developed tendinopathy ($p<.05$). A two-way repeated-measures ANOVA showed patellar-tendinopathy X time interactions for knee-extension, hip-abduction and hip-extension strength; and Achilles-tendinopathy X time interactions for ankle-plantarflexion and ankle-dorsiflexion strength ($p<.005$), indicated higher muscle strength at follow-up for the recovered and healthy groups compared to the developed and remained groups.

CONCLUSION: Between one-third and one-half of the young elite female gymnasts had tendinopathy, with limited chance of recovery. At baseline, gymnasts without tendinopathy exhibited higher muscle strength and lower prevalence of disorganized patellar-tendon and Achilles-tendon fibers than gymnasts diagnosed with tendinopathy. Twelve months later, the recovered gymnasts exhibited higher muscle strength and lower prevalence of disorganized tendon fibers than those who had sustained or developed tendinopathy. These findings should be addressed in training programs for young elite female gymnasts, to prevent and manage tendinopathy.

## Conventional Print Poster Presentations

### CP-MH25 Warm-up and Recovery

**ANALYSIS OF SPORT RECOVERY METHODS - EVIDENCE-BASED RECOMMENDATIONS**

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INTRODUCTION: Recovery from intense physical exertion is essential for athletes to maintain performance and prevent overtraining or injuries. Various active and passive recovery methods, such as hydrotherapy, massage, compression garments, and stretching, aim to reduce fatigue and muscle soreness. However, the optimal application of these strategies remains unclear, and practical guidelines for athletes and coaches are still debated.

METHODS: The review analyzes 120 studies from peer-reviewed journals indexed in PubMed, Clarivate Analytics, Scopus, ScienceDirect, and the Cochrane Library, published over the last five years, with a focus on high-performance sports research. Studies include randomized controlled trials (RCTs), crossover trials, case-control, cohort, and longitudinal studies to ensure methodological rigor. Active recovery methods such as stretching and low-intensity exercise are compared with passive strategies like cold-water immersion (CWI), sleep, relaxation techniques, and nutrition. All included studies provide practical recovery guidelines.

RESULTS: Active recovery timing and type significantly influence performance and injury prevention. Prolonged static stretching (>60s per muscle) can impair strength, while dynamic stretching (20–30s) may offer benefits. Passive recovery methods, such as CWI, affect muscle recovery and nerve function by altering ion exchange, slowing action potential generation, and reducing contraction speed. Cryotherapy, including CWI and ice packs, provides small but consistent benefits 48–96 hours post-exercise.

CONCLUSION: Evidence-based recommendations highlight active recovery techniques, like low-intensity exercises, for improving blood flow, lactate clearance, and endurance. Passive methods, including massage, compression garments, and water immersion, effectively reduce fatigue and muscle soreness. Recovery strategies should be tailored to individual needs, sport-specific demands, and exercise intensity. Further research is needed to refine long-term guidelines for athletic recovery.

**THE EFFECT OF THE FIFA+ WARM UP PROGRAM ON KNEE INSTABILITY AND MOTOR PERFORMANCE IN YOUTH SOCCER PLAYERS.**

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INTRODUCTION: This study aimed to investigate the effect of the FIFA+ warm up program on knee instability and motor performance in youth soccer players

METHODS: Thirty youth soccer players were divided into two groups: the experimental group (FIFA+) performed the FIFA+ program for 10 weeks, while the control group followed their usual warm-up routine. Dynamic knee valgus (DKV) and squat depth were assessed using a Microsoft Azure Kinect camera and dynaknee software. Maximal isometric muscle

force was measured with a dynamometer. The Y Balance test was used to evaluate dynamic balance, while a countermovement jump test assessed lower limb power. The knee range of motion was measured with a goniometer, and the T-test was used to evaluate agility

RESULTS: After the intervention, the FIFA+ group showed a significant decrease in DKV and squat depth ($p < 0.01$), while the control group showed no significant changes ($p > 0.01$). Both groups improved in motor performance, with slight progress noted in the FIFA+ group. However, neither group demonstrated significant improvement in dynamic balance ($p > 0.01$)

CONCLUSION: While the FIFA+ program may not substantially enhance overall motor performance or match the effectiveness of other training regimens, it shows potential for addressing biomechanical deficiencies and reducing the risk of injuries, particularly those related to dynamic knee valgus.

**ACUTE EFFECTS OF MASSAGE ON STIFFNESS OF THE MEDIAL GASTROCNEMIUS AND ITS FASCIA: RELATIONSHIP TO THE THICKNESS OF MUSCLE AND SUBCUTANEOUS FAT**

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INTRODUCTION: Massage is widely used in clinical and sports settings. However, it remains controversial whether massage decreases tissue stiffness (muscle and fascia). Some studies reported that massage decreased the stiffness of muscle (1) or deep fascia (2), but others reported no effect on the stiffness of muscle (3) or aponeurosis (2). In massage therapy, the fingers of the therapist apply mechanical stress to the muscle and fascia through the superficial tissues. This suggests that massage effects were affected by the thicknesses of superficial tissue covering the muscle and the muscle itself. Therefore, this study aimed to examine the acute effects of massage on muscle and fascia stiffness of the medial gastrocnemius (MG) and its fascia and their relationships with muscle thickness (MT) and subcutaneous fat thickness (SFT).

METHODS: The participants were 14 healthy adults (8 males and 6 females). Massage was applied by a physical therapist with its intensity was subjectively standardized across participants as much as possible. No intervention was applied on another day as a control condition. The intervention period was 11 min [massage for 2 min × 4 sets with a 1 min interval). The shear modulus of MG, shear wave velocity of MG fascia, ankle joint dorsiflexion ROM, and passive torque were measured before (Pre), immediately after (Post1), and 30 min after (Post2) the intervention. The MT and SFT were measured using an ultrasound imaging device at Pre. Data were analyzed using the Friedman test, post hoc Wilcoxon signed-rank test with Bonferroni corrections, and Spearmans rank correlation coefficient.

RESULTS: The shear modulus of MG was significantly increased from Pre to Post1 (+1.3 kPa [median difference], $p = 0.011$) in the massage condition, but not in the control condition. The main effect of the time was not significant for the ankle joint dorsiflexion ROM, passive torque, or the shear wave velocity of MG fascia in the massage or control conditions. Additionally, there were no significant correlations between the changes in the shear modulus of MG and MT (rho = −0.238, $p = 0.413$), SFT (rho = −0.253, $p = 0.382$) or MT+SFT (rho = −0.306, $p = 0.288$) in the massage condition.

CONCLUSION: Our results indicate that massage can increase muscle stiffness irrespective of MT and SFT, which is contrary to the prevailing belief. A possible explanation for the increase in shear modulus is inflammation (4) induced by massage. The present findings suggest that athletes and therapists should understand the possibility of an increase in muscle stiffness immediately after massage.

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**A STRUCTURED 7 MINUTES WARM-UP PROGRAM FOR PADEL PLAYERS**

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INTRODUCTION: Padel is considered as the fastest-growing sport in the world. Female players make up 37.5% of recreational players and 54% of padel players are 26 years old and above. It is fun, and easy to play, which makes it very attractive for people who either has never practiced sport or who quit sport long time ago and consider it as a sport without risk of injury or physical requirements.According to our studies, less than 50% of padel players perform some kind of warm-up before playing, and one of the reasons argued is that the court is usually occupied by the players of the previous match, and that renting the court is too expensive to waste time warming-up instead of playing.

METHODS: A web search was done in order to find if there is scientifically sound information for amateur player on the subject "Warm-up for padel". Almost no sites included the different phases of a structured program, and were not specific for padel: mosto f them referred to stroke practise in the court. To solve this problem, we have designed a 7 minute warm-up program (the INCIDE padel warm-up) that can be completed in the aísles surrounding the courts. In this way, the players could enter the court ready to practise the different racquet strokes for specific technical warm-up and start playing.

RESULTS: Phase 1: General Mobility (2 minutes) 1. Mobility for Spine and Shoulders (2 minutes) - Arm Circles: 30 seconds (15 seconds forward and 15 seconds backward). Forward lung with shoulder sweep (15 repetitions on each side). - Lateral Cross over lunge (10 repetitions on each side). - Shoulder Rotations: Raise your shoulders towards your ears and then roll them backward, 10 repetitions

Phase 2: General Activation (2 minutes) 2. Activation Tasks (2 minutes) – Walking heel rise with overhead reach (10 repetition s on each side). Jumping Jacks: 30 seconds. - Front Plank: 30 seconds. (Ensure you maintain good body alignment). - Side Plank: 15 seconds on each side (30 seconds total).

Phase 3: Change of Direction (3 minutes) 3. Change of Direction Tasks (3 minutes) - Light Jogging Forward and Backward: 1 minute. (Run from one end of the hallway to the other, touching the ground at each end). - Lateral Shuffles: 1 minute. (Side movements from one side to the other along the hallway). - In-Place Running with Direction Changes: 1 minute. (Run in place and make a turn every 10 seconds, simulating direction changes during the game).

CONCLUSION: The INCIDE padel warm-up program was tested during the 24/25 padel season, and most of the players found it easy to perform and adecuate for their sport level.

The INCIDE padel warm-up program has been uploaded to the Internet to offer a free tool for players who want to use it

**PRE-EXERCISE HIGH-INTENSITY LASER THERAPY ALTERS DYNAMIC MUSCLE DISPLACEMENT USING ULTRASOUND SPECKLE TRACKING AFTER FATIGUE: PRELIMINARY RESULTS**

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INTRODUCTION: Muscle fatigue, defined as a decrease in force or power during intense exercise, raises injury risk [1], highlighting the need for preventive strategies in sports. High-intensity laser therapy (HILT) has been shown to mitigate strength loss from fatigue [2], yet its effects on muscle contractile behaviors—specifically muscle shortening and displacement—remain unclear. Research using ultrasound speckle tracking (UST) has linked muscle displacement to isometric contractions [3], showing reduced displacement during fatigue [4]. However, the potential of pre-exercise HILT to counteract these changes has not been thoroughly explored. This study hypothesizes that pre-exercise HILT can attenuate declines in muscle displacement and force loss from fatigue, as assessed through UST.

METHODS: Eight healthy males (23.44 ± 1.59 years) received HILT with a Class 4 laser (900 J) and a sham treatment on two separate days, in randomized order. After each treatment, participants performed concentric knee extensions at 60°/s to induce fatigue. Before and after fatigue, maximal voluntary isometric contraction (MVIC) knee extensions were performed on an isokinetic dynamometer, measuring muscle displacement and peak torque. Ultrasound imaging quantified vastus lateralis displacement (mm) and MVIC decline (%). Two-way repeated measures ANOVA and paired t-tests analyzed muscle displacement and strength loss.

RESULTS: A significant time-treatment interaction was found for muscle displacement ($p = 0.03$). Displacement differed between HILT and sham both pre- and post-fatigue ($p = 0.033$ and $p = 0.001$, respectively). The post-fatigue displacement change was lower with HILT (2.12 ± 1.6 mm) than sham (3.43 ± 1.15 mm, $p = 0.03$). MVIC declined less with HILT (17.75 ± 12.86%) than sham (30.61 ± 17.29%, $p = 0.007$).

CONCLUSION: Preliminary findings suggest HILT reduces fatigue-induced declines in muscle displacement and strength. Muscle contractile decline post-fatigue may stem from inadequate blood flow. Laser-induced vasodilation could enhance contractility, minimizing strength loss. Future research should explore whether muscle displacement serves as a marker for force loss post-fatigue.

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**NEUROMUSCULAR PRIMING WITH SPINAL CORD TRANSCUTANEOUS STIMULATION: EFFECTS ON LOWER LIMB MOTOR PERFORMANCE**

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INTRODUCTION: Neuromuscular priming strategies can be implemented to enhance muscle strength and power generation (1), which are critical determinants for daily life activities and athletic performance. However, the effects of non-invasive spinal cord transcutaneous stimulation (scTS) on motor control and neuromuscular performance in healthy subjects are not known. Therefore, the aim of this study was to investigate the effects of an exercise-based priming protocol combined with scTS on the neuromuscular performance of lower limbs in young active males. We also evaluated how scTS alone influenced lower limb motor performance.

METHODS: Twelve volunteers (age: 22.7±2.1 years) participated in this randomized crossover, sham-controlled study. Maximal voluntary contraction of the knee extensors (MVC) and maximal explosive power of the lower limbs were assessed at baseline, with scTS or sham stimulation, and after the priming protocol with scTS or sham across four experi-

mental sessions. Further, characteristics of evoked potentials to scTS related to spinal circuitry excitability were assessed in supine position before and after the scTS priming protocol. The exercise component of the ~25-minute priming protocol was characterized by low-volume, low- and high-intensity lower limb motor tasks.

RESULTS: We found trends toward enhanced mechanical outputs following the scTS priming protocol, whereas the sham priming protocol was associated with reduced neuromuscular performance. This resulted in a 9% difference between the scTS and sham priming protocols during MVC of knee extensors (p=0.002). Similarly, for maximal explosive power, the mean differences in peak force and rate of force development (RFD) were 3.1% and 21.1%, respectively (p = 0.019 and 0.002, respectively)). Conversely, no significant differences were observed between baseline and maximal efforts performed with scTS or sham for any of the investigated variables (p values between 0.850 and 0.465). Furthermore, assessment of evoked potentials to scTS in supine showed a trend of increased excitability after scTS priming protocol.

CONCLUSION: scTS priming protocol enhanced the performance of lower limb maximal efforts when compared to the sham priming protocol. This is associated with trends of increased spinal excitability after the scTS priming protocol. Positive effects of scTS priming protocol on maximal neuromuscular performance might be related with spinal excitability modulation that brings neural networks closer to the activation threshold and amplifies descending neural drive during exercise. No effects of scTS alone might be related to the interference of stimulation with neural processes (2).

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**ACUTE EFFECTS OF NERVE GLIDING VERSUS STATIC STRETCHING ON STIFFNESS AND STRENGTH AT HIGH AND MODERATE STRETCH AMPLITUDES.**

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INTRODUCTION: Acute stretching effects have widely been studied in the literature. However, the mechanisms and structures involved in stretch tolerance remain poorly understood (1). While muscle structures play a key role, other factors are also implicated such as fascia and nervous tissue (2). This study investigated stretching modalities targeting specific anatomical structures (nerves or muscles) at different intensities (at pain threshold and 10% below). The objective is to determine whether nerve-targeted stretching can contribute to reducing muscular and/or neural stiffness and to increasing the range of motion without affecting force production.

METHODS: 21 physically active volunteers (12 women and 9 men) participated in this randomized crossover study. Experimental sessions involved stretching exercises in five conditions: static stretching, nerve gliding flossing performed both at pain threshold and 10% below, and a control condition where participants rested passively.

The static stretching protocol included five 60-seconds sets, while nerve gliding flossing was comprised of five 30-repetitions sets at 0.5 Hz combining dorsiflexion/plantar flexion and cervical spine flexion/extension. Testing included maximal voluntary isometric contractions of the right hamstrings, EMG measurements of biceps femoris (BF) and semitendinosus (ST), passive knee extension (PKE), Stand and Reach test (SR), and ultrasound elastography to measure shear wave velocity of the right sciatic nerve and BF. A two-factor ANOVA was used to compare effects before and after the interventions.

RESULTS: No significant interaction between condition and time was observed for maximal torque (p= 0.971) or EMG activity of the BF (p = 0.381) and ST (p = 0.553). The control condition had no significant effect on amplitude, whereas all stretching modalities demonstrated a time-dependent improvement. For both PKE and SR, the amplitude increased immediately after the experimental session (p < 0.001). Shear wave velocity of the BF muscle significantly decreased after stretching (p= 0.003), with no significant differences between conditions (p= 0.433). However, the sciatic nerve shear wave velocity decreased over time only in the nerve gliding flossing at pain threshold condition (p < 0.001).

CONCLUSION: All stretching modalities increased the amplitude without significantly affecting strength. However, nerve gliding flossing induced an additional performance gain by reducing shear wave velocity on the nerve, suggesting that stretch tolerance may be partly modulated by nerve properties. Therefore, nerve gliding flossing could be as critical as muscle stretching in optimizing both amplitude and strength, making it an important part of sports training protocols.

**DEVELOPMENT OF A NEW INDEX OF RECOVERY AFTER SPORTS INJURY: EXCITABILITY OF CENTRAL NERVOUS SYSTEM FUNCTION DURING MUSCLE STRENGTH ADJUSTMENT.**

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INTRODUCTION: Tissue healing, muscle strength, range of motion, and performance tests are often used to assess return to play after sports injuries. However, muscle strength itself can sometimes cause injury, and a smaller range of motion may be beneficial in sprinting. Therefore, these may not be sufficient for recovery and return to play. Additionally, standard performance tests may fail to evaluate the complex motor skills needed in sports. As a preliminary step in developing objective indicators for determining return to play, this study aimed to investigate the excitability changes in central nervous function (CNS) during muscle output regulation under different feedback methods among athletes, as well as to examine the characteristics of cases where athletes have not yet returned to play after a sports injury.

METHODS: The study involved 13 female university basketball players. Of these, 12 were participating in the sport without any issues, and 1 (Case), three months post hemilateral meniscal repair, was unable to run. Using the BIODEX System 4 (Biodex), participants were seated with the knee flexed at 60 degrees and were asked to maintain 25% of the maximum effort of voluntary isometric contraction of knee extension for 60 seconds. During torque maintenance, a mixed-nerve silent period (SP) was derived from the ipsilateral opponens pollicis muscle using a Neuropack (Nihon Kohden). SP was recorded 16 times by applying electrical stimulation to the median nerve at the wrist while the participant lightly held a rubber ball to induce slight contraction in the opponens pollicis muscle. The electrical stimulation conditions were a supramaximal intensity, a frequency of 0.5Hz, and a duration of 0.2msec. Torque maintenance was performed under two conditions: visual feedback (A) and verbal instructions from the examiner (B), in the order of A-B-A. The duration of the 16 recorded SPs was measured, and their average was used as the representative value for each condition. Statistically, the Shapiro-Wilk test was used to confirm normality, followed by the Wilcoxon signed-rank test, with a significance level set at 5%.

RESULTS: SP (ABA) for the dominant leg were 109.5±10.5ms, 106.3±7.5ms, and 109.6±7.3ms, and that for the non-dominant leg were 104.9±5.9ms, 103.2±6.5ms, and 105.7±6.6ms, with no significant difference (n=12). In Case, similarly, the injured leg had SP of 113.3ms, 123.7ms, and 115.2ms, and the non-injured leg showed SP of 111.7ms, 110.8ms, and 103.3ms.

CONCLUSION: In this study, the excitability of the upper CNS in athletes did not change based on the feedback method, unlike a previous study where verbal instructions increased CNS excitability in non-exercising individuals. However, in Case A, where movement acquisition was delayed, the results differed not only from the athletes but were also the opposite of those found in non-exercising individuals in the previous study. The results of this study suggest that individuals who have not achieved smooth recovery post-sports injury may experience changes in CNS excitability dynamics during muscle output regulation. This indicates the potential of using neurophysiological tests, such as those involving evoked electromyography, as one indicator to evaluate recovery progress after sports injuries.

## Conventional Print Poster Presentations

### CP-MH26 Sarcopenia / Osteoporosis

**DOES THE EFFECT OF BODYWEIGHT RESISTANCE TRAINING ON THE 30-SECOND CHAIR STAND TEST RELATE TO MUSCLE STRENGTH, MUSCLE MASS, AND LOCOMOTIVE FUNCTION?**

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INTRODUCTION: The 30-second chair stand test (CS-30) has been reported to be useful for evaluating lower limb muscle strength and sarcopenia in older people [1,2], and we also reported at ECSS 2024, that the CS-30 score is associated with gait speed. We also have previously reported that 12 weeks of bodyweight-based resistance training improves muscle mass, muscle strength, and locomotive function [3, 4]. In this study, we aimed to verify the effect of resistance training on improving the CS-30 score and to clarify the relationship with changes in other factors.

METHODS: Fifty-two community-dwelling Japanese people aged ≥60 years (72.0±5.4 years) were divided into a training (TR) group and a control (CTR) group. The TR group participated in a 12-week exercise class that included resistance training once per week and were instructed to perform the same training at home once per week. In contrast, the CTR group were instructed to maintain their daily activities.

Physical fitness measurements were performed before and after the 12-week intervention period, including the CS-30, maximum gait speed, isometric knee extension strength, and body composition assessment using the InBody 770. The body composition assessment focused on lower limb muscle mass and phase angle (PhA).

Two-way ANOVA was used to determine training effects and for multiple regression analysis, the rate of change in the CS-30 was used as the objective variable, and the rates of change in gait speed, isometric knee extension strength, lower limb muscle mass, and lower limb PhA were used as explanatory variables.

RESULTS: Two-way ANOVA revealed that time was a significant main effect for CS-30 ($p<0.001$), but there was no significant main effect between groups ($p=0.44$) or interaction ($p=0.80$), and the TR and CTR groups improved. Multiple regression analysis revealed that the rate of change in isometric knee extension strength, corrected for lower limb PhA, was the only significant explanatory variable in the CTR group ($\beta=0.50$, $p<0.01$), with a statistically significant regression (adjusted R-squared=0.22, $p<0.01$). There was no statistically significant regression in the TR group.

CONCLUSION: CS-30 improved significantly in the TR and CTR groups before and after the 12-week intervention; however, the related factors are thought to be different. This suggests that improvement in the CTR group was influenced by an improvement in maximum muscle strength in isometric knee extension. Moreover, since no variables showed a significant association in the TR group, it is possible that the improvement in CS-30 due to resistance training using body weight involves changes in factors other than maximum muscle strength in isometric knee extension, muscle mass, and locomotive function.

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**IMPACT OF A 12-WEEK TRX-BASED MULTICOMPONENT EXERCISE PROGRAM ON SARCOPENIA IN OLDER ADULTS: A PILOT STUDY**

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INTRODUCTION: Sarcopenia is undoubtedly one of the most defining aspects of aging, significantly affecting both health and quality of life. This condition is marked by a progressive decline in muscle mass and strength, which negatively impacts physical performance. Promoting healthy aging requires a focus on maintaining muscle mass and strength, with regular exercise being a effective prescription for improving physical function. It has shown that multicomponent exercise programs yield superior outcomes compared to concurrent exercise programs in older adults, enhancing various physical fitness measures [1]. To comprehensively address sarcopenia, it is crucial to incorporate a combination of aerobic, resistance, and balance training. In this context, we have developed a multicomponent exercise program that uniquely integrates TRX suspension exercises as a resistance training component. We hypothesize that a 12-week multicomponent exercise program will not only enhance daily physical performance but also improve appendicular skeletal muscle mass index (ASMMI) and grip strength in older adults with sarcopenia.

METHODS: This is a pilot study aimed at assessing the feasibility and initial effects of an exercise intervention on muscle quantity and quality. Twenty-one women (77.24 ± 9.53) were randomly assigned to two groups: the multicomponent exercise group (EG; n = 12) and the control group (CG; n = 9). Body composition and physical performance were evaluated before and after training using the Short Physical Performance Battery (SPPB), Timed Up and Go (TUG) test, and a Jamar hydraulic dynamometer. Body composition was assessed via the Akern 101 bio-impedance analysis system.

RESULTS: Univariate ANCOVA analyses, controlling for baseline measurements, consistently demonstrated that the exercise group outperformed the control group in SPPB ($F = 4.688$, $p = 0.046$, $\eta^2 = 0.227$), particularly in TUG performance ($F = 7.410$, $p = 0.014$, $\eta^2 = 0.293$) and walking speed (4-meter test) ($F = 8.031$, $p = 0.011$, $\eta^2 = 0.321$). Regarding sarcopenia indicators, including ASMMI and dominant grip strength, only grip strength showed a significant difference between the exercise and control groups after baseline adjustments ($F = 6.863$, $p = 0.019$, $\eta^2 = 0.271$). Notably, the control group experienced a decline in grip strength over time. The paired t-test revealed a significant increase in ASMMI in the exercise group, while the control group did not show any significant change.

CONCLUSION: In conclusion, this pilot study provides promising evidence for the efficacy of a 12-week multicomponent exercise program in improving both physical performance and sarcopenia-related outcomes in older adults. The incorporation of TRX exercises, proved to be an effective strategy and feasible with older adults.

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**HIGH-INTENSITY INTERVAL TRAINING ENHANCES OSTEOCALCIN LEVELS: A META-ANALYSIS OF EXERCISE EFFECTS ON BONE REMODELLING BIOMARKERS**

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INTRODUCTION: The relationship between biomarkers of bone remodelling due to regular exercise is unknown, it cannot be predicted what type and volume of exercise are optimal for bone remodelling. We aimed to quantify the effects of regular training on bone remodelling biomarkers, particularly osteocalcin and bone alkaline phosphatase in healthy adult populations.

METHODS: This study (PROSPERO: CRD42023483811) explored the effects of regular training through a systematic review and meta-analysis and included only randomized controlled trials examining different types (endurance, power, mixed) and intensities, frequency and duration of training. MEDLINE, Embase, and CENTRAL were searched on November 22, 2023. Risk-of-bias and quality assessment were performed by Cochrane RoB2 and GradePro.

RESULTS: 12,828 records were screened, and 22 studies with 1,126 participants were analysed. Endurance training showed no significant effect on osteocalcin level. High- and low-intensity endurance training also did not significantly affect osteocalcin. High-intensity interval training (HIIT) significantly increased osteocalcin levels (MD = 12.00; 95% CI: 8.40 to 15.50). Power training showed no significant change in osteocalcin level. Mixed training (endurance + power) did not significantly change osteocalcin level. Bone alkaline phosphatase showed no significant change following endurance training. Bone Mineral Density showed no significant changes following endurance and power training. Endurance training decreased body mass index, but the result was statistically not significant. The risk of bias for all outcomes was low. Grade assessment for osteocalcin in the HIIT group revealed moderate to low certainty.

CONCLUSION: This study is the first systematic review and meta-analysis that summarizes the results of the currently available randomized controlled trials, investigating the effects of regular training on bone biomarkers in healthy adults,

specifically osteocalcin and bone-alkaline phosphatase. Our study demonstrates that only HIIT significantly impacts osteocalcin levels, whereas other exercise types such as high-intensity, low-intensity, power, and mixed training do not. After the analysis of the training effectiveness in different training frequency and duration we also found that, osteocalcin synthesis is not dependent on duration or frequency but rather intensity. Specifically, we observed significant changes in osteocalcin levels exclusively with high intensity interval training, regardless of whether the training was of short or long duration. Our analysis showed similar patterns in the effect of training on bone-alkaline phosphatase level. Our findings highlight that when the synergistic effect of high intensity, dynamical loading, and rest periods during training were simultaneously present, we observed significant changes in bone metabolism markers, and a strong positive trend in the improvement of body mass index and bone mineral density.

**OPTIMIZING BONE-LOADING INTENSITY FOR OSTEOPOROSIS PREVENTION: PROTOCOL FOR AN MHEALTH INTERVENTION IN POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Osteoporosis poses a global health challenge, particularly in postmenopausal women, due to decreased bone density and increased fracture risk. Physical activity, specifically weight-bearing and impact-loading exercises, is a proven strategy to stimulate bone growth and prevent bone loss. However, identifying and sustaining the appropriate intensity of mechanical loading remains a challenge for individualized intervention. This study presents a protocol for a randomized controlled trial using an mHealth-based approach to assess the impact of exercise intensity on bone health outcomes in postmenopausal women.

METHODS: Participants are postmenopausal women (n=120) aged 50–65 years, randomized into intervention and control groups. The intervention group engages in structured daily physical activity incorporating weight-bearing and impact-loading exercises. Wearable accelerometers measure biomechanical loads, focusing on achieving optimal osteogenic thresholds (≥3.9G). Intensity and frequency data are personalized and monitored via an mHealth app, which provides real-time feedback and adaptive programming to enhance adherence. Bone mineral density, geometry, and strength are assessed via DXA scans and peripheral quantitative computed tomography (pQCT) at baseline, 6 months, and 12 months. Machine learning models analyze biomechanical data to refine individualized intensity thresholds.

RESULTS: Preliminary testing has validated the accelerometer-based approach to reliably capture impact-loading intensity. Pilot participants successfully maintained the target loading thresholds in over 80% of sessions, demonstrating the feasibility and acceptability of the mHealth platform. Bone-loading patterns correlated positively with improvements in surrogate markers of bone health, including markers of bone turnover.

CONCLUSION: This protocol emphasizes the critical role of personalized exercise intensity in driving osteogenic responses. By leveraging accelerometer technology and mHealth integration, it provides a scalable and adaptive model for osteoporosis prevention. Future results will contribute to the evidence base for individualized bone-loading thresholds, guiding clinical and public health strategies to reduce osteoporosis-related morbidity. This innovative framework highlights the potential of technology-driven interventions to enhance adherence and optimize health outcomes in at-risk populations.

**SENIOR FITNESS TEST AS A PREDICTOR OF BONE HEALTH IN OLDER ADULTS**

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INTRODUCTION: Osteoporosis poses a significant health risk in older adults, yet reliable and rapid screening methods remain limited. The Senior Fitness Test is widely used to assess physical fitness in older adults, but few studies have explored its relationship with bone mineral density (BMD) and osteoporois risk. This study aimed to examine the association between Senior Fitness Test performance and BMD and compare BMD values among endurance-trained athletes, resistance-trained individuals, and inactive older adults.

METHODS: A three-year longitudinal study was conducted with 138 adults aged 65+, divided into three groups: endurance-trained athletes (SP, n=46), resistance-trained individuals (RT, n=46), and inactive older adults (IN, n=46). Participants underwent annual DEXA scans to assess BMD at the lumbar spine and femur and completed the Senior Fitness Test, including lower-body strength (Chair Stand Test), dynamic balance (8-Foot Up-and-Go Test), and aerobic capacity (2-Minute Step Test). Osteoporois risk factors were assessed based on prior fractures and fall history.

RESULTS: A significant correlation was found between Senior Fitness Test performance and BMD. Chair Stand Test and 8-Foot Up-and-Go Test scores positively correlated with BMD ($r=0.68$, $p<0,01$), while flexibility tests showed no significant association ($p>0,05$). The RT group exhibited the highest BMD values, whereas no significant difference was found between the SP and IN groups ($p=0.12$). In the SP group, femur BMD was 7.1% lower compared to the RT group ($p<0.05$), particularly among those who did not incorporate resistance training into their regimen.

CONCLUSION: Our findings suggest that Senior Fitness Testm particularly Chair Stand Test and 8-Foot Up-and-Go Test, may serve as effective predictors of BMD and osteoporis risk. This indicates that Senior Fitness Test could be a rapid and cost-effective screening tool for assessing bone loss in older adults. Furthermore, our results highlight that endurance training alone may not be sufficient for maintaining BMD, whereas resistance training appears to play a crucial role in bone mass preservation.

**AGE RELATED-SEX DIFFERENCES IN CARDIOVASCULAR RESPONSES TO ECCENTRIC CYCLING : PRELIMINARY OUTCOMES OF THE SWEETEXC STUDY**

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INTRODUCTION: Endurance exercises are well-documented to improve cardiorespiratory fitness that reduces overall mortality, including in elderly and pathological populations. However, traditional exercises such as locomotors activities (e.g. walking, cycling) are mainly used in their concentric muscle contraction form, but may prevent deconditioned people from achieving sufficient levels of muscle mechanical tension. Eccentric cycling seems to be a promising alternative in a clinical context as it requires less oxygen uptake than traditional cycling for greater muscle stimulation. While the neuromuscular approach has been largely studied, the evolution of cardiovascular responses during eccentric cycling as a function of age and sex remains unexplored. We hypothesize that the rate pressure product (RPP = Heart Rate*Systolic Blood Pressure) is a reliable easy-to-monitor indicator for prescribing the intensity of eccentric cycling.

METHODS: 9 healthy young and old people have so far been included in this study (14 are currently included). The first visit was an incremental test to determine concentric maximal aerobic power on a semi-recumbent seated cycle (MAPCON). After familiarisation, eccentric cycling consisted of 5-minute stages at 5 intensities (40%, 55%, 70%, 85%, 100% of MAPCON) performed at 40 rpm. A non-invasive blood pressure device (Finapres Medical Systems, Chennai, India) and a 3-lead electrocardiogram were used to collect hemodynamic responses and heart rate, respectively.

RESULTS: The higher the intensity, the greater the hemodynamic responses and heart rate. All responses tended to be proportional to intensity, whether the heart rate (100%MAPCON : 110.2 ± 8.6 bpm; 70% MAPCON : 102.9 ± 10.4 bpm; 40%MAPCON : 82.8 ± 12.0 bpm), systolic blood pressure (100%MAPCON : 171.6 ± 12.6 mmHg; 70% MAPCON : 156.6 ± 16.2 mmHg; 40%MAPCON : 149.8 ± 8.4 mmHg), or cardiac output (100%MAPCON : 10.5 ± 2.9 L.min-1; 70% MAPCON : 10.2 ± 2.2 L.min-1; 40%MAPCON : 6.2 ± 0.9 L.min-1). As a result, RPP showed a similar increase (100%MAPCON : 10.5 ± 2.9 L.min-1; 70% MAPCON : 8.2 ± 1.7 L.min-1; 40%MAPCON : 6.2 ± 0.9 L.min-1), with no threshold since a linear increase seems to be apparent with the intensity increments (R2=0.988).

CONCLUSION: These preliminary data do not allow further investigation or comparisons between groups. However, eccentric cycling appears to be a safe and tolerated alternative when performed at submaximal intensity. Its consideration in the clinical context may be relevant for population with severely limited exercise capacity.

## Conventional Print Poster Presentations

### CP-MH27 Sports Medicine and Orthopedics - Knee, Ankle, Foot

**OUTCOME DEFICITS IN FEMALE ATHLETES AT 8-12 MONTHS FOLLOWING ACL RECONSTRUCTION**

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INTRODUCTION: Female athletes face a 2-8 times higher likelihood of sustaining an ACL injury compared to their male counterparts. Reinjury rates following ACL reconstruction (ACLR) are notably high, ranging from 20-30%. Decisions on return to sports (RTS) are often based on time rather than objective measures. Current RTS testing for ACL injuries primarily assesses quadriceps strength and hop test symmetry, overlooking crucial performance gaps and asymmetries that are vital for athletic success. Rehabilitation and RTS protocols have predominantly been developed using male-centric models, which do not fully address the unique biomechanical and neuromuscular factors that influence recovery and performance in females. This study explored the differences between genders in ACL RTS testing, incorporating patient-reported outcomes (PROs), balance, strength, and single-leg (SL) jump performance metrics.

METHODS: Athletes who were 8-12 months from ACLR surgery and aged 15-17 years (N= 55; female = 31, male = 24) performed an ACL RTS test battery that included PROs (GRIT, IKDC, ACL-RSI), y-balance, SL hop, SL triple hop, SL countermovement jump (CMJ) using force plates, and isokinetic dynamometry.

RESULTS: A Principal Component Analysis (PCA) identified key variables that differentiate ACLR athletes. Principal component one (PC1) explained 25% of the variance that was primarily driven by the involved limb in SL hop (female = 110.6±26.83cm; male = 151.6±30.73cm), SL CMJ jump height Imp-Mom (female = 8.9±3.06cm; male = 14.2 ± 4.37cm), peak power (female = 22.2±3.85W/kg; male = 29.1±5.65W/kg), concentric impulse (female = 82.2±18.76Ns; male = 124.8±26.09Ns), and peak landing force (female = 29.7±4.69N/kg; male = 35.7±5.82N/kg). Uninvolved limbs, as well as isokinetic quad and hamstring strength (60 deg/s), and SL triple hop, contributed to a small proportion of the variance. There were no differences in PROs and y-balance.

CONCLUSION: Significant gender differences in neuromuscular performance extend beyond the affected limb, reflecting both local and systemic adaptations that occur 8-12 months following ACLR. Force plate testing revealed critical neuromuscular deficits that are frequently overlooked in standard RTS protocols for ACL rehabilitation that do not incorporate force plate testing. These deficits involve gender-specific variations with asymmetry across the sequence of a CMJ (concentric impulse, peak power, and landing force), implying training gaps in force application, propulsion, and landing mechanics. This may be a result of a younger training age in which these athletes have less experience with strength

training and plyometrics that would address neuromuscular control and proper biomechanics. Female athletes may require additional focused interventions during rehabilitation to address more aspects of neuromuscular performance due to their lower training ages and different levels of competition.

**EXERCISE PREHABILITATION BEFORE ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION – A SINGLE-BLINDED RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: Although the effectiveness of preoperative training before anterior cruciate ligament (ACL) reconstruction is well-established, there is ongoing debate regarding its optimal structure, including the specific components, degree of supervision (one-on-one guidance or self-administered training) and overall framework. This study evaluated the effectiveness of an individually tailored, adaptive, guided, structured, and criteria-based preoperative rehabilitation program in contrast to a non-guided, self-administered home training program in individuals with an ACL rupture.

METHODS: Participants with an unilateral complete ACL rupture, scheduled to an arthroscopic ACL-reconstruction with a hamstrings or quadriceps autograft in >3 weeks after inclusion were included. They were investigator-blinded block-randomised using an 1:1 allocation to one of the following groups: intervention group (structured, criteria-based, guided prehabilitation training) and comparator group (non-guided, self-administered home training). After ACL reconstruction, patients of both groups participated in a standard, postoperative rehabilitation program. Self-reported knee function (KOOS sum score) was the primary outcome and assessed at six specified time points: during the initial anamnesis in the hospital (t1), 1-7 days prior to ACL reconstruction (t2), and at 30 (t3), 60 (t4), 90 (t5), and 180 (t6) days postoperatively. The analyses were conducted based on an intention-to-treat basis, linear mixed models for the change scores to t1 were calculated.

RESULTS: In the 114 enrolled participants (mean age M = 31.03 years, SD = 10.30 years; 47% males, 53% females), the ACL rupture injuries occurred while playing football (37%), while skiing (26%), others (37%). After study commencement, 59 participants discontinued intervention or withdrew consent during the course of the study. The intervention group (KOOS score M1: mean = 46.04, 95% confidence interval = [45.07 to 47.02]; M2: 58.52, [57.51 to 59.54]) demonstrated a more pronounced preoperative improvement from t1 to t2 in the KOOS score compared to the comparator group (KOOS score M1: 51.01, [50.10 to 51.92]; M2: 59.18, [58.40 to 59.96]). The interaction (group*time) of the KOOS score reached significance for the change score from t1 to t3 (p = 0.039) and to t5 (p = 0.039).

CONCLUSION: An individually tailored, adaptive, guided, structured, and criteria-based preoperative rehabilitation program improved perceived knee function more than self-guided training. However, the evidence is limited as the effects are small. Self-administered training presents the challenge of maintaining self-motivation due to the absence of structured scheduling and personal guidance while guided training is more structured and more accountable.

**MEDIAL MENISCUS EXTRUSION BEFORE AND AFTER 30-MIN RUNNING IN INDIVIDUALS WITH MENISCUS SURGERY, ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION, AND HEALTHY CONTROLS**

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INTRODUCTION: While medial meniscus extrusion (MME) is one of the potential contributors to developing knee joint complications, the relative degree of MME and its response to running in individuals with a history of knee joint surgery remain unclear. This study evaluated whether the MME in individuals with meniscus surgery, anterior cruciate ligament reconstruction (ACLR), and healthy individuals differ before and after 30-min of treadmill running.

METHODS: A total of 63 subjects (21 individuals each in meniscus surgery: 30.0 years, 172.5 cm, 74.4 kg, time since surgery: 47.9 months; ACLR: 27.0 years, 174.2 cm, 76.2 kg, time since surgery: 44.4 months; and healthy control: 24.9 years, 171.3 cm, 68.7 kg). Ultrasonographic images using a 12 MHz linear probe (gain: 20 Db; dynamic range: 50 dB; frame rates: 30 fps; depth: 3 cm) of the MME in the supine and standing positions [1] were obtained before and after 30-min of treadmill running at a self-selected moderate intensity (running speed to correspond to the Borg's Perceived Rate of Exertion of the 5-6 /10 scale) [2]. Running speed, heart rate, and step count were compared between groups to assess running intensity. Data were analyzed using analysis of variance and Tukey-adjusted post hoc tests ($p<0.05$) with effect sizes (d).

RESULTS: MME in the supine position was different (group by time: $F_{2,60}=8.00$, $p=0.0008$) that individuals with meniscus surgery showed a 13% increase in MME after running ($p=0.01$, $d=0.57$). MME in the standing position was different (group by time: $F_{2,60}=3.42$, $p=0.04$), but Tukey-adjusted pairwise comparisons did not identify any statistical differences ($p>0.16$ for all tests). Statistical trends were observed that individuals with ACLR showed greater MME than those with meniscus surgery (supine: –16%, $p=0.09$, $d=0.68$; standing: –11%, $p=0.19$, $d=0.56$) and control group (supine: –12%, $p=0.10$, $d=0.68$; standing: –14%, $p=0.16$, $d=0.69$) group before running. The running speed ($F_{2,60}=1.16$, $p=0.32$), heart rate ($F_{2,60}=0.70$, $p=0.50$) and step count ($F_{2,60}=1.92$, $p=0.16$) during 30-min treadmill running did not differ between groups.

CONCLUSION: While limited data are available on change in MME in response to functional movements, our results provide meaningful clinical insights into MME morphology, suggesting that (1) running activity may immediately induce further extrusion of the medial meniscus in individuals who have undergone meniscus surgery and (2) individuals with ACLR may have greater MME than those with meniscus surgery healthy controls.

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**CHRONIC EFFECTS OF RESISTANCE TRAINING ON FUNCTIONAL AND CLINICAL OUTCOMES IN INDIVIDUALS WITH PATELLAR AND ACHILLES TENDINOPATHY: A SCOPING REVIEW.**

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INTRODUCTION: Tendinopathy is a disabling and painful condition in athletes, with a prevalence of up to 45% in specific sports like running, basketball, and volleyball [1]. One of its predominant causes is mechanical overuse of the tendon tissue, which can result in repetitive strain beyond physiological limits, resulting in a degenerated and weakened tendon [2]. Eccentric training has been the gold standard of treatment; however, it is pain-provoking leading to maladaptive changes in the excitability and inhibition of the primary motor cortex, resulting in altered movement patterns of the affected muscles [3]. This study is part of a bigger scoping review, that aims to investigate the different outcomes of chronic eccentric training (ECC) and heavy slow resistance training (HSRT) regarding functional, morphological, and clinical outcomes in participants with patellar and Achilles tendinopathy.

METHODS: An electronic search was conducted in three databases (Pubmed, Scopus, and Web of Science). In total, 5460 studies were identified. After removing duplicates (n=1862), two researchers screened the remaining articles by title and, if necessary, by abstract. After extracting the data from the included studies, pain (VAS), VISA questionnaire (Patellar and Achilles), neovascularization, and strength of main muscles were assessed. Values are expressed as weighted mean changes (in percentage) and pooled standard deviation.

RESULTS: after a thorough screening process, 24 studies were included in the review. Eccentric training yielded the highest changes in neovascularization, with a 5.11% ± 0.04 decrease in neovessels in the tendon (HSRT increased by 11.42%). On the contrary, HSRT showed higher gains in strength (12.06% ± 0.14 vs. 5.79% for ECC) and VISA questionnaire (36.79% ± 0.04 vs. 34.09% for ECC), and the greatest reduction in pain (56.16% ± 0.06 vs. 41.74% for ECC). Correlation analyses revealed a strong positive correlation ($r = 0.797$, $p = 0.01$) between neovascularization and pain, for ECC and HSRT combined.

CONCLUSION: Although ECC training showed a decrease of neovessels in the tendon, HSRT had a greater impact on performance and clinical outcomes, representing the main areas of interest in recovery for athletes. Therefore, ECC training seems to have a bigger influence on morphological parameters in the tendon. However, it does not seem to be the best option when returning to pre-injury levels regarding performance and absence of pain, which is the main goal for athletes during tendinopathy rehabilitation.

**IMPROVING DECISION MAKING IN ACLR: SHAP ANALYSIS OF A SUPPORT VECTOR MACHINE**

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INTRODUCTION: Treatment of anterior cruciate ligament (ACL) injuries involves various decisions. Most obviously, the type of graft to reconstruct the ACL has to be chosen. In recent years, the lateral extra-articular tenodesis (LET)[1] is regaining more attention, introducing another decision to make. Opting for the LET increases knee rotatory stability and may reduce the re-rupture rate of the ACL [2], but it causes increased surgery and recovery time as well as an elevated risk of limited range of motion [3]. Hence, LET should only be performed when necessary. In this work we seek to develop a data-based recommendation system to aid in this decision-making process.

METHODS: The ACL treatment decision-making process was recorded in a dataset for 500+ patients treated at the Gelenkpunkt Medical Practice. The dataset contains 23 features per patient such as age, gender, posterior tibial slope, pivot shift test results etc. Expert level surgeons judged each patient's condition to determine which graft type should be used and if an LET should be performed. These decisions were stored in the database together with all input features. After normalising and splitting the dataset into training and test parts a support vector machine (SVM) was fitted to predict the LET decision based on the patient's input features. Using Shapley-based explanations, the resulting SVM was investigated to gain insight in the most important features.

RESULTS: The trained SVM obtained the following scores on the test dataset: accuracy: 78%, precision: 63%, F1: 65% and an area under the ROC curve of 86%. Using SHAP analysis the most important patient's features were found to be participation in competitive sports with an average value of 0.19, a high positive pivot-shift test with an average value of 0.17 and gender with an average value of 0.11. Upon inspecting the SHAP values, it is observed that most features contribute positively to the LET decision. Age at surgery is one of the few exceptions, which indicates a younger patient is more likely to receive an LET.

CONCLUSION: The performance of the SVM is satisfactory but leaves room for improvement. The developed methodology of fitting a machine learning model on the decision-making dataset proves promising and could help the development of

new decision-making tools for the LET procedure. These tools could for example be used to help more unexperienced physicians to make better decisions in the ACLR treatment process.

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**HOW GENU VARUM AFFECTS LOWER LIMB MUSCLE ACTIVITY AND IILIOTIBIAL BAND TENSION IN RUNNERS**

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INTRODUCTION: Iliotibial band syndrome (ITBS) is the most prevalent running-related injury, characterized by lateral knee pain and affecting approximately 12% of runners annually (Taunton et al., 2002) Several risk factors contribute to increased ITB tension, including gender, knee malalignment, and altered muscle activation (Hamill et al., 2008). ITBS is influenced by both anatomical and neuromuscular factors, with genu varum alignment and impaired muscle activation playing key roles in increasing ITB tension. Understanding these contributing factors can aid in developing targeted prevention and rehabilitation strategies, such as correcting malalignment and optimizing muscle activation patterns to mitigate the risk of ITBS.

This study aimed to identify differences in muscle activity between runners with and without genu varum during running and to explore the relationship between ITB strain and muscle activation.

METHODS: Seventeen healthy recreational female runners participated in the study (genu varum group: GV = 8; normal alignment group: N = 9). Participants ran for 30 minutes while the muscle activity of the gluteus maximus (GMAX), gluteus medius (GMED), and tensor fasciae latae (TFL) was recorded every 10 minutes. ITB strain was measured before and after running. A repeated two-way ANOVA was conducted to examine differences in EMG data between the two groups.

RESULTS: Significant differences in muscle activation were observed between the groups. The GV group exhibited greater muscle activity in the TFL and GMAX compared to the N group. Additionally, only the GV group demonstrated a significant increase in ITB strain after running.

CONCLUSION: These findings suggest that genu varum alignment may lead to increased ITB tension due to greater TFL activation during running. The ITB is influenced by both the TFL and GMAX, as the TFL inserts into the ITB anteriorly, while the lower fibers of the GMAX contribute posteriorly. Genu varum-induced overactivation of the TFL may elevate ITB tension, thereby increasing the risk of developing ITBS. Given that excessive TFL activation may promote hip internal rotation and impose greater tensile stress on the ITB, our findings indicate that the increased ITB strain observed in the GV group was likely a consequence of heightened TFL activation during running.

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**COMPARATIVE ANALYSIS OF AUTOGRAFT CHOICES IN ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: IMPLICATIONS FOR MUSCLE STRENGTH RECOVERY AND JOINT BIOMECHANICS**

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INTRODUCTION: This study aimed to address critical gaps in the management of anterior cruciate ligament reconstruction (ACLR) by comparing the effectiveness of four autograft types—iliotibial band (ITB), ITB with hamstring tendon augmentation (ITB+HT), hamstring tendon (HT), and bone-tendon-bone (BTB)—on quadriceps and hamstring peak torque recovery (QPT and HPT) and evaluating their impact on knee stability and function through the hamstring-to-quadriceps (H:Q) ratio. We hypothesized that ACLR would improve isokinetic muscle strength six months post-surgery, with the HT graft offering the most balanced recovery.

METHODS: In this prospective cohort study, 42 physically active males (aged 18-40 years) with primary ACL injury underwent ACLR using one of four graft techniques: iliotibial band (ITB, n=16), combined ITB with hamstring tendon (ITB+HT, n=12), hamstring tendon (HT, n=7), or bone-tendon-bone (BTB, n=7). All participants completed a standardized four-phase rehabilitation protocol. Isokinetic muscle strength testing was performed at 60°/s, measuring quadriceps peak torque (QPT), hamstring peak torque (HPT), and H:Q ratio. Statistical analyses included one-way ANOVA, post hoc Holm-Bonferroni tests, effect size estimation, and Bland-Altman plots for agreement assessment.

RESULTS: Significant differences were observed between the BTB group and other groups in QPT (Cohen's d = 3.17–4.63, $P < 0.001$), HPT (Cohen's d = 1.79–2.66, $P < 0.001$), and H:Q ratios (Cohen's d = 1.16–2.03, $P < 0.001$). The BTB group exhibited the highest mean differences in QPT (+133.4 Nm) and HPT (+41.1 Nm) between healthy and injured legs, with substan-

tial limits of agreement. Pearson correlation coefficients between healthy and injured legs were high for QPT and HPT (r = 0.66–0.88, P < 0.001) but low for H:Q ratios (r = 0.05–0.25).

CONCLUSION: The study highlights significant variations in muscle strength recovery among different autograft types, with the BTB graft demonstrating the most pronounced deficits. While all graft types contribute to muscle strength recovery, the HT graft may offer advantages in balancing muscle strength and enhancing knee stability. These findings underscore the importance of individualized rehabilitation protocols tailored to specific graft types to optimize functional outcomes and mitigate re-injury risks. Long-term assessments are crucial for ensuring sustained muscle strength recovery and overall knee health following ACLR.

**COMPARISON OF BAREFOOT AND SHOD TRAINING EFFECTS ON FOOT STRUCTURE, MUSCLE STRENGTH, AND SENSORY FUNCTION**

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INTRODUCTION: The structure and function of the human foot are critical for maintaining balance and generating propulsion during physical activities. Therefore, improving foot structure and function is essential for injury prevention and the enhancement of athletic performance. Several studies have investigated the effects of training on enhancing foot structure and function. For example, foot exercise training has been reported to alter arch morphology (Holowka et al. 2018) and enhance force-generating capacity (Koyama & Yamauchi, 2023) as well as sensory function (Maemichi et al. 2024). However, evidence suggests that these training effects may be influenced by footwear use. Specifically, individuals who habitually wear footwear that closely mimics barefoot conditions exhibit higher and stiffer foot arches and larger cross-sectional areas of the intrinsic foot muscles compared to those who habitually wear conventional shoes (Holowka et al. 2018). Therefore, differences in training outcomes may arise depending on whether foot-strengthening exercises are performed barefoot or while wearing shoes. Nevertheless, no studies have directly compared the effects of foot training on muscle strength under barefoot and shod conditions. This study investigated how footwear use during training influences foot structure, muscle strength, and sensory function.

METHODS: Healthy adults (20–50 years) participated. Foot length, arch height, toe flexor strength, and sensory perception were measured. Subjects were assigned to a barefoot training group (BARE), a shod training group (SHOD), or a control group (CON), matched for age, height, weight, and measurement variables. Training groups followed a foot and lower limb strengthening program (Koyama & Yamauchi, 2023) for 60 minutes, twice a week, for eight weeks. Measurements were taken once every two weeks. Foot dimensions were measured with a ruler in sitting and standing positions. Toe flexor strength was assessed with a dynamometer, and sensory perception with a Semmes–Weinstein monofilament at seven plantar and two dorsal sites. To control for body composition, arch height was normalized by foot length and toe flexor strength by body weight. Data were expressed as percentage changes from baseline.

RESULTS: After eight weeks, no significant differences were found between BARE and SHOD in most variables, except seated arch parameters. Neither group showed significant changes in arch-related variables or sensory perception. However, BARE significantly increased toe flexor strength at weeks 4, 6, and 8 from baseline and at weeks 6 and 8 from week 2. SHOD showed significant increases at weeks 4, 6, and 8 from baseline. In the CON, no significant changes were observed in any of the measured variables during the training period.

CONCLUSION: Training effects were similar between conditions, but barefoot training appeared more effective for enhancing toe flexor strength.

**THE RELATIONSHIP BETWEEN JOINT RESTRICTION AND POSTURAL ADJUSTMENT PATTERNS IN DIFFERENT ANKLE TAPING METHODS**

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INTRODUCTION: For taping in sports, while some studies have evaluated taping effects using a single method, comparisons of different techniques are lacking. This study examined the relationship between taping methods and changes in joint restriction and postural adjustment patterns.

METHODS: This study involved 22 healthy participants classified based on ankle instability. Ankle taping was applied to the non-dominant side (side not kicking the ball) using two methods: a non-elastic tape method (Taping A) and Functional Taping™ (1988), which primarily uses elastic tape to restrict calcaneal inversion and foot supination (Taping B). Measured variables included ankle and foot range of motion (ROM), rearfoot alignment (RA), center of pressure (COP) sway, and %IEMG of the soleus (SOL) and tibialis anterior (TA) during a 10-second single-leg stance. Muscle activation latency (MAL) of SOL and TA in the non-dominant leg was assessed during rapid upper limb raising in quiet bipedal standing. Subjective discomfort of taping was rated using an 11-point Numerical Rating Scale (NRS).

RESULTS: In the group without instability (n=13), plantar flexion and dorsiflexion (DF) ROM decreased with both Taping A (p=0.04) and B (p<0.001) compared with no taping. Eversion ROM (p=0.03) and inversion ROM (p<0.001) decreased with Taping A compared with no taping. In non-weight-bearing, RA shifted toward eversion in both taping conditions (p<0.001). In weight-bearing, all conditions showed eversion, but Taping A (p=0.01) and B (p=0.04) reduced the eversion angle. NRS scores were higher for Taping A in both rest (p=0.04) and motion (p=0.02), but discomfort changes from rest to motion did not differ. No significant differences were found in COP sway, %IEMG, or MAL. The instability group (n=9)

showed following different results: DF ROM significantly decreased with Taping A compared with no taping (p=0.001). NRS scores showed no difference between taping types at rest and in motion. MAL of SOL was significantly prolonged in Taping A (p=0.03).

CONCLUSION: Notable findings include the following: In the group without instability, Taping A had a stronger restriction effect. For DF ROM, both taping methods restricted movement in the group without instability, but in the instability group, Taping B showed no restriction effect. For eversion ROM, in the group without instability, the greatest restriction was seen in Taping A, followed by Taping B, and then no taping. However, in the instability group, restriction effects between Taping A and B did not differ. These results indicate that although Taping A provides greater joint restriction, it may risk over-restricting normal motion. In the instability group, Taping A prolonged MAL of SOL, suggesting that it may negatively impact anticipatory postural control during standing.

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**NORMATIVE ISOKINETIC KNEE STRENGTH VALUES AND PREDICTION MODELS IN NON-ATHLETIC CHINESE ADULTS**

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INTRODUCTION: Establishing normative isokinetic muscle strength values and prediction models for knee joints in non-athletic healthy Chinese adults aids in clinical assessments, diagnosis, and rehabilitation. However, there has been limited research on these normal reference values, particularly involving large sample cohorts. Therefore, this study aimed to develop normative reference values and predictive models for knee joint isokinetic muscle strength across different age groups and genders in non-athletic healthy Chinese adults.

METHODS: A total of 2208 participants aged between 20 years old and 70 years old were included in the study. The participants were divided into two groups by gender and further divided into five age groups: 20–29, 30–39, 40–49, 50–59 and 60–69 years old, resulting in a total of 10 groups. Key parameters, including peak torque of knee flexors and extensors, relative peak torque, peak torque ratio of flexors to extensors, peak torque angle and work, were collected using an isokinetic dynamometer at angular velocities of 60°/s and 180°/s. Two-way analysis of variance was utilised to analyse the characteristics and differences of these parameters amongst different age groups and genders. Pearson correlation coefficients were calculated to examine the relationships between these parameters and gender, age, height, weight and body mass index. Predictive models were developed using linear regression and various machine learning techniques.

RESULTS: Males exhibited significantly higher knee isokinetic strength values than females across all age groups, with knee extensor strength 20.47%–38.01% higher and knee flexor strength 22.91%–43.42% higher at both 60°/s and 180°/s. Muscle strength showed a moderate negative correlation with age, indicating a decline with increasing age. Extension strength values were greater than flexion, and measurements at 180°/s were lower compared to 60°/s. The multilayer perceptron regressor demonstrated the highest predictive capability among the models tested.

CONCLUSION: This study provides comprehensive normative reference values and predictive models for knee joint isokinetic muscle strength in non-athletic healthy Chinese adults. The results highlight significant gender and age differences, offering valuable data for clinical assessments and personalized rehabilitation strategies to improve knee joint health and overall quality of life.

## Conventional Print Poster Presentations

### CP-MH28 Epidemiology of Injury

**RISK FACTORS FOR LOWER EXTREMITY INJURIES IN MALE COLLEGE BASKETBALL PLAYERS**

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INTRODUCTION: Basketball is associated with a high incidence of lower extremity injuries, affecting 55–63% of NCAA basketball players (1). Core stability plays a crucial role in injury prevention. For example, a study of Australian football players found that a smaller cross-sectional area of the multifidus muscle was associated with an increased risk of lower extremity injuries (2). However, it remains unclear whether trunk muscle area influences the incidence of lower extremity injuries in basketball—a sport with distinct competitive characteristics. Therefore, the aim of this study was to identify risk factors for lower extremity injuries in collegiate basketball players.

METHODS: Twenty-four male basketball players from a single club participated in the study. An athletic trainer collected sports injury data using injury management software from April to September 2024. Athlete exposure was quantified in "athlete-hours (AH)" (1 AH = 1 hour of practice or competition). Magnetic resonance imaging (MRI) was employed to measure the cross-sectional area of the trunk muscles at their maximal points (L5/S1 for the multifidus, L3/L4 for the quadratus

lumborum, and L4/L5 for the psoas major) (2). Logistic regression analysis was subsequently conducted to identify risk factors for lower extremity injuries.

RESULTS: A total of 23 injury and disability events were recorded, 18 of which involved the lower extremities. The incidence rate was 5.1 lower extremity injuries per 1,000 AH. Both AH and age were identified as significant risk factors for lower extremity injuries. Specifically, the odds ratio (OR) for AH was 1.08 (95% confidence interval [CI]: 1.017–1.167), while the OR for age was 0.35 (95% CI: 0.074–0.991).

CONCLUSION: Our findings suggest that a rapid increase in athlete exposure and younger age are key risk factors for lower extremity injuries among male university basketball players. Notably, 18-year-old athletes exhibited a particularly high injury rate, implying that insufficient adaptation to the competitive environment may contribute to the elevated risk. In contrast, trunk muscle cross-sectional area did not appear to be a significant risk factor for the development of lower extremity injuries.

**INTRINSIC RISK FACTORS ASSOCIATED WITH MUSCLE STRAIN LOCATIONS IN JAPANESE FEMALE COLLEGIATE SOCCER PLAYERS**

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*SENDAI UNIVERSITY*

INTRODUCTION: Football is a high-intensity sport involving rapid direction changes, sprints, and technical movements in both sexes.

Female players have higher rates of ACL injuries and ankle sprains than males, with a recent rise in thigh muscle strains. While males mainly sustain hamstring strains during sprinting, females more frequently experience quadriceps strains during kicking, along with hamstring strains. However, the link between strain location and intrinsic risk factors remains unclear. This study aimed to clarify this relationship in female soccer players.

METHODS: A prospective cohort study was conducted on a Japanese women's collegiate football team from 2017 to 2022, which competed in major national tournaments.

Muscle strains sustained during soccer matches and training sessions were recorded. Participants underwent a pre-season medical assessment, which included height, weight, body fat percentage, muscle strength, and flexibility, and injury history (knee ligament injuries, ankle sprains and muscle strains within the past year).

Participants were categorized based on the location of the muscle strain (quadriceps or hamstrings) and associations with pre-season medical assessments and injury history were analyzed. An unpaired t-test was used to compare physical characteristics between groups, while Fishers exact test was applied to analyze differences in injury history ($\alpha = 0.05$).

RESULTS: During the study, 22 quadriceps and 12 hamstring strains were recorded. A comparison of the physical characteristics between athletes with quadriceps and hamstring strains revealed that isokinetic knee flexion strength was significantly higher in the hamstring strain group ($p < 0.05$). Additionally, a history of ankle sprains was significantly associated with an increased incidence of thigh muscle strains ($p < 0.05$).

CONCLUSION: This study showed that players with hamstring strains had significantly higher knee flexion muscle strength. In soccer, hamstring strains may result from sprinting and hip rotational stress caused by ground reaction forces during turning movements. Therefore, strengthening knee flexor muscles, particularly during eccentric contractions, is crucial for preventing hamstring injuries.

Furthermore, the present study suggests that a history of ankle sprains is associated with an increased risk of thigh muscle strains. A history of ankle sprains may not only affect sprinting mechanics but also influence quadriceps function during the kicking motion. Further research is needed to investigate the long-term effects of ankle sprains on thigh muscle function, particularly in female soccer players.

**MUSCULOSKELETAL INJURY CHARACTERISTICS AND ACUTE-TO-CHRONIC WORKLOAD RATIOS IN COLLEGIATE HANDBALL: A ONE-YEAR FOLLOW-UP PROSPECTIVE STUDY ACUTE-TO-CHRONIC WORKLOAD RATIOS IN COLLEGIATE HANDBALL**

LIM, J., LEE, J., PARK, J.

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INTRODUCTION: This study aimed to: (1) report the incidence and characteristics of musculoskeletal injuries (body location, type, and mechanism) in Handball; and (2) examine the association between the injury incidence and the acute-to-chronic workload ratio (ACWR).

METHODS: A total of 17 Korean collegiate Handball players (21.8 years; 181.6 cm; 81.4 kg; body mass index: 24.6 kg/m²; playing experience: 10.4 years) were prospectively studied during the 2024 season. Injury rates per 1,000 hours were calculated for training, scrimmages, and competitions. An athletic trainer recorded exposure (duration of training, scrimmages, and competitions), rate of perceived exertion (RPE), and musculoskeletal injury (injury rate, body location, type, and mechanism) in real time using a spreadsheet programme. The RPE was obtained after each session on a 1-5 scale, where a score 3 indicated the average exercise intensity over the past four weeks. The ACWR was determined by multiplying the RPE by the session duration (min) for training, scrimmage, and competition. The calculation was performed using two different approaches: the rolling average (RA) and exponentially weighted moving average (EWMA) methods [1]. Calculated ACWR values were categorised as high (>1.5), relatively high (1.3-1.5), moderate (0.8-1.3), or low (<0.8) [2].

RESULTS: Among the 124 injuries recorded, the highest injury rate per 1,000 hours was during scrimmage (n=47; 33.9/1,000 hours), compared to competition (n=6; 17.3/1,000 hours) and training (n=71; 9.7/1,000 hours). Regardless of the session, the ankle was the most frequently injured body location (n=21; 17%), followed by foot/toe (n=13; 10%) and hand (n=13; 10%). Sprain (n=34; 27%) was the most frequent injury type, followed by strain (n=19; 15%) and laceration/abrasion/skin lesion (n=14; 11%). Contact with another athlete was the most predominant injury mechanism (n=27; 22%), followed by non-contact trauma (n=23; 19%) and overuse (n=21; 17%). Of the 91 injuries (injuries that required at least 4 weeks to calculate the ACWR), the 65 (71%) were recorded under the moderate ACWR when calculated using RA method, and 75 (82%) when using the EWMA method.

CONCLUSION: Contrary to previous findings in team sports (football: >1.5 [3]), the greatest number of injuries were recorded under the moderate ACWR range (0.8-1.3) in Handball. This highlights the need for sport-specific workload management and careful adjustment of ACWR thresholds to reduce the risk of injury.

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**POST-COVID-19 SYNDROME: SEVERITY, SYMPTOMS, AND ASSOCIATIONS WITH QUALITY OF LIFE AND IMMUNE BIOMARKERS IN MASTER ATHLETES—INSIGHTS FROM THE 2024 WORLD MASTERS ATHLETICS CHAMPIONSHIP**

ZHANG, B., GRAU, M., PUTA, C., PESTA, D., FORBES, S.C., CHILIBECK, P., MCLAURIN, N., TANAKA, H., BÖCKER, J., PUSTOWALOW, W., ARZ, M., KAISER-STOLZ, C., MIYAMOTO-MIKAMI, E., ARVIDSSON, D., RITTWEGER, J., BLOCH, W.
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INTRODUCTION: Post-COVID-19 condition (PCC) is a persistent, multisystem condition that significantly impacts well-being and quality of life, with a prevalence rate of 41.8% in the general population. However, limited evidence exists regarding its prevalence and effects in master athletes (MAs). Understanding PCC in this unique group is critical for developing targeted management strategies and exploring links between high physical fitness, immune function, and symptom burden. This study aimed to assess the prevalence of PCC in master track and field athletes and investigate its associations with quality of life and biomarkers of immune response.

METHODS: This cross-sectional study analyzed track and field MAs who competed in the 2024 Gothenburg World Masters Athletics Competition. A total of 237 MAs (48% females, age = 57 ± 12 years, BMI = 22.8 ± 2.7 kg/m²) reported their previous highest competition level and current training regimens via a survey. Post-COVID symptoms were assessed using the Post-COVID Syndrome Questionnaire (PCSQ), while health-related quality of life (HRQoL) was evaluated using the Short Form-12 Health Survey (SF-12). In a subgroup of MAs (n = 118, 51% females, age = 59 ± 13 years, BMI = 22.4 ± 2.5 kg/m²), fasting blood samples were collected to measure C-reactive protein (CRP) level as an immune status biomarker. Differences in PCC severity were analyzed across sex, athletic specialties (endurance, sprint, and strength/power), previous highest competition levels, immune status, training intensities and volumes (hours and days), and SF-12 physical and mental component summary scores between MAs with and without PCC.

RESULTS: A total of 51 (21%) MAs were identified with moderate to severe and clinically relevant post-COVID condition (PCSQ score > 10.75). Overall, 43% of MAs reported at least one symptom, with musculoskeletal pain being the most prevalent (22%). No significant differences were observed in training intensities or volumes among different PCC severities (all $p > 0.05$), nor were there differences in sex, athletic specialties or previous highest competition levels ($p > 0.05$). However, significant differences in subjective quality of life were observed: MAs without PCC exhibited higher physical (54.4 vs. 52.0, $p = 0.003$) and mental component summary scores (60.9 vs. 56.4, $p = 0.003$) compared to those with moderate to severe PCC. While no significant correlation was found between PCC severity and CRP levels, MAs with reported cardiac ailments or flu-like symptoms showed significantly elevated CRP concentrations (4.4 vs. 1.4 mg/L and 3.0 vs. 1.2 mg/L, $p = 0.027$ and $p = 0.003$, respectively).

CONCLUSION: Post-COVID syndrome is prevalent among track and field MAs, significantly affecting subjective quality of life despite no difference in training intensity, while elevated C-reactive protein levels in MAs with cardiac ailments or flu-like symptoms indicate distinct low grade inflammatory profiles and ongoing post-acute infection regulation.

**THE MUSCULOSKELETAL CHARACTERISTICS OF RECURRENT SHOULDER PAIN IN COMPETITIVE SWIMMERS: A PILOT STUDY**

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INTRODUCTION: Shoulder pain is the most common musculoskeletal injury for competitive swimmers and a primary cause of cessation from training and competition. A history of previous shoulder pain is one of the factors contributing to recurrent shoulder pain in swimmers, altering athletes physical characteristics and generating risk factors distinct from those of healthy swimmers. Previous studies have mainly focused on exploring risk factors for shoulder pain in healthy swimmers, but they have not investigated musculoskeletal characteristics related to recurrent shoulder pain.[1] The purpose of this study was to identify the musculoskeletal characteristics associated with recurrent shoulder pain in competitive swimmers.

METHODS: Eleven competitive swimmers from high schools and colleges were recruited. For the recurrent shoulder pain group, participants had experienced unilateral shoulder pain in two or more episodes during training or competition

within one year, with no symptoms during their most recent training session. The control group consisted of individuals with a history of shoulder pain but had not experienced shoulder pain within one year. The testing items of musculoskeletal characteristics included shoulder internal rotation, external rotation, and horizontal adduction range of motion (ROM); cervical and thoracic posture and thoracic spine ROM; trunk rotational ROM; latissimus dorsi and pectoralis minor muscle length; glenohumeral joint laxity and generalized joint hypermobility; shoulder and periscapular muscle strength and fatigue resistance; scapular dyskinesis; scapulothoracic and glenohumeral joint control ability, and upper quarter dynamic balance performance.

RESULTS: There were 8 participants in the recurrent shoulder pain group and 3 in the control group in this pilot study. Using non-parametric analysis, the results showed that the recurrent shoulder pain group exhibited a significantly smaller forward head angle (more forward head posture) compared to the control group ($p = 0.041$). No statistically significant differences were observed in the other parameters.

CONCLUSION: Excessive forward head posture may be associated with recurrent shoulder pain in competitive swimmers. More participants should be recruited to confirm the findings.

**CAFFEINE INTAKE AND THE PREVALENCE OF LEG CRAMPS: CROSS-SECTIONAL STUDY**

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INTRODUCTION: Caffeine is a stimulant, and it has been suggested that it may cause leg cramps. However, there are few studies that have investigated the relationship between caffeine intake and the onset of leg cramps. Therefore, we conducted a cross-sectional study of Japanese adult men and women who have experience of participating in sports in order to investigate the relationship between caffeine intake and the onset of leg cramps.

METHODS: This study was conducted using an Internet survey between September 1st and 6th, 2023 in Japan. The study participants consisted of 2,446 adults (mean age = 41.3 years, 50% women). The participants were asked about their daily caffeine intake (almost none, small amount [e.g. less than one cup of caffeinated drink], medium amount [e.g. 1–3 cups of caffeinated drink], large amount [e.g. 4 or more cups of caffeinated drink]), and the frequency of leg cramps (every day, several times a week, several times a month, several times a year, never). We then divided the participants into three groups: a non-intake group (almost none), a small-medium intake group (small or medium amounts), and a large intake group (large amounts). We also divided the occurrence of leg cramps into two groups: a high-frequency occurrence group (every day, several times a week, several times a month) and a low-frequency occurrence group (several times a year, never occurs). Multivariable-adjusted odds ratios and 95% confidence intervals (95% CIs) for the high-frequency occurrence of leg cramps were obtained using logistic regression models while adjusting for age, sex, sleep time, drinking habit and smoking habit.

RESULTS: The high-frequency of occurrence of leg cramps group was 684 (28%). Compared to the non-intake group, the odds ratios (95% CIs) were 1.82 (1.34 – 2.49) for small-medium intake group, and 2.12 (1.37 – 3.30) for large intake group, respectively (P for trend < 0.001).

CONCLUSION: This study showed that the group with a high frequency of caffeine intake had a high-frequency of leg cramps. A prospective study is warranted to further investigate this association.

**ASSESSING THE RELATIONSHIP BETWEEN GRIP STRENGTH, HEAVY MANUAL LABOR, AND THE RISK OF NON-TRAUMATIC ROTATOR CUFF TEARS IN ADULT POPULATIONS**

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INTRODUCTION: Rotator cuff tears are a prevalent condition that affects the upper extremities in primary care settings. The causal relationship between degenerative changes and rotator cuff tears remains largely unclear. Additionally, physically demanding occupations may contribute to the risk of rotator cuff tears, and the role of grip strength as an early predictor of these injuries has yet to be definitively established.

METHODS: This study is a prospective cohort analysis derived from the UK Biobank, encompassing participants aged 40 to 69 years. The primary outcome of interest was non-traumatic rotator cuff tears. Grip strength was measured using a Jamar J00105 hydraulic hand dynamometer. Information regarding job involvement in heavy manual or physical labor was collected, categorized as never/rarely, sometimes, usually, or always. The relationships between these variables and the occurrence of rotator cuff tears were analyzed using logistic regression.

RESULTS: A total of 400,321 individuals were included in the final analysis. The mean age of the participants was 55.2 (standard deviation: 8.0) years, and 53.2% were female. Over a median follow-up period of 14 years, 3,008 participants developed rotator cuff tears. Analysis revealed significant associations between grip strength and rotator cuff tear risk (odds ratio (OR) 1.18, 95% confidence interval: 1.12-1.25). Heavy manual or physical work was significantly associated with increased rotator cuff tear risk, with those reporting "Always" engaging in such work having an odds ratio of 2.00 ($p < 0.001$).

CONCLUSION: The analysis revealed significant associations between grip strength and rotator cuff tear risk, along with an elevated risk linked to engagement in heavy manual or physical work. These findings highlight the importance of considering both grip strength and physically demanding occupations when assessing the risk for rotator cuff injuries.

Conventional Print Poster Presentations

CP-MH29 Lifestyle

**THE ASSESSMENT OF ANTHROPOMETRIC PROFILES OF FEMALE UNIVERSITY STUDENTS STUDYING SPORT SCIENCE AND PHYSICAL ACTIVITY AT TAIBAH UNIVERSITY, SAUDI ARABIA**

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INTRODUCTION: Physical activity offers significant benefits for health, economy, and culture, and the Saudi government is committed to promoting it. In 2018, the Sport Science and Physical Activity (SSPA) major was introduced for female students at several universities, including Taibah University in Madinah, western Saudi Arabia. To our knowledge, anthropometric profiles of Saudi Arabian female SSPA university students are not currently available. Therefore, the aim of this study was to provide the anthropometric profiles of SSPA female students at Taibah University in Saudi Arabia.

METHODS: The anthropometric profiles of 20 female university students from the College of Education at Taibah University were assessed. Body weight was measured using a digital scale (Seca) to the nearest 0.1 kg, and height was measured using a portable stadiometer (Seca) to the nearest 0.5 cm, with the head in the horizontal Frankfort plane. Eight skinfold thicknesses (biceps, triceps, subscapular, suprailiac, supraspinal, abdominal, front thigh, and medial calf) were measured using a skinfold caliper (Cescorf). Six circumferences (relaxed and contracted arm, waist, hip, thigh, and calf) were measured using an anthropometric tape (Cescorf). Three bone breadths (humerus, bi-styloid, and femur) were measured using a small sliding caliper (Cescorf). All measurements were conducted by a trained female (accredited level 1 anthropometrist) following procedures established by the International Society for the Advancement of Kinanthropometry (ISAK). Repeated measurements were taken for each parameter to determine the technical error of measurement (≤5% for skinfolds and ≤1% for all other measurements).

RESULTS: The mean and standard deviation (±SD) for age, height, weight, and BMI were 21.65 ± 1.23 years, 160.17 ± 5.31 cm, 51.62 ± 6.59 kg, and 20.14 ± 2.59 kg/m², respectively. The percentage of fat mass and skeletal muscle mass were 28.80 ± 4.99% and 40.80 ± 3.40%, respectively. The sum of the eight skinfolds was 81.25 ± 25.15 mm. Waist circumference and hip circumference were 64.05 ± 6.70 cm and 91.30 ± 3.37 cm, respectively. The waist-to-hip ratio and waist-to-height ratio were 0.70 ± 0.06 and 0.40 ± 0.04, respectively. Mid-upper arm circumference was 25.08 ± 3.06 cm.

CONCLUSION: This study provides, for the first time, anthropometric data on a sample of SSPA female university students in Saudi Arabia. The results indicate that the participants exhibited normal values for key health indicators when compared to individuals from the general population.

**BODY COMPOSITION EVALUATION: BIOIMPEDANCE, ULTRASOUND, ANTHROPOMETRY AND DIGITAL PHOTOGRAPH COMPARED TO IDXA**

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INTRODUCTION: Body composition evaluation is a research area that has gained much attention recently. On the other hand, for all the methods, these are indirect estimates since it is impossible to evaluate the quantity of adipose tissue directly; therefore, each method has advantages and disadvantages; in this work, we have compared four of the most used methods (Bioimpedance, ultrasound, plycometry, and digital imaging) compared to what is currently considered the gold standard, iDXA; to provide an evaluation tool.

METHODS: 60 subjects aged between 19 and 60 (33 women and 27 men), without pathologies and not using drugs regularly, BMI range of 19,8 and 50. All subjects were tested on the same day, with a pause of at least 10 minutes between every test. Subjects were asked not to do any physical activity in the 24 hours preceding the test, not to eat in the 8 hours preceding the test, and not to drink any liquids in the 2 hours preceding the test. The devices used were for iDXA: Lunar GE HealthCare – California – USA, for Bioimpedance: BIA 101 BIVA Pro Akern – Florence – Italy, BIA Dex Mascaretti, Ancona – Italy and InBody 770 Seoul – South Corea; for Ultrasound: BX2000, BodyMetrix, IntelaMetrix, California – USA; Anthropometry: Lipowise Pro, Wisify Matosinhos - Portugal; Digital: FitYourOutfit Pixelcando Tenerife - Spain

RESULTS: Respect to iDXA in overall BIA showed a difference respectively of Akern -5%, Mascaretti -15% and InBody -10%, ultrasound -11%, anthropometry -0,1% and Digital +2%; if taken by sex in women we recorded BIA showed a difference respectively of Akern -4,3%, Mascaretti -13% and InBody -7%, ultrasound -10%, Antrhopometry -3.6% and Digital -3.2%; in men we recorded BIA showed a difference respectively of Akern -6,5%, Mascaretti -18% and InBody -12%, ultrasound -12%, Anthropometry +6% and Digital +1%; if grouped by BMI we recorded: between 19,8 and 25 BIA showed a difference respectively of Akern -7%, Mascaretti -19% and InBody -15%, ultrasound -12%, Anthropometry +5,8% and Digital +2%, between 25 and 29,8 BIA showed a difference respectively of Akern -11,6%, Mascaretti -24% and InBody -16%, ultrasound -19%, anthropometry -8,7% and Digital -7,8%; and over 29,8 BIA showed a difference respectively of Akern +6,7%, Mascaretti -13% and InBody +4%, ultrasound -12%, anthropometry -2,6% and Digital +5,5%

CONCLUSION: From the results obtained, which certainly should be evaluated on a larger sample (and in fact, the study is continuing with the objective of a sample of 100 people), it can be noted that the percentage of fat is estimated acceptably

even in the worst cases, with an error of maximum 20%; the most reliable methods would seem to be the simplest and simplest and cheapest ones, namely visual and anthropometry; on the other hand, bioimpedance and also ultrasonography, in exchange for a higher cost, provide other data on muscle mass, hydration, and general fitness; from a sports perspective using at least two combined tools is probably the best choice.

**ROLE OF MEDITERRANEAN DIET AND PHYSICAL ACTIVITY ON IMPROVING SALIVARY ANTIOXIDANT CAPACITY AND IN BODY RECOMPOSITION.**

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INTRODUCTION: There is ample evidence that a Mediterranean-style diet and physical activity can reduce risk factors such as obesity, hypertension, and improve antioxidant defenses. Unfortunately, people drop out after a period of following a nutritional pattern or physical activity because of poor willpower or poor short-term results. The purpose of our study was to devise and observe the effects of combining a nutritional and motor plan that could coexist over the long term (1 year of activity), with the ultimate goal of reducing risk factors and teaching a proper lifestyle.

METHODS: 60 subjects (10 men and 50 women, between 20 and 50 years) overweight and with a sedentary lifestyle were recruited for the study. They underwent to nutritional, body composition (plicometry and anthropometry) and Total Antioxidant Activity on saliva samples (TOSC assay) evalutation. All subjects underwent a 1 year of personalized Mediterranean-style nutritional scheme characterized by periods of calorie restriction, alternating with periods of restitution, so as to teach a healthy diet and not induce metabolic damage. We also added a highly personalized motor scheme (45 minutes, 2 times a week). Both the motor and nutritional patterns were highly personalized in relation to the clinical needs of each individual subject. The motor protocol included exercises dervant from different disciplines such as pilates, weight training, endurance, boxing. The exercises and the order of the latter were varied at each session so as not to bore the subjects. The real and only variable was represented by the recovery times, which turned out to be very low, about 10-20-30 seconds between sets and a maximum of 1-2 minutes between one exercise and another. The number of repetitions and exercise were varied each time, so as not to create an adaptation phenomenon.

RESULTS: At the end of 1 year of teatment, a significant decrease in weight was observed (90.99±8.86 vs 73.44±8.01; $p<0.01$) and in waist, abdomen and hip circumferences ($P<0.05$). In terms of body composition, there was a significant decrease in fat mass (38.12±5.544 vs 27.05±5.50 $p<0.05$), with an increase of free fat mass ($p<0.05$). In addition, we found an increase in salivary antioxidant capacity against the three radical species peroxyl (13.67±3.16 vs 19.88±2.02 $p<0.01$), hydroxyl (3.48±1.51 vs 5.96±1.72 $p<0.01$), and peroxynitrite derivatives (14.21±3.43 vs 18.46±2.58 $p<0.05$). Only 3% of subjects dropped out of the study.

CONCLUSION: The purpose of the study was to understand how nutrition and motor activity could interact in the long run to improve health and teach a proper lifestyle. From our results, we can conclude how the combination of our nutrition and motor program can be sustained in the long run (pointing out that only 3 percent of subjects dropped out of the study) leading to both excellent compliance and a significant decrease in various risk factors (weight, circumferences, and antioxidant capacity).

**ACUTE EFFECTS OF MEAL AND EXERCISE SEQUENCE ON POSTPRANDIAL METABOLISM IN HEALTHY ADULTS**

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INTRODUCTION: Exercise has been shown to improve metabolic health. However, the efficacy of meal-exercise timing on postprandial metabolism, such as glucose and triglyceride (TG) responses, remains not fully understood. This study aims to investigate the effect of different sequences of meals and exercise on postprandial glucose, insulin, and TG concentrations.

METHODS: 16 healthy and physically active individuals (8 men and 8 women; age: 25 ± 3.1 years; BMI: 22.8 ± 2.4 kg/m²) were recruited and randomly assigned to perform 30 min of brisk walking either before (EM) or after the breakfast (ME) in a repeated-measures crossover design. Blood (plasma) samples were collected at baseline, 30- (immediately post-exercise in EM or after the breakfast in ME), 60- (immediately post-exercise in ME or after the breakfast in EM), 75-, 90-, 105-, 120-, 150-, and 180-min and then at immediately, 15-, 30-, 45-, 60-, 90-, 120-, 150-, and 180-min following the lunch. The outcome was the incremental area under the curve (iAUC) over the 375-min sampling period, with separate analyses for the 0-180 min and 180-375 min periods (i.e., after the lunch).

RESULTS: No significant differences were observed in oxygen uptake (18.5 ± 1.9 vs.18.8 ± 2.0 mL/kg/min; $p = 0.394$) and rating of perceived exertion (10.7 ± 1.5 vs.10.5 ± 1.4; $p = 0.394$) between EM and ME during exercise. iAUC180-375 for glucose was lower in the EM (2834 [95% CI = 3660, 2009] mmol/L) compared to ME (3641 [95% CI = 4751, 2531] mmol/L, Cohen's $d = 0.55$, $p = 0.043$). There were no differences in the glucose iAUC0-180 ($p = 0.610$) and iAUC0-375 ($p = 0.265$) between trials. iAUC0-180 for TG was lower in the EM (822 [95% CI = 1342, 303] mmol/L) compared to ME (2022 [95% CI = 2663, 1381] mmol/L, Cohen's $d = 0.83$, $p = 0.005$). There were no differences in the TG iAUC180-375 ($p = 0.754$) and iAUC0-375 ($p = 0.251$) between trials. The iAUC for insulin across all three periods did not differ between trials (iAUC0-375, $p = 0.345$; iAUC0-180, $p = 0.598$; iAUC180-375, $p = 0.098$).

CONCLUSION: EM (i.e., fasted-exercise) reduced postprandial glucose concentrations after lunch (iAUC180-375) and TG concentrations in the morning period (iAUC0-180) compared ME (i.e., fed-exercise). Our findings suggest potential benefits of pre-breakfast exercise in modulating postprandial metabolism.

**CHARACTERISTIC OF BODY COMPOSITION CHAGES IN PHYSICAL ENDURANCE EXERCISES.**

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INTRODUCTION: The endurance training course is essential part of professional skills support for military personnel. The aim of the study is to provide an assessment of body composition` characteristics changes in a group of well-trained individuals depending on level of BMI (standard and overweight) in pre-course preparatory phase ,to endurance exercises, directly after endurance training and in four weeks after endurance training course

METHODS: The study group included 66 healthy persons in aged from 21 till 35 years. They participated in pre-course training (four month) and endurance training course (ten days long total 24hrs), with high intensity physical load that included aerobic and anaerobic training elements, in combination with related energy deficiency (RED). Participants were divided into two subgroups according BMI levels: with standard level and with overweight level. We fixed in both subgroups body fat (%), muscle mass(kg) four times: at the beginning of pre-course training (1) no RED; after four months of pre-course training, directly before endurance exercises (2)no RED, directly after endurance training course (3)with RED and four weeks after endurance training course (4)no RED. The median and interquartile range (IQR) described non-normally distributed variables, data analysis was provided by Friedman`s test and by using IBM SPSS Statistics 29.

RESULTS: The results revealed changes of body composition characteristics in both respondents` subgroups with standard BMI level (≤24,9) as well with overweight BMI level (>25,0). The median of body fat % had small changes during pre-course training (no RED) for respondents with standard BMI level (p>0.999) and with the overweight BMI level (p>0.999), the body fat % characteristics in third measurements directly after endurance course (with RED)decreased for respondents with standard BMI level (p<0.001) and with the overweight BMI level (p<0.001). These changes of body fat% were not stabile that fixed in fourth measurement in four weeks after endurance course(no RED) for respondents with standard BMI level (p<0.001) and with the overweight BMI level (p=0.079). The median of muscle mass(kg) had changes during pre-course training (no RED)for respondents with standard BMI level (p>0.999) and with the overweight BMI level (p>0.999), then characteristic of muscle mass measured directly after endurance training course( with RED) shown that they jumped up (in group with standards BMI (p<0.001) and in group with overweight BMI level(p=0.003). These changes diminished in four weeks after endurance course (no RED)and last measurement fixed that muscle mass returned to in initial level in group with standards BMI p=0.623 and in group with overweight BMI level (p=0.010

CONCLUSION: Body composition characteristics were affected by intensity physical load and combination with RED or no RED for participants of both subgroups with standard and overweight level of BMI level, but changes of body composition characteristics were not longtermly.

**DETERMINANTS INFLUENCING THE UPTAKE OF A WEB-BASED HEALTH INTERVENTION FOR PATIENTS WITH TYPE 2 DIABETES AND/OR CORONARY HEART DISEASE**

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INTRODUCTION: Digital health interventions (DHIs), including web-based applications, provide personalised, location-independent and effective support. However, effectiveness of DHIs depends on use. Accordingly, appropriate application and/or targeted design of DHIs requires intervention developers to know which variables determine use (e.g., personality traits, health literacy). In particular, knowledge regarding the uptake, i.e., using the DHI at least once, is important. The objective of the study presented here is to investigate the determinants of uptake of a specific DHI.

METHODS: The DHI investigated is a web portal for promoting physical activity and healthy nutrition in patients with type 2 diabetes mellitus and/or coronary heart disease. This DHI is a component of a complex intervention for improving self-management in persons with at least one of these two diseases. This study is a secondary analysis of a randomised controlled trial (RCT) [1] and refers to 465 persons (49.9% female; 64.8 ± 10.2 years of age) who had been assigned to the intervention condition of this RCT. Possible determinants of uptake were extracted from register data of the study centre and from data of a baseline survey. These variables encompass gender, age, education, the Big Five personality traits, loneliness, emotional distress, health literacy, patient activation, intention regarding physical activity, and intention regarding healthy nutrition. The relationship with DHI uptake was investigated using logistic regression, both for each variable separately (univariate analysis) and for all variables together in one model (multivariate analysis).

RESULTS: Univariate analysis showed significant positive associations of uptake with higher education (p<.01), the Big-Five-dimension openness (p<.01), health literacy (p<.05), intention regarding physical activity (p<.001), and intention regarding healthy nutrition (p<.001). Of these effects, only those for intention regarding physical activity (p<.01) and intention regarding healthy nutrition (p<.001) remained significant in multivariate analysis. Patient activation, previously non-significant, emerged as a significant negative predictor (p<.001).

CONCLUSION: The findings suggest that uptake of the DHI investigated here depends on whether people believe the DHI to support them in performing a behaviour they would like to perform. Persons without distinct intentions regarding physical activity or healthy nutrition must be approached in different ways.

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**ASSOCIATION BETWEEN ADHERENCE TO 24-HOUR MOVEMENT GUIDELINES AND RISKS OF ALL-CAUSE MORTALITY AMONG ADULTS WITH TYPE 2 DIABETES: PROSPECTIVE COHORT STUDY**

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INTRODUCTION: The incidence and mortality rates of type 2 diabetes (T2D) are rising annually[1]. Prior research has demonstrated that adherence to the 24-Hour Movement Guidelines (24HGs) in the general population is associated with reduced all-cause mortality[2]. However, there is limited understanding of the potential health benefits in individuals with T2D. This long-term study aimed to investigate the link between the T2D patients adherence to 24HGs and their risk of all-cause mortality.

METHODS: This study included U.S. adults diagnosed with T2D, utilizing information from the National Health and Nutrition Examination Survey (NHANES) conducted from 2007–2008 to 08/2021–08/2023 cycle. The mortality data were provided by the National Center for Health Statistics (NCHS). The adherence of the 24HGs was evaluated through self-reported levels of moderate-to-vigorous-intensity physical activity (MVPA) during leisure time, sedentary behavior, and sleep, with scores ranging from 0 to 3. A multivariable Cox proportional hazards model was used to assess the association between adherence to 24HGs and all-cause mortality.

RESULTS: The study included 5,047 individuals with T2D (mean age: 61.3 years, SD = 13.6) and a median follow-up period of 84 months. During follow-up, the all-cause mortality events of 1, 151 (22.8 %) participants were recorded. After the adjustment of sociodemographic, healthcare factors, and lifestyle influences, compared with non-adherence, following one recommendation (HR = 0.72, 95% CI: 0.60–0.87, P < 0.001), two recommendations (HR = 0.60, 95% CI: 0.50–0.73, P < 0.001), or all recommendations (HR = 0.37, 95% CI: 0.27–0.49, P < 0.001) were associated with a reduced risk of mortality. Compliance with either the MVPA (2.4% of participants) or sedentary behavior recommendation (29.0%) was linked to a 62% (95% CI 21%-71%, P = 0.002) and 28% (95% CI 60%-88%, P < 0.001) decrease in mortality risk, respectively. Adhering solely to the sleep recommendation showed no significant association (HR = 0.79, 95% CI 0.71–1.01, P = 0.06).

CONCLUSION: Adherence to the 24HGs in individuals with T2D is associated with a reduced risk of all-cause mortality, with the recommendations for MVPA and sedentary behavior conferring the greatest benefits. To manage or control T2D, prioritizing compliance with the sedentary behavior recommendation—being the more achievable component of the 24HGs—may serve as an effective starting point. This research is significant for individuals with T2D, as adhering to the 24HGs can help manage the disease and potentially extend the lifespan.

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**LOSS OF COMPETITIVE ADVANTAGE – ACADEMY FOOTBALL HAS HIGH LEVELS OF ORAL DISEASE**

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INTRODUCTION: We have previously reported high levels of oral disease in professional senior team footballers in England and Wales and have linked poor oral health with a perceived negative impact on athletic performance. Good oral health is a basic human right and an essential determinant of general health, well-being and quality of life. Poor oral health is related to systemic disease. This study aimed to determine the prevalence of oral disease in professional academy footballers, to identify if problems start earlier and to inform health promotion strategies.

METHODS: Professional academy football clubs in England (16–18-year-olds) were invited to participate. Questionnaires were used to collect oral health behaviours and self-reported impacts and validated clinical outcomes to assess oral health. An oral health screening for dental decay, periodontal (gum) disease, dental erosion and dental trauma was undertaken on the volunteers at the clubs training grounds.

RESULTS: 160 academy footballers were recruited from 10 English academy football clubs, of which 86.8% (n=139) were male and 13.2% (n=21) female, with a median age of 16.9 years. High levels of oral disease were identified. 31.2% (n=50) had dental caries requiring treatment. 76.8% (n=123) had inflammation of the gums and 22.5% (n=36) periodontitis (gum disease). Tooth wear affecting up to at least 50% of tooth structure was present in 15.5% (n=25) of participants. 35.6% (n=57) of participants had experienced dental trauma with 10% (n=16) actively recalling that they received either a soft tissue injury (lips or tongue) or dental trauma during training or competition.

Whilst 76.2% (n=122) self-reported brushing their teeth twice per day, 15.5% (n=18) brushed once or less a day and 21% (n=34) had not attended the dentist for over 2 years. There was a general perception that oral health issues did impact the participants' sporting performance.

CONCLUSION: The prevalence of oral diseases amongst professional academy footballers in England is high and greater than found in national surveys of a similar age demographic. There is also poor oral hygiene routines and dental attendance. This is surprising given the attention given to achieving optimal health and wellbeing of this cohort. Urgent action is needed to embed oral health promotion in development and youth football, to reverse and prevent the disadvantages that will have lifelong consequences for treatment burden, quality of life and sporting performance.

## Conventional Print Poster Presentations

### CP-MH30 Inflammation and Hormones

**ACUTE KETONE MONOESTER INTAKE IMPROVES BLOOD FLOW REGULATION IN FEMALES WITH POLYCYSTIC OVARY SYNDROME**

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INTRODUCTION: Polycystic ovary syndrome (PCOS) is an endocrinopathy associated with vascular dysfunction and insulin resistance, resulting in an elevated cardiovascular disease risk. Exogenous ketone supplementation can decrease blood glucose concentration and has been suggested to improve vascular function via improvements in blood flow in individuals predisposed to cardiovascular disease, but has yet to be assessed in females with PCOS. Therefore, we tested the hypothesis that acute ketone monoester (KME) ingestion would improve glucose-stimulated increases in blood flow in healthy lean females with PCOS.

METHODS: Ten otherwise healthy females with PCOS (age: 27 ± 5 yr, body mass index: 23.8 ± 2.7 kg/m2, physical activity: 229 ± 111 min/week), participated in a randomized, double-blind, placebo controlled, acute crossover intervention study. In the overnight post-absorptive state, participants consumed the KME (R)-3-hydroxybutyl (R)-3-hydroxybutyrate (0.45 ml/kg body mass) or a taste-matched non-caloric placebo 30 minutes prior to completing a 2-hour 75g oral glucose tolerance test (OGTT). Venous blood samples to assess beta-hydroxybutyrate (β-OHB) concentrations were collected at baseline, at 30-min after KME intake and concurrent with OGTT ingestion (time point 0), and at 15, 30, 60, 90, and 120-min post-OGTT. Blood pressure (measured via finger photoplethysmography calibrated to manual sphygmomanometry) was continuously recorded throughout the OGTT. Leg blood flow (LBF; duplex ultrasound, superficial femoral artery) and femoral vascular conductance (FVC; LBF/mean arterial pressure) were assessed at baseline and at 0, 15, 30, 60, 90, 120-min post-OGTT.

RESULTS: In the placebo trial, blood β-OHB concentration, LBF, and FVC remained unchanged throughout the OGTT (main effects of time all $P>0.05$). In contrast, KME intake significantly elevated blood β-OHB concentration, reaching 3.1 ± 0.8 mM within 30 minutes and remained elevated throughout the OGTT (main effect of time $P<0.01$). Additionally, KME ingestion led to a sustained increase in both LBF and FVC across all OGTT timepoints (main effects of time all $P<0.01$). Notably, peak OGTT-induced increases in LBF (+171 ± 50 vs. +27 ± 14 mL/min, $P<0.01$) and FVC (+1.9 ± 0.7 vs. +0.5 ± 0.3 mL/min/mmHg, $P<0.01$) were greater in the KME compared to placebo trial.

CONCLUSION: These findings suggest that acute KME ingestion enhances glucose-stimulated vascular function in lean females with PCOS. Notably, this lean, physically active phenotype of PCOS is frequently overlooked in both research and clinical interventions, despite evidence suggesting it may represent the most severe form of the disorder. Given the heightened cardiovascular disease risk in this cohort, KME supplements may offer a potential therapeutic strategy in the managements and prevention of cardiometabolic disease risk in females with PCOS.

**EFFECTS OF A PROBIOTIC-PLANT EXTRACT COMBINATION AND SPONTANEOUS PHYSICAL ACTIVITY ON INTESTINAL INFLAMMATION IN A MOUSE MODEL OF CROHNS DISEASE**

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INTRODUCTION: Crohns disease (CD) is an inflammatory bowel disease affecting over 2 million people in Europe, significantly impacting patients quality of life. In a preliminary study conducted in our laboratory, an in vitro screening of 17 probiotic strains and 3 plant extracts led to the identification of a promising combination capable of reducing the adhesion of Adherent-Invasive Escherichia coli (AIEC), a pathobiont bacteria involved in CD, to intestinal epithelial cells and mitigating inflammation. Building on these findings, the present study aimed to evaluate, in a mouse model of CD, the potential of a formulation combining two Lacticaseibacillus strains and walnut leaf extract, together with the protective effects of spontaneous physical activity (PA), known to reduce systemic and tissue inflammation.

METHODS: Male C57BL/6 mice were initially assigned to either a normal diet (control) or a high-fat diet (HFD) for 11 weeks to induce obesity. Following this period, HFD-fed mice were further divided into four subgroups: two groups had access to

spontaneous PA (individually housed with running wheels) for an additional 11 weeks while the other two groups remained sedentary (with locked wheels), each condition receiving either the formulation or not. Mice received oral gavage of the formulation or placebo once daily, 5 days a week, for 5 weeks from the 7th week of PA. During the final two weeks before sacrifice, colitis was induced by adding 1% DSS to the drinking water, with or without an additional challenge with AIEC bacteria to mimic CD, resulting in the formation of eight distinct subgroups.

RESULTS: After the first 11 weeks, HFD-fed mice exhibited significantly higher body mass gain ($p < 0.0001$) than control. During the second phase, despite consuming significantly more energy ($p < 0.0001$), physically active mice gained less mass than their sedentary counterparts ($p = 0.0027$). A negative correlation ($r = -0.4704$, $p = 0.01$) was observed between total distance covered and weight gain. The combination of probiotics and plant extracts had no significant effect on body mass or PA levels. Neither PA, the formulation, nor their combination had a significant effect on post-mortem muscle mass (soleus, gastrocnemius, or tibialis anterior) or adipose tissue mass (epididymal or mesenteric). On the day of sacrifice, the Disease Activity Index score, measuring colitis severity, and fecal lipocalin-2 levels, an indicator of intestinal inflammation, remained unaffected across conditions.

CONCLUSION: The formulation, spontaneous PA, or their combination failed to show effectiveness in the primary prevention of acute intestinal inflammation induced by DSS or DSS + AIEC. Further analyses of serum and tissue inflammation, dysbiosis markers, intestinal permeability, and microbiota composition will complement these data for a better understanding of these findings.

**HYALURONAN ENHANCES PROLIFERATION AND MYOGENIC DIFFERENTIATION OF C2C12 MURINE MYOBLASTS UNDER OXIDATIVE AND INFLAMMATORY STRESS**

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INTRODUCTION: Hyaluronan (HA) is a non-sulfated glycosaminoglycan widely utilized in medical and pharmaceutical applications, particularly in muscle tissue repair. Recent studies highlight its crucial role in muscle regeneration, demonstrating that HA activates muscle stem cells by promoting JMJD3-driven hyaluronic acid synthesis, facilitating adaptation to inflammation and initiating the repair process (1).

METHODS: In this study, we investigated the potential of HA in rescuing myoblasts exposed to oxidative and inflammatory stress using C2C12 murine muscle cells. We first performed a wound healing assay to assess cell monolayer repair at baseline (t0) and after 24 hours (t1), in the presence or absence of an HA blend (2–1000 KDa, 1 mg/ml, Regenflex T&M, Regenyal Laboratories SRL), with or without pro-inflammatory agents (IL-1β, TNF-α, LPS) and oxidative stressors ($H_2O_2$), known to impair proliferation.

RESULTS: Results revealed that HA significantly improved reparative mechanisms even in the presence of inflammatory and oxidative stimuli. Additionally, we evaluated the myogenic potential of C2C12 cells treated with HA by analyzing the expression of key myogenic markers, including MyoD, Mrf4, myogenin, and IGF-1, under the same stress conditions. Preliminary findings indicate that HA exerts a strong pro-proliferative effect, enhancing wound healing within 24 hours post-injury. Moreover, HA treatment upregulated myogenic biomarkers, suggesting a positive impact on differentiation pathways.

CONCLUSION: These results support the potential use of this HA formulation as a promising therapeutic strategy for muscle tissue regeneration

**PATTERNS OF DAILY ACTIVITY, SLEEP, DIET AND HORMONAL FLUCTUATIONS AMONG PREMENOPAUSAL WOMEN: A TWO-MONTH ANALYSIS**

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INTRODUCTION: Despite growing recognition of potential interplays among female reproductive hormones, physical activity (PA), sedentary behavior (SB), sleep, and diet; a dearth of evidence exists examining how these behaviors interact. Existing literature is primarily cross-sectional and typically examines only a single hormonal cycle, despite well-known fluctuations in hormonal fluctuations between cycles. Further, most research often only includes naturally menstruating (NM) women, excluding women using hormonal contraceptives (HC). Therefore, the purpose of this study was to identify potential interactions between estradiol (E2), progesterone (P4), follicle stimulating hormone (FSH), luteinizing hormone (LH), leptin on PA, SB, sleep, and diet among NM and HC women across two hormonal cycles.

METHODS: Premenopausal women (N=16, HC=9, NM=7) completed weekly testing for 8 weeks including a serum blood draw and completion of the Simple Physical Activity Questionnaire (SIMPAQ), the Automated Self-Administered Dietary Assessment Tool (ASA-24), and the Pittsburgh Sleep Quality Index (PSQI). Body fat percentage (BF%) was assessed at baseline via a dual-energy x-ray absorptiometry scan. Data was analyzed using general linear mixed models with HC/NM and cycle phase as fixed effects and participant as a random effect.

RESULTS: BF% (28.4 ± 6.7) was positively related to leptin across all time points for all participants ($b=1.7$, $p<0.001$). Significant positive interactions were identified between FSH and carbohydrate (g) and added sugar (g) intake among all participants ($b=0.93$, $p=0.030$; $b=0.15$, $p=0.006$; respectively). A significant negative interaction was observed between LH and added sugar intake ($b=-1.91$, $p=0.006$). E2 and protein were positively related ($b=0.10$, $p=0.013$). A significant interaction between walking and cycle phase was identified ($b=1.26$, $p=0.002$), and walking was significantly higher in the mid-

follicular phase compared to menstruation (p=0.007). A significant interaction between sleep and cycle phase was observed in NM participants (b=5.21, p=0.004), with sleep differing between menstruation and luteal phase (p<0.001). Additionally, a positive interaction between leptin and sleep was observed (b=0.124, p<0.001). No other significant interactions between lifestyle behaviors and hormones were identified.

CONCLUSION: In a relatively healthy female population, carbohydrate, added sugar, and protein intake appear to be related to infradian female hormonal fluctuations. PA and sleep both appear to have cycle phase interactions among NM participants. In a relatively healthy population, leptin has a strong relationship with BF% and sleep. Additional research is needed to better understand these interactions, particularly within a larger and more diverse population to ensure generalizability.

**ENDURANCE RUNNING IN ELDERLY: ITS EFFECT ON PRODUCTION OF SELECTED HORMONES DURING AGING IN MEN, WITH FOCUS ON CIRCADIAN RHYTHMS AND REPRODUCTIVE HEALTH**

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INTRODUCTION: Aging is associated with a gradual decline in biological functions across all body systems including hormone production and its daily rhythmicity. Regular exercise has been identified as important factor for maintaining healthy ageing, in contrast to a sedentary lifestyle. However, extensive endurance training may also negatively impact physiological functions, such as reproductive health. The main goal of our cross-sectional study was to assess the impact of long-term endurance activity on the secretion of selected hormones in men during ageing.

METHODS: We recruited 51 participants in total, who were divided into 4 groups based on their age and endurance running activity: young athletes (YA, 20-30 years), young sedentary (YS, 20-30 years), master athletes (MA, 65-75 years) and elderly sedentary (ES, 65-75 years). Two venous blood samples were collected (between 7:30–8:00 and 15:30–16:00). We analyzed the levels of SHBG, testosterone (T) and cortisol (C) using commercial enzyme-linked immunosorbent assay kits (ELISA, Cloud-Clone Corp., USA) from both samples (n=11 YA, 10 YS, 9 MA, and 10 ES). Additionally, the percentage of bioavailable testosterone (BT) was analyzed via commercial laboratory (Unilabs Slovensko, s. r. o.) from the morning samples (n=13 YA, 15 YS, 13 MA, and 10 ES). Data were analyzed by two-way ANOVA (for the factors of age and activity) with Tukeys post-hoc test, and mixed-design three-way ANOVA (with a repeated measure factor), followed by Sidak's post-hoc test.

RESULTS: We observed the elevating impact of both the age (p<0,0001) and activity (p=0,006) on SHBG levels. While both C and T production exhibited circadian rhythmicity with the levels decreasing in the afternoon samples (p<0,0001), T levels showed a negative effect of age on the decrease (p=0,0422). There was also an indication of interaction between the activity and age on the decrease (p=0,0934), as the MA group maintained the rhythm (4,43±0,22 ng/mL to 3,17±0,21 ng/mL, (p=0,0003)) whereas the ES group did not (3,97±0,30 ng/mL to 3,58±0,29 ng/mL, (p=0,585)). BT levels were impacted by age (p<0,0001) and activity (p<0,0001), but not their interaction (p=0,747). While the highest levels reached the YS group (compared with YA: p=0,003; MA: p<0,0001; ES: p<0,0001), the MA group reached the lowest levels (YA: p<0,0001; YS: p<0,0001; ES: p=0,003).

CONCLUSION: We found that both age and endurance activity negatively impact SHBG and BT levels, which may have consequences for reproductive health in men. On the other hand, while we did observe the negative effect of age on daily rhythmicity of T levels, there is a suggestion that long-term endurance running may have a beneficial impact on maintaining its circadian rhythmicity. However, a larger sample size is required for statistical confirmation.

The study was partially supported by the Slovak Research and Development Agency (grant no. APVV-21-0164).

**ANALYSIS OF IRISIN AND BRAIN-DERIVED NEUROTROPHIC FACTOR (BDNF) EXPRESSION IN SELECTED ORGANS OF RATS UNDERGOING VARIED PHYSICAL EXERCISE**

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INTRODUCTION: Regular physical activity induces adaptive molecular and physiological changes in various organs, contributing to improved health. Irisin is a myokine produced, among others, by skeletal muscles during physical exertion and plays a crucial role in regulating energy metabolism while also exhibiting neuroprotective properties. Brain-derived neurotrophic factor (BDNF) is a key neurotrophin involved in neuronal plasticity and cognitive functions, with its expression also modulated by physical activity. Despite the growing interest in the systemic effects of these two proteins, their expression in different organs remains insufficiently understood. This study aimed to analyze the expression levels of irisin and BDNF in selected organs of rats subjected to physical training of varying intensity.

METHODS: Female Sprague-Dawley rats were divided into a control group (n=12, no training) and an experimental group (n=36) subjected to an 8-week treadmill training program, followed by a 4-week period of voluntary physical activity. The control group was kept under standard conditions for 12 weeks. The exercising group was further divided into subgroups with low (n=12), moderate (n=12), and high-intensity training (n=12). The training was conducted 5 days per week on a mechanical treadmill, with intensity adjustments of ±20% relative to moderate load. After the experiment, the rats were euthanized following standard animal study procedures, and selected organs—liver, kidneys, and lungs—were collected for immunohistochemical (IHC) analysis of irisin and BDNF expression levels.

RESULTS: Expression of irisin and BDNF was detected in the selected organs in both control and trained groups. The highest expression of both proteins was observed in the liver of rats subjected to physical exercise. High-intensity physical activity induced the greatest increase in irisin and BDNF expression.

CONCLUSION: This study confirms that physical training modulates irisin and BDNF expression, which may contribute to a better understanding of the effects of myokines and neurotrophins in the analyzed organs. Further research is necessary to elucidate the precise molecular mechanisms underlying physiological adaptations to physical exercise.

## Conventional Print Poster Presentations

### CP-MH31 Exercise Therapy

**EFFECTS OF TELEREHABILITATION-BASED MULTILEVEL OROPHARYNGEAL EXERCISES IN OBSTRUCTIVE SLEEP APNEA PATIENTS**

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INTRODUCTION: Obstructive sleep apnea (OSA) is characterized by recurrent upper airway collapse during sleep, leading to serious health consequences, including increased cardiovascular risk and cognitive impairment. Multilevel airway collapse, particularly at the soft palate and tongue base, is common among OSA patients. While oropharyngeal exercises have been proposed as a non-invasive treatment, traditional delivery methods face challenges such as poor adherence due to time constraints and lack of feedback. The efficacy of group-based telerehabilitation for oropharyngeal exercises remains largely unexplored. This study evaluates the effectiveness of group-based telerehabilitation in delivering multilevel oropharyngeal exercises for OSA management.

METHODS: A quasi-experimental, two-group design was employed. Thirty-nine participants diagnosed with OSA via polysomnography were enrolled. The telerehabilitation group attended one to two 45-minute online sessions per week, guided by a trainer, while the control group followed conventional instructions. Generalized Estimating Equations (GEE) were used to analyze the interaction effects between group and time on key outcomes, including Apnea-Hypopnea Index (AHI), sleep quality, and tongue muscle strength.

RESULTS: Significant interaction effects ($p < .05$) were observed in AHI, Hypopnea Index (HI), and AHI in supine position (AHI_S), with the telerehabilitation group showing greater reductions compared to the control group. Additionally, the telerehabilitation group exhibited significant improvements in snoring outcomes, tongue strength (depression, lateralization), and tongue endurance across five directions. While BMI, waist, and hip circumference showed no significant changes, a reduction in neck circumference was noted in the telerehabilitation group, possibly due to improved oropharyngeal muscle function.

CONCLUSION: Group-based telerehabilitation of multilevel oropharyngeal exercises demonstrates potential as an effective intervention for OSA by improving AHI, sleep-related outcomes, and tongue muscle function. Future studies with larger sample sizes and randomized allocation are recommended to further validate these findings and enhance exercise adherence monitoring.

**ECCENTRIC CYCLING EXERCISE IMPROVES CARDIOPULMONARY FITNESS AND MUSCLE FUNCTION IN CHRONIC KIDNEY DISEASE**

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INTRODUCTION: Chronic kidney disease (CKD) involves irreversible renal dysfunction and is linked to various complications that impair quality-of-life, increase mortality, and reduce exercise capacity. Regular physical activity contributes to overall health, with aerobic exercise particularly enhancing exercise capacity. However, conventional aerobic exercise may increase cardiac workload and hemodynamic stress, posing potential risks for CKD patients. Eccentric cycling (ECC), characterized by lower oxygen and energy demands, provides an alternative for individuals with exercise intolerance, enabling higher-intensity training with reduced hemodynamic stress. This study aimed to compare the effectiveness of ECC and concentric cycling (CON) in improving body composition, cardiopulmonary fitness, and respiratory function in CKD patients.

METHODS: This randomized controlled trial, conducted at a single center, included 45 CKD patients assigned to CTL, CON, and ECC groups. The CON and ECC groups underwent 8-week, 24-session cycling programs. The initial exercise intensity was set at 50% of the maximal output (Watts) while maintaining a rating of perceived exertion (RPE) level maintained at 13. Exercise intensity was progressively increased weekly by 5%–10. Outcomes were evaluated through body composition, cardiopulmonary exercise tests, and respiratory function tests (diaphragm ultrasonography, maximum respiratory pressure), assessed at baseline (pre-test), after 1-month exercise (mid-term test) and post-intervention (post-test).

RESULTS: The ECC group exhibited a significant group-by-time interaction in body composition compared to the CON and CTL groups, particularly in skeletal muscle mass (CTL vs. ECC: $p < 0.001$; CON vs. ECC: $p < 0.001$/slope: CTL: -0.16, CON: -0.267, ECC: 0.343), bilateral upper hand grip strength (CTL vs. ECC: $p < 0.001$; CON vs. ECC: $p < 0.001$),and bilateral lower

limb knee extensor strength (CTL vs. ECC: $p < 0.001$; CON vs. ECC: $p < 0.001$). Regarding functional capacity, both the ECC and CON groups showed improvements in the Timed Up-and-Go and the 6-Minute Walk Test. Notable, the ECC group demonstrated significantly greater diaphragm excursion performance (CTL vs. ECC: $p < 0.001$; CON vs. ECC: $p < 0.001$/slope: CTL: -6.037, CON: -8.006, ECC: 1.285). Furthermore, the ECC group reported a higher quality of life, as reflected in the SF-36 Mental Component Summary (MCS) domain.

CONCLUSION: Our study is the first to explore the effects of eccentric cycling exercise on body composition and cardiopulmonary fitness with CKD. The results indicate that ECC is a low-effort, high-benefit exercise modality significantly enhancing body composition, cardiopulmonary fitness, and quality of life in CKD patients. Importantly, no adverse effects were reported throughout the study. These results advocate its use as an innovative intervention for this population.

**INFLUENCE OF RESISTANCE TRAINING ON INFLAMMATORY FUNCTION IN ANOREXIA NERVOSA: AN EXPLORATORY STUDY**

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INTRODUCTION: Anorexia Nervosa (AN) is a psychiatric disorder characterized by a distorted of body image, fear of weight gain and a high rate of chronicity associated with an increased risk of mortality [1]. The overall prevalence of AN is 3.6% in women and 0.3 % in men [2], with peak onset around 15.5 years of age [3]. Recently AN was associated to Neutrophil/Lymphocyte Ratio (NLR), Monocyte/Lymphocyte Ratio (MLR), and Platelet/Lymphocyte Ratio (PLR) serum increase, suggesting a dysfunctional inflammatory response in this population [4,5]. Although Resistance Training (RT) has been explored as a complementary intervention to improve physical and mental well-being in individuals with AN [6], its effect on inflammatory markers remains unknown. Therefore, this study aimed to analyze the effect of 10-week RT program on NLR, LMR and PLR in serum samples from AN patients receiving day hospital care.

METHODS: A total of 20 AN patients (22.25±8.6 years; BMI 16.32±6.1 kg/m2) were enrolled and randomly assigned to either exercise (ANE = 10) or control (ANC = 10) groups. Blood samples were drawn at baseline (T0) and after 10-week training (T1) inflammatory markers were measured and NLR, MLR, and PLR ratios were calculated. Physical fitness assessment included body composition analysis using Tanita BC418 MA and circumferences and skinfold thickness measurements were evaluated at T0 and T1. The RT program consisted of a 10-week supervised program (three per week, 50–60 minutes/session), with progressive moderate-to-high intensity training that included exercises for large muscle groups [6]. A non-parametric U Mann-Whitney or a parametric Student's t-test was performed based on normality tests.

RESULTS: A significant time x group effect was found for neutrophil count, NLR, thigh circumference (TC), lean body mass (LBM) and skeletal muscle mass (SMM) ($p < 0.05$). The ANE group presented significantly lower absolute neutrophil count ($p = 0.010$) and NLR ratio ($p = 0.017$) as well as significantly increased TC ($p = 0.032$), LBM ($p = 0.06$) and SMM ($p = 0.047$) after the 10-week exercise intervention.

CONCLUSION: Results from this study revealed for the first time RT's contribution to the improvement of inflammatory markers in AN patients under day-hospital care. In addition to the improvements found in CT, LBM and SMM, these results show underlying positive effects of RT in regulating inflammatory function in AN.

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**A DELPHI SURVEY TO ESTABLISH THE CORE KNOWLEDGE AND SKILLS OF CLINICAL EXERCISE PHYSIOLOGISTS WORKING IN THE UK**

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INTRODUCTION: Registered Clinical Exercise Physiologists (CEPs) are recognised healthcare professionals in the United Kingdom (UK) and are registered through the Academy of Healthcare Science (AHCS). Their practice is guided by the Clinical Exercise Physiology UK (CEP-UK) standards outlined in their scope of practice and the accompanying curriculum framework. This study aimed to identify and reach consensus on the key knowledge and skills of a UK CEP to ensure that current standards and guidelines are fit for purpose in the UK.

METHODS: Two phases, (i) a scoping review of Medline, Web of Science, and Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases. Key requirements were identified from analysis, the current CEP-UK scope of practice, curriculum framework, the AHCS standards of proficiency and good clinical practice. Based on evidence gathered in phase (i), a modified Delphi survey was administered as phase (ii), which contained CEP key knowledge and skills (n=58), health conditions that a CEP should be able to work with (n=15), and healthcare professions that a CEP should understand

the roles and expertise of (n=9). Academics (n=26), healthcare professionals (n=25), CEPs (n=10), service managers (n=6), and researchers (n=4) were identified through purposive sampling, public advertisement through social media, and snowball sampling. A 1-to-5 rating Likert scale was completed by participants based on the importance of each component for a CEP to practice effectively in the UK. A consensus was reached based on >65% agreement for each component.

RESULTS: Phase (i) identified 24 studies that contained relevant knowledge and skills data. During phase (ii) n=58 (82%) of participants completed the survey. All knowledge and skills identified from the scoping review, the CEP-UK scope of practice, curriculum framework and the AHCS standards of proficiency and good clinical practice (n=58) were accepted, with those in clinical practice (99%) deemed the most important. For CEP practice, 12 of the health conditions identified (80%) were accepted, with cardiovascular and respiratory diseases (100%) identified as the most important and eating disorders (54%) the least important. All healthcare professions (n=9) were accepted, with specialist exercise instructors (100%) being the most important and podiatrists (73%) the least important.

CONCLUSION: The final consensus list contains 58 key knowledge and skills, 12 health conditions and 9 healthcare professions that are important for CEPs to work effectively in UK healthcare. This study confirms that the current CEP-UK curriculum framework is fit for purpose with minimal changes required for the next iteration scheduled for 2025 based on consensus. Further research is required to understand how to best teach and assess these key knowledge and skills within academic institutions.

**FROM THEORY INTO PRACTICE: INSIGHTS FROM A REAL-WORLD IMPLEMENTATION MODEL FOR TAILORED EXERCISE PRESCRIPTION IN CHRONIC DISEASES**

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INTRODUCTION: Although physical exercise is an evidence-based treatment for patients with chronic diseases, providing benefits in terms of morbidity, mortality and quality of life, its implementation in real-world healthcare systems is still limited. Even when physicians recommend physical activity, compliance and adherence to exercise programs remain very low. This study aims to implement a real-world model for tailored exercise prescription (TEP) in an outpatient clinic to evaluate feasibility, effectiveness, compliance and adherence.

METHODS: A TEP was set for each participant, based on a complete clinical and functional evaluation including cardiopulmonary exercise testing and fitness test battery. Subsequent supervised training sessions (STS) were performed in the hospital gym for at least 6 weeks. Lastly, the TEP was adapted for an unsupervised out-of-hospital gym training. After 6 months functional evaluations were repeated during follow-up meeting, also assessing compliance with general recommendations and adherence to the prescribed exercise program.

RESULTS: A total of 312 patients (44% male) with a mean age of 52.1±13.6 years were enrolled. The most frequent main chronic conditions were obesity (47%), solid organ transplantation (32%), primary cardiovascular diseases (8%) and cancer (4%). The initial STS program was completed by 85.9% of patients, all without adverse events. All analyzed tests in the whole population showed improvement after the initial STS period, with maintenance in the medium term. The compliance at the 6-month follow-up meeting was 53.2%, without differences between patients with different chronic conditions. In those patients evaluated at follow-up, the adherence to prescribed exercise in the 6 months was 65.7% (44.9% considering the whole population).

CONCLUSION: A real-world implementation model involving medical evaluation, tailored exercise prescription, and supervised training sessions is safe and effective in the short-term, also impacting medium-term follow-up outcomes.

Despite achieving a compliance rate of two out of three patients for a medical intervention program that includes exercise therapy, only half maintained adherence to exercise after 6 months.

Intervention strategies based on implementation science, behavioral change and motivation, are needed to foster greater adherence to physical exercise in the mid-to-long term.

**HOW DOES AN AEROBIC AND RESISTANCE INTERVAL TRAINING PROGRAM SHAPE CYTOKINE PROFILES AND COGNITIVE FUNCTIONS?**

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INTRODUCTION: Growing evidence suggests that elevated pro-inflammatory cytokines may impair executive function by exerting neurotoxic effects on the prefrontal cortex (PFC). In contrast, prolonged systemic inflammation appears to make the hippocampus, crucial for memory, more susceptible to neurodegeneration. This suggests that inflammation could differentially affect brain regions, driving domain-specific cognitive decline. It has been also suggested that circulating inflammatory factors may penetrate the blood-brain barrier, triggering neuroinflammation that disrupts brain neurotransmission. Regular exercise reduces systemic inflammation by lowering pro-inflammatory and increasing anti-inflammatory cytokines. This dual action not only protects the PFC and hippocampus from inflammatory damage but also promotes neuroplasticity and synaptic resilience. Furthermore, exercise-induced factors called "exerkines" have been shown to counteract the detrimental effects of pro-inflammatory cytokines, supporting both executive function and

memory processes. The aim of this study was to determine the effect of 12-week aerobic and resistance interval training program on peripheral pro-inflammatory and anti-inflammatory cytokine concentrations and cognitive function among the elderlies.

METHODS: The study involved 70 elderlies. Participants were randomly assigned to Aerobic High-Intensity Interval Training (AHIIT), Resistance Circuit High-Intensity Interval Training (HICT) or a control group (CON). The AHIIT protocol involved eight 60-second cycling bouts at 80–90% HRmax with 30 seconds of passive rest. The HICT protocol consisted of eight body-weight exercises with a 30-second rest period. Before and after the 12-week intervention, participants completed cognitive tests assessing executive functions (Stroop Test, Trail Making Test Parts A and B) and memory performance (Visual Pattern Test). Venous blood samples were collected to evaluate pro- and anti-inflammatory cytokine concentrations using the ELISA method.

RESULTS: This study found that HICT significantly reduced the execution time in the TMT-B test. AHIIT improved cognitive flexibility and inhibitory control, as indicated by a shorter Stroop Interference time. Additionally, both HICT and AHIIT enhanced short-term memory, shown by better VPT scores. Interestingly, only HICT program significantly reduced pro-inflammatory cytokines (TNF, IL-5, IL-2, IL-7, IL-1B), demonstrating a strong anti-inflammatory effect.

CONCLUSION: This study shows that a 12-week interval training program significantly improved executive function and memory performance. HICT significantly lowered pro-inflammatory cytokines, while anti-inflammatory levels remained unchanged. Improvements in cognitive function highlight the broader benefits of HICT and AHIIT for physical and mental health. No specific effects of aerobic or resistance training on cognitive domains were observed.

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**SKELETAL MUSCLE MITOCHONDRIAL DYSFUNCTION AS A POTENTIAL DRIVER OF EXERCISE INTOLERANCE IN PATIENTS WITH ADVANCED CHRONIC KIDNEY DISEASE**

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INTRODUCTION: Patients with advanced chronic kidney disease (CKD) often present with fatigue and exercise intolerance, which limits physical functioning and reduces quality of life. Within skeletal muscle, mitochondria are essential for maintaining energy production and, as such, mitochondrial dysfunction may contribute to exercise intolerance in patients with CKD. This study assessed whether skeletal muscle mitochondrial respiration differs between individuals with and without advanced CKD and whether mitochondrial respiration is associated with whole-body aerobic capacity. Furthermore, we assessed the effect of one week of resistance exercise training on skeletal muscle mitochondrial respiration in patients with CKD and healthy controls.

METHODS: Twenty patients with CKD stage G3b-G4 (3F/17M, age 66±13 y, BMI 30±5 kg/m2) and twenty sex-, age-, and BMI-matched controls (3F/17M, age 65±14 y, BMI 29±4 kg/m2) participated in the current study. At screening, all participants underwent a cardiopulmonary exercise test (CPET) to assess aerobic capacity (VO2peak). Next, throughout a 1-week intervention period, participants completed three resistance exercise sessions (day 0, 2, and 4) consisting of 4 sets of leg press and leg extension at 70-80% of one-repetition maximum (1RM). Skeletal muscle biopsies were obtained from the m. vastus lateralis in an overnight fasted and rested state prior to (day 0) and after the intervention period (day 7). Permeabilized fiber bundles were prepared from skeletal muscle tissue to measure mitochondrial respiration. Respiration experiments were performed in an Oroboros O2k respirometer with the addition of saturating ADP and complex I- and II-linked substrates.

RESULTS: VO2peak was significantly lower in patients with CKD compared with healthy controls (21.3±5.9 vs 30.3±11.2 mL/min/kg, P=0.004). Maximal mitochondrial respiration at baseline was significantly lower in patients with CKD compared with healthy controls (376±71 vs 443±128 pmol/s/mg dry wgt, P=0.048). Maximal mitochondrial respiration and VO2 peak were significantly correlated in both patients with CKD (Pearson's r=0.54, P=0.014) and healthy controls (r=0.72, P<0.001). Following one week of resistance training, maximal mitochondrial respiration tended to increase in patients with CKD (376±71 to 408±94 pmol/s/mg dry wgt; paired t-test, P=0.058) but no significant time*group interaction was observed (P=0.453).

CONCLUSION: Whole-body aerobic capacity in patients with advanced CKD is lower when compared with matched healthy controls. The lower aerobic capacity is, at least partly, attributed to lower skeletal muscle mitochondrial respiration. Further work is required to assess the ability of resistance exercise training to augment muscle mitochondrial respiratory capacity, increase aerobic capacity, and hence improve exercise tolerance in patients with CKD.

**QUANTIFICATION OF STREPTOCOCCUS SALIVARIUS K12 ABUNDANCE IN SALIVA AFTER ORAL PROBIOTIC SUPPLEMENTATION AND FOLLOWING A HIGH-INTENSITY TRAINING (HIT) PROGRAM**

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INTRODUCTION: The human oral cavity harbors over 700 bacterial species, making it the second most complex microbiota in the human body [1]. Streptococcus salivarius K12 is bacterial strain potentially implicated in the reduction of upper respiratory tract infections (URTIs) [2]. Here, we quantified K12 strain in eighteen young subjects before and after S. salivarius K12 supplementation and following an high-intensity training (HIT) program. Additionally, total oral bacterial abundance

and dominant bacterial Orders present in saliva were analyzed using real-time PCR along with salivary IgA and cortisol levels.

METHODS: Participants were administrated either a probiotic containing S. salivarius K12 (Bactoblis®, PharmExtracta S.p.A., Pontenure, Italy) or a placebo for 30 days. Following this supplementation period, participants discontinued probiotic intake and underwent a graded exercise test followed by five HIT sessions within three days. Saliva samples (1 mL) were collected at baseline, after 30 days of supplementation, and at 24h and 72h post-exercise. Relative abundances of S. salivarius K12 and the bacterial Orders Lactobacillales, Bacteroidales, Clostridiales, and Enterobacteriales, as well as total bacterial load, were quantified in saliva DNA using real-time PCR [2-3]. sIgA and cortisol levels were quantified using a lateral flow device (LFD). Statistical significance was determined using repeated-measures ANOVA.

RESULTS: At baseline, S. salivarius K12 was undetectable in both the placebo and the supplemented groups. After 30 days of supplementation, its relative abundance significantly increased in all supplemented subjects, though with a high inter-individual variability. S. salivarius K12 levels remained elevated for three days after supplementation but declined sharply thereafter. Total oral bacterial levels were unaffected by S. salivarius K12 supplementation or HIT sessions. Interestingly, the abundance of the Bacteroidales order decreased 24h post-exercise but returned to pre-exercise levels after 72h. In contrast, Clostridiales abundance increased 24h post-exercise. Notably, post-supplementation S. salivarius K12 abundance negatively correlated with salivary cortisol levels. Additionally, Bacteroidales abundance negatively correlated with IgAs level and positively correlated with cortisol level.

CONCLUSION: Real-time PCR quantification may serve as a simple method to assess the efficacy of S. salivarius K12 supplementation and its persistence in the oral cavity. A three-day intensive exercise training programme did not significantly alter total oral bacterial abundance; however, the observed changes in specific bacterial Orders suggest potential modifications of oral microbiome composition. Further studies are warranted to identify the species involved in these microbiome changes and their potential implication on URTI.

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## Conventional Print Poster Presentations

### CP-SH07 Physical Education III

**EFFECTS OF INTERGENERATIONAL AND PARTICIPATORY-DESIGNED EXERCISE INTERVENTIONS ON ACTIVITY LEVELS IN OLDER ADULTS: A SYSTEMATIC REVIEW**

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Background: Older adults are the most sedentary segment of the population, highlighting the need for sustainable interventions to promote lasting behavioral change. Intergenerational programs and participatory approaches have shown promise in enhancing adherence and maintaining longer term benefits.

Objectives: This study aimed to assess the effects of intergenerational and participatory-designed exercise-based interventions to reduce sedentary behaviour (SB) and/or increase physical activity (PA) in older adults.

Design: Literature searches were conducted up to February 2025 within PubMed, Scopus, Web of Science and Cochrane databases. The selected papers met the following eligibility criteria: interventions had to (a) target older adults aged 60 and above, along with younger participants of any age; (b) incorporate intergenerational connections; (c) be experimental studies utilizing a participatory approach; (d) evaluate the effects of an exercise- or SB-focused intervention; and (e) measure at least one PA or SB outcome in older adults, with both pre- and post-intervention assessments.

Measurements: Primary outcomes measured PA or SB in older adults, with assessments conducted before and after the intervention. Secondary outcomes included additional indicators of physical and emotional health, as well as perceived benefits, satisfaction, and intervention acceptability.

Results: A total of 1 out of 148 identified articles met these criteria. The study showed non-significant, but positive associations between intergenerational interactions and increased PA.

Conclusions: While both intergenerational exercise-based interventions and participatory-designed interventions have independently shown positive outcomes in older adults, further research is needed to explore the benefits of combining these approaches.

**INVESTIGATING PHYSICAL EDUCATION TEACHERS ASSESSMENT LITERACY: PRELIMINARY FINDINGS OF A MULTI-STEP APPROACH**

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Introduction: Assessment literacy is crucial for teachers, enabling them to adequately assess their students' learning process and adapt their teaching accordingly. Teachers' assessment is influenced by multiple facets, e.g. cognitive ability and perception [1]. The framework of assessment literacy encompasses cognitive abilities, teachers beliefs regarding assessments and their navigation of the institutional context [2]. However, assessment literacy in the context of physical education (PE) remains to be elucidated. In a multi-step approach, it is aimed to develop and evaluate a reliable instrument, specifically designed to investigate assessment literacy of PE teachers.

Methods: At first, an international (i.e., AUS, CAN, ESP, NED, USA) panel of research experts (n=7) agreed to review and adapt ACAI [3] and KOSTA [4] to account for the unique context of PE. Secondly, PE teachers (n=10), serving as practitioner experts, review the adapted instrument. Subsequent to piloting, reliability and validity will be tested within international PE teacher cohorts.

Results: Preliminary findings from the expert panels and pilot testing (German cohort; n=87) indicate context adaptability of assessment literacy in PE, particularly concerning to Scenario 1 "You give your class a paper-pencil summative unit test with accommodations and modifications for identified learners. Sixteen of the 24 students fail." and Scenario 2 "You discover that a student has plagiarized some of their assignment (e.g., an essay, lab report)" from ACAI.

Discussion and Conclusion: The studies contribute to assessment literacy research by developing a reliable instrument specifically tailored to PE. Eventually, the instrument aims to foster a more comprehensive as well as culturally informed understanding of teachers' assessment and may allow cross-cultural analyses.

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**ENGAGEMENT IN PHYSICAL EDUCATION AS A MEDIATOR BETWEEN PSYCHOLOGICAL NEED SATISFACTION AND SELF-REPORT OUT-OF-SCHOOL PHYSICAL ACTIVITY: THE MODERATING ROLE OF GENDER**

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INTRODUCTION: Physical inactivity among adolescents remains a global public health concern, with schools playing a crucial role in promoting lifelong physical activity habits. Self-Determination Theory (SDT) [1] suggests that satisfying students basic psychological needs for autonomy, competence, and relatedness in physical education (PE) fosters intrinsic motivation, enhancing engagement and long-term physical activity participation. However, how engagement in PE translates into out-of-school physical activity remains unclear, and potential gender differences in this relationship require further investigation. This study examines engagement in PE as a mediator between psychological need satisfaction in PE and self-reported physical activity outside school, while also testing whether gender moderates this mediation effect. Understanding these mechanisms can provide insights into how PE environments can be tailored to foster engagement and long-term physical activity in youth.

METHODS: Self-report instruments measuring basic psychological need satisfaction (BPNS) in PE (autonomy, competence, relatedness, 5 items each, $\omega \geq .66$), behavioral engagement in PE (5 items, $\omega = .81$), and out-of-school physical activity (2 items, $\omega = .91$) were administered online to N = 2,967 Czech high school students. Multi-group structural equation modeling tested gender differences in mediating effects of PE engagement on general PA separately for each psychological need.

RESULTS: We observed varying total effects on out-of-school PA across needs, with competence having the strongest effect for both males ($\beta = .52$) and females ($\beta = .39$). The mediating role of PE engagement varied, ranging from none/partial for competence to substantial/full for autonomy. Gender moderated the mediation for relatedness, where PE engagement fully mediated the effect in females but only partially in males.

CONCLUSION: Our findings emphasize the role of engagement in PE as a mediator linking psychological need satisfaction to out-of-school physical activity, with its influence varying across needs. While competence had the strongest direct effect on PA, engagement played a key role in translating autonomy and relatedness satisfaction into sustained physical activity behaviors. The gender-specific mediation pattern highlights the need for differentiated PE strategies. These results suggest that enhancing PE engagement—through autonomy-supportive, competence-building, and socially inclusive environments—could be key to promoting lifelong physical activity habits among adolescents. Future interventions should focus on strengthening engagement in PE as a mechanism for increasing physical activity beyond school.

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**THE INFLUENCE OF SPORTS COACHES' EMOTIONAL EXPRESSIONS ON STUDENTS IN EXTRACURRICULAR SPORTS CLUB ACTIVITIES OF JAPANESE JUNIOR HIGH AND HIGH SCHOOLS**

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INTRODUCTION : In Japan, approximately 70% of middle school and 42% of high school students participate in sports clubs. Sports clubs play an important educational role as extracurricular activities run by schoolteachers. However, in recent years, many problems with inappropriate instruction in middle and high school club activities have surfaced. The underlying factor is the psychological burden on teachers who lead club activities. Therefore, this study examined how the "teacher's emotional control," which is a background factor for "inappropriate instruction" and "appropriate instruction" by teachers who lead club activities, affects the adaptation and performance of sports club members in terms of club activities.

METHODS : The study participants were 2,500 Japanese middle and high school students involved in school sports club activities (mean age: 15.23 years, SD: 1.739). They voluntarily responded to a questionnaire comprising items from the Coaching Emotion Control Scale (CEC), Inappropriate Guidance Scale (IG), Appropriate Guidance Scale (AG), Coaching Evaluation Scale (CE), Club Activity Engagement Scale (CAE), Maladaptive for Club Activity Scale (MCA), and Self-Growth for Club Activity Scale (SCA). All these scales were originally developed for this study and confirmed as having shown acceptable reliability and meaningful content validity. A covariance structure analysis was conducted to confirm the acceptability of the hypothetical model and relationships between the seven scales.

RESULTS : The results showed that our hypothetical model, having CEC as the determinant independent variable, SCA as the dependent variable, and IG, AG, CE, CAE, and MCA as mediators, yielded acceptable fit indices (GFI: 0.995, AGFI: 0.977, CFI: 0.997, RMSEA: 0.049). Direct effects were observed for CEC, IG, and AG (pass coefficients: 0.53, $p<0.001$, -0.14, $p<0.001$, respectively). The indirect effects of CEC on SCA through AG, CAE, and MCA were statistically significant.

DISCUSSION : The hypothetical model predicted that teachers' emotional control would directly affect students' awareness of inappropriate and appropriate coaching. The study findings indicated that emotional coaching conditions indirectly affected students' club engagement and self-growth through mediating variables. These findings imply that sports club coaches should have opportunities to learn emotional regulation or participate in regular coaching consultations and counseling sessions with psychological specialists in teachers' seminars. Additionally, educational committee boards or governments should create a coaching system and program for school club managers.

**PREDICTORS AND WELL-BEING OUTCOMES OF PSYCHOLOGICAL NEED SATISFACTION IN PHYSICAL EDUCATION: A LATENT CLASS ANALYSIS**

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INTRODUCTION: According to Self-Determination Theory (SDT), psychological need satisfaction is key to motivation and well-being in physical education (PE). When students feel their autonomy, competence, and relatedness needs are met, they experience intrinsic motivation, leading to sustained participation, enjoyment, and improved mental health [1]. This study adopted a person-centered approach to identify typologies of high school students based on psychological need satisfaction in PE. We also examined whether motivational climates in PE, shaped by different socialization agents (parents, peers, and teachers), predict class membership and compared well-being outcomes across classes.

METHODS: Self-report instruments measuring basic psychological need satisfaction (BPNS) in PE (autonomy: $\alpha = .84$, competence: $\alpha = .89$, relatedness: $\alpha = .90$), empowering motivational climates (parents: $\alpha = .86$, peers: $\alpha = .86$, teachers: $\alpha = .91$), and well-being outcomes (happiness, optimism, depression) were administered online to N = 2,967 Czech high school students. Latent class analysis (LCA) identified the optimal number of classes based on 15 BPNS indicators, and a three-step method [2] examined predictors and outcomes of the latent typology.

RESULTS: LCA model fit indices (e.g., reduction in $G^2$ statistics) and parameter estimates supported a four-class solution for need satisfaction. The largest latent class (Low Satisfaction) included over 30% of participants with low response probabilities across all 15 BPNS indicators. Participants in this class reported significantly lower happiness and optimism and higher depression compared to others (all $p < .001$). Multinomial logistic regression showed that all three socialization agents fostering an empowering motivational climate were significant predictors of class membership—a more positive perception of the climate was associated with membership in a qualitatively better class.

CONCLUSION: Consistent with expectations and prior research using LCA, we identified four BPNS classes in PE. A significant proportion of students reported low need satisfaction, highlighting the need for interventions fostering supportive environments to improve well-being. Our findings underscore the importance of a holistic approach to shaping PE's motivational climate, as all socialization agents critically influence students' psychological need satisfaction and well-being.

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**EXPLORING THE IMPACT OF PLEASURE-ORIENTED EXERCISE ON MOTIVATION AND BEHAVIOR IN HEALTH CLUBS: RESULTS FROM A RANDOMIZED CONTROLLED TRIAL ANCILLARY STUDY**

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INTRODUCTION: The sustainability of exercise behavior has been consistently linked to pleasurable affective responses, highlighting a motivational hedonic approach as a promising strategy to reduce physical inactivity. This randomized experimental study aimed to compare two individualized methods of exercise assessment, prescription, and supervision—adjusted for intensity—on motivational and behavioral variables defined as secondary outcomes.

METHODS: A total of 46 apparently healthy, insufficiently active adults (Mage = 32 years, SD = 8.62) were randomly assigned to one of two groups: a control group (FITT; n = 23) and an experimental group (FITT-AFFECT; n = 23). Participants completed three training sessions over two weeks in a gym. The control group followed general exercise prescriptions aligned with the American College of Sports Medicine (ACSM) guidelines, while the experimental group received prescriptions tailored to enhance pleasurable feelings via: (1) consideration of individual preferences and tolerance for exercise intensity, (2) self-selection/regulation of intensity, and (3) repeated affective assessments. Motivational and behavioral constructs—including intention to continue exercising, exercise-related habit, perceived choice, perceived competence, intrinsic motivation, and subjective vitality—were measured subjectively and analysed using descriptive statistics, correlational analyses, and 2 (group) x 2 (time) split-plot ANOVAs.

RESULTS: Both prescriptions were associated with positive outcomes across time in motivational and behavioral variables, such as intrinsic motivation, perceived competence, subjective vitality, exercise-related habit, and intention to engage in physical activity. No relevant differences emerged between groups favouring the presented hypothesis.

Discussion: The present study demonstrated that both a structured and individualized pre-defined intensity as a pleasured-guided intensity prescription can support several motivational and behavior-related variables like intrinsic motivation, choice, competence, subjective vitality, exercise habit, and intention to be physically active. The absence of significant differences between groups indicates that the increased exercise frequency observed in the experimental group of this RCT may be independent of these motivational constructs. Nevertheless, considering the same results in the motivational constructs and the higher frequency experienced in the experimental group, there is no empirical justification for discouraging engagement in pleasurable activities or related prescriptions.

**REDUCING SCHOOL ABSENCE THROUGH HEALTH PROMOTION: A QUALITATIVE STUDY ON SCHOOL STAFF'S EFFORTS TO IMPROVE WELL-BEING, MOTIVATION, AND PHYSICAL ACTIVITY AMONG SECONDARY SCHOOL STUDENTS**

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INTRODUCTION: An increasing problem among students in todays compulsory school is the reduced physical activity, poor psychosocial health, and an increased number of students with problematic school absences. Working on health promotion and early detection of signs of discomfort and school absence is of utmost importance in order to work preventively. The PIA project – (Promote Health, Important Choices and Attendance) is a three-year school project in three smaller municipalities and three secondary schools in the western parts of Sweden. The project aims to reduce school absence through health promotion, with a focus on enhancing well-being, motivation, and physical activity among students aged 13 to 16.

The aim of this study is to qualitatively evaluate the PIA project. The study seeks to answer the following questions; How do school staff describe the types of interventions that have been implemented? Do the school staff experience that the activities enhance well-being, school motivation and physical activity during the school day?

Method: The study involves qualitative interviews with school staff (n= 27) who are part of the student health teams in three schools. These teams include roles such as school nurse, health coach, special needs teacher, study and career counselor. The project is grounded in ecological systems theory, which highlights the importance of interventions at various levels within the environment to influence and change the socio-cultural processes of individuals and groups. Data was analyzed using thematic analysis, involving a thorough review of the material followed by grouping codes into themes to develop a comprehensive understanding of the data.

RESULTS: Three themes were constructed from interview data. 'Opportunities for Movement' highlights efforts to promote physical activity and mental health. 'Management of Absence' display the teams work to influence student's decisions to attend school. The theme 'Collaboration and Relationships' emphasize the importance of cultivating and developing secure relationships with students in order to better engage them and involve them in the schools health promotion work.

Discussion: The results illustrate how the health teams in the PIA project attempt to implement interventions at multiple levels within the school organization, both directly targeting students and within overarching structures. The results of the study can contribute to a knowledge base recommending methods for schools to use in preventing problematic school absences, psychosocial ill health and physical inactivity.

**THE IMPACT OF MENTAL HEALTH EDUCATION THROUGH THE DELIVERY OF A STRUCTURED PLAY-BASED LEARNING CURRICULUM ON CHILDRENS' MENTAL WELLBEING**

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INTRODUCTION: Engaging in regular physical activity (PA) offers numerous benefits for the mental health of children. Those who are physically active often experience greater well-being, higher self-esteem, and an improved quality of life (Kopp et al., 2024). PA interventions in children have shown a reduction in symptoms of depression, stress and anxiety. It is well established that involvement in team sports promotes a more active lifestyle, enhances physical fitness and improves clinical health (Hills et al., 2015). In addition, mental health education has been found to support children managing emotion regulation, which is a precursor to the development of mental health concerns in adolescence (Moran et al., 2024). Very few studies in Asia have placed emphasis on the use of team sports among youth groups as an intervention strategy to enhance emotional wellbeing and psychosocial status.

METHODS: 18 children participated in a 10-week programme of play-based rugby and mental health coaching. Psychosocial assessments were conducted pre- and post-programme. These included The Depression, Anxiety and Stress Scale - 21 Items (DASS-21); The Physical Self-Description Questionnaire (PSDQ); Connor-Davidson Resilience Scale (CD-RISC); Buss Perry Aggression Questionnaire (BPAQ). The programme was delivered by full-time rugby coaches and mental health professionals. Informed consent was obtained from all parents prior to the commencement of the study.

RESULTS: A total of 18 participants (mean age 9 ± 1.6 y) took part in this study. Post-test analysis of data identified a significant reduction in stress levels as measured by the DASS-21 (pre: 149 ± 19; post: 127 ± 50; p=0.06). At the same time, self-concept scores according to the PSDQ significantly increased over the same period (pre: 4.6 ± 1.3; post: 5.2 ± 1; p=0.07). In addition, non-statistically significant improvements in scores for depression (pre: 7.6 ± 6.9; post: 5.1 ± 5.1; p=0.25) and anxiety (pre: 190 ± 28; post: 116 ± 19; p=1.6) were also observed amongst the same cohort. No differences were observed in CD-RISC. Aggression scores were slightly increased post-test (pre: 7.2 ± 3.1; post: 7.6 ± 3.2; p = 0.17).

Conclusions

The current study shows that increased access to safe and inclusive sports activity in a structured learning environment can promote the wellbeing of children and equip them with the ability to manage their emotional health. This research can provide useful information for sporting and community organisations to assist policy makers in designing new positive exercise programmes through a systematic learning environment that prioritises mental and physical well-being.

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## Conventional Print Poster Presentations

### CP-MH33 Health and Fitness II - Mixed

**TEACHING AND ASSESSMENT OF CLINICAL EXERCISE PHYSIOLOGISTS IN THE UK**

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INTRODUCTION: Development of clinical skills in areas such as exercise risk stratification, testing, prescription, monitoring and outcome assessment are vital for patient safety and clinical effectiveness in clinical exercise physiology (CEP). This study explored how current CEP courses are being taught and assessed, and how current curricula are aligned with the real-world clinical requirements in the UK.

METHODS: Qualitative methods were employed to explore the thoughts of CEPs, academics and current students regarding the teaching and assessment of CEPs in the UK. Research design involved, (i) semi-structured interviews with students (n=16), and (ii) focus groups with academics (n=8) and CEP (n=5) stakeholders. Data obtained were audio recorded using a portable Dictaphone and transcribed verbatim, then thematically analysed manually using reflexive thematic analysis.

RESULTS: Three themes: (i) in situ learning / real world practice (working with patients and specialist practitioners); (ii) programme design (scaffold learning and integrated modules) and, (iii) teaching approach (simulated learning and research competency) were generated concerning teaching methods and approaches across CEP postgraduate degrees. The current use of simulated tasks for the delivery of taught content was identified as lacking effectiveness, with clinical placements identified as being the most important source of knowledge and skill attainment due to the real-world exposure to patients and practitioners. Clinical placements and simulated learning were recognised as the main two methods of problem-based learning (PBL) used to develop student knowledge, skills and competency to practice. Two themes (placement tariffs/assessors in situ and role play/simulation) were identified for the assessment of students.

CONCLUSION: Clinical placements remain the optimal method for developing the knowledge, skills and competency to practice for student CEPs. However, suitable placements remain limited and novel approaches such as university-led exercise services require consideration for student competency development. A standardized and accredited training pathway from undergraduate through to postgraduate level should be explored to allow student competency to be developed over a longer period, to enhance knowledge, skills and competency upon graduation and registration.

**WORK INTENSITY IN INDIVIDUALS WITH RHEUMATIC AND MUSCULOSKELETAL DISEASES INSTRUCTED TO GET THE HEART RATE UP**

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INTRODUCTION: Persons suffering from rheumatic and musculoskeletal diseases are urged to do aerobic exercise to reduce the risk of cardiovascular disease and symptoms. A suitable case of exercise is constant exercise at an intensity causing the rate of perceived exertion to be 15, on the 6-20 point Borg scale [1,2]. But, the instruction "Now you need to get your heart rate up" is commonly utilised before aerobic exercise. Here, the following hypothesis was tested: Work intensity during ergometer cycling initiated with the instruction "Now you need to get your heart rate up" is lower than when a score of 15 on the Borg scale is targeted.

METHODS: This was a counterbalanced crossover study. Individuals (n=15) with rheumatic and musculoskeletal diseases participated. Familiarisation was followed by two test sessions termed reference session and exercise session. In the reference session, the relationship between Borg scale score [3] and intensity was established by a progressive protocol, which included cycling at a target score of 15 on the Borg scale. The protocol was initiated by 2 min of cycling at a target score of 7 on the Borg scale. It continued without interruption with 2 min of cycling at a target value of 8 etc. - until the last 2 min at a target of 16 was completed. In the exercise session, intensity was recorded over 20 min of cycling. The participant received the instruction "Now you need to get your heart rate up" in advance. During cycling, the participant could regulate the power output as preferred. Heart rate, power output, and cadence were noted every second min. Heart rate, as a percentage of maximal heart rate, was estimated as earlier [4]

RESULTS: Average values of power output, heart rate, and heart rate as a percentage of maximal heart rate, during cycling at a Borg scale value of 15 in the reference session amounted to 89±40 W, 138±19 (beats/min), and 86±9%, respectively. For comparison, the average values of power output, heart rate, and heart rate as a percentage of maximal heart rate, across the 20 min of cycling in the exercise session, were 7±13%, 5±7%, and 5±6 percentage points, respectively, lower than during cycling at a target score of 15 on the Borg scale in the reference session ($p<0.05$). Cadence was on average 77 rpm in each session ($p>0.05$).

CONCLUSION: A value separating moderate and high intensity is 82% of the maximal heart rate [2]. Accordingly, the intensity after the instruction "Now you need to get your heart rate up" in the exercise session may be considered moderate. The intensity when targeting a value of 15 on the Borg scale in the reference session may be considered high.

In conclusion, work intensity during ergometer cycling, preceded by the instruction "Now you need to get your heart rate up", was lower than during cycling targeting a score of 15 on the Borg scale.

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**PIFIT - PHARMA IN FIT: EXERGAMES AS NONPHARMACOLOGICAL DRUG**

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INTRODUCTION: Physical activity is essential for health promotion and disease prevention. However, sedentary behavior remains prevalent, with one in four adults not meeting the WHOs recommended levels (WHO, 2016). Exergames, active video games combining movement with digital interaction, have emerged as innovative tools to promote physical activity among both healthy and no-healthy individuals, play a key role in enabling more frequent, comprehensive, and out-of-hospital follow-up. This systematic review analyzes the effectiveness of exergames in improving physical and cognitive health, evaluates their potential implementation in pharmacies to support medication reduction through physical activity.

METHODS: This review follows PRISMA guidelines, analyzing studies from the past five years in PubMed and Scopus. Studiess focus on exergames use in healthy and pathological populations, assessing their impact on physical health, cognitive function, and quality of life. Studies were evaluated using PICO model; exclusion criteria were rehabilitation or lacking "systematic review" or "meta-analysis" in their titles were excluded. Data extraction was conducted via Microsoft Excel, and bias risk assessment followed AMSTAR2.

RESULTS: The review identified studies involving both healthy and pathological populations. Among healthy individuals, exergames improved fundamental motor skills in children, cognitive functions in the elderly, and physical education outcomes in students. In pathological populations, exergames aided in managing childhood obesity, reducing chronic pain,

and enhancing balance and coordination in patients with peripheral neuropathies and Parkinson's disease. However, some studies highlighted methodological limitations, necessitating further research to standardize interventions.

CONCLUSION: Exergames offer a promising strategy to promote physical activity across populations, with potential applications in pharmacies to support public health initiatives. Findings suggest that integrating exergames into pharmacies could reduce medication prescriptions by offering physical activity as an alternative therapy. Further studies are needed to refine their integration into educational and healthcare settings, fostering exercise medicine.

**ONLINE STRENGTH TRAINING: IMPACT ON FIBROMYALGIA AND ASSOCIATED SYMPTOMS**

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INTRODUCTION: Physical exercise is recommended as an adjunctive treatment for fibromyalgia in several guidelines [1]. However, the effects of remote and online strength training in this population remain poorly studied. This study aimed to investigate the effects of online strength training on disease impact and associated symptoms in individuals with fibromyalgia.

METHODS: Thirteen participants (45.77±12.82 years) completed 16 sessions of online strength training using seven bodyweight exercises with adaptations where necessary [2]. Sessions were conducted via Google Meet and lasted 50 minutes (1-8 sessions: 3x8 reps) or 75 minutes (9-16 sessions: 5x6 reps), twice a week. Exercises were performed at maximum intended velocity during the concentric phase, with exertion monitored using the Borg scale. Disease severity was assessed before and after training using the Fibromyalgia Impact Questionnaire (FIQ), and symptoms of pain, anxiety, fatigue, mood, and sleep quality were measured using a visual analogue scale (VAS).

RESULTS: All participants showed improvements after the sessions. The total FIQ demonstrated a 23% reduction in disease impact, with domain reductions ranging from 7% to 44%. Pain, anxiety, and fatigue symptoms decreased by 33%, 31%, and 38%, respectively. Additionally, 24% of participants reported improved mood, and 50% noted better sleep quality during the intervention.

CONCLUSION: Online strength training, without external loads and using an adapted exercise protocol, appears to be beneficial for reducing disease impact and improving symptoms in individuals with fibromyalgia.

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**HEALTH RELATED FITNESS OF HUNGARIAN ADULT FEMALES**

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INTRODUCTION: Multifaceted challenges are faced in Hungary in terms of life expectancy and premature mortality, oppositely to global standards. There are several lifestyle factors modifying health, leading to early death, contributing to higher mortality and high ratio of circulatory system diseases, malignant tumors. Oppositely among many positive factors regular physical activity (PA) proofed to be important in health, and it is rather low among Hungarian adults. The primary aim of our research was to investigate health related fitness parameters, physical condition and performance of adult Hungarian women, analyzing data of 194 participants. Assessing lifestyles with the European Health Interview Survey, measuring body composition and physical fitness with the aid of Senior Fitness Test were employed.

METHODS: Subjects were assigned into 4 groups: Group 1 (G1) the age range was of 45-55 years (n= 43, mean age: 49.09±0.58y), in Group 2 (G2) from 55-65 years (n=22, 59.20±0.82 y), Group 3 (G3) young mostly inactive university students (n=16, 23.85±3.15y), and G4 (n=98 healthy active women, 46.48±9.26y). In G1 and G2 and G4 the volunteers were physically active, regularly participating in recreational activities and sports throughout their life, but none of them ever participated in elite sports at least three times a week. PAs mentioned were cycling, hiking or walking in town, jogging. A six-minute walking test (6MWT) was conducted to measure aerobic capacity/endurance (Enright 2003). In G1 and G2 a spiro-ergometric Bruce protocol was also conducted to correlate 6MWT results and relVO2max measured using treadmill. In 6MWT besides distance covered in meters, expected distance was calculated, maximal Heart Rate (HRmax) and O2-saturation with a pulse oximeter was registered.

RESULTS: Results of 6MWT average in G1:583.5m, and G2:693m reached the calculated expected distance, while in G3 the covered distance was 666.94±46m, the expected (894m) was much higher, although the body composition profile, BMI was lower than in the older population. In G4 the covered distance 633.26±64.4m did not reach the expected one 7(42.6±63.34m). Their VO2max calculated according to Laskin et al. (2007) was in G1=41.87ml/kg/min, G2 42.18ml/kg/min, while in G3=37.05ml/kg/min, in G4 was higher (38.52±5.07ml/kg/min) than that in the younger generation. No significant difference was found between the measured and calculated VO2max. Calculating age matched performance by the 6MWT, most subjects in the older groups were in the excellent category, in G3 VO2max was below the average. Analyzing G3 data subjects had either a very low, or good/excellent aerobic performance. Intensity of the 6MWT

measured with HRmax were over 75% in G1, G2 and G3, while in G4 it was only 57.3±18.81%. O2-saturation did not change significantly in any groups by the end of the walk.

CONCLUSION: Results of our study suggest that among Hungarian adult women younger sedentary subjects are in worse fitness and health status than the older active ones.

## Conventional Print Poster Presentations

### CP-MH34 Health and Fitness III - Mixed

**EFFECTS OF EXERCISE UNDER DIFFERENT FEEDING STATES (FASTED VERSUS FED) ON APPETITE AND FOOD PREFERENCE**

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INTRODUCTION: Carbohydrate availability (e.g., muscle and/or liver glycogen) in the human body might play a role in regulating subsequent energy intake. Compared to fed-state exercise, fasted exercise may significantly reduce endogenous glycogen stores, and it may potentially affect appetite and macronutrient choices. Up-to-date, most studies have only used a single ad libitum lunch to assess eating behaviour, and it is still unclear whether food preferences, choices, and dietary behavior in free-living may be affected.

METHODS: Twenty-four (12 females) healthy and physically active participants (age: 24 ± 4 yr; BMI: 21.3 ± 1.7 kg/m²; VO2max: 47 ± 6 ml/kg/min) were recruited, and performed a 60-minute running exercise at 60% VO2max in a randomized, counterbalanced order either after an overnight fasting (Fasted-Ex) or consuming breakfast (5.8 kcal/kg, Fed-Ex). Subjective appetite sensation (i.e., hunger, fullness, prospective food consumption and desire to eat) was regularly measured during trials (baseline, 30, 60, 120, 150 and 180 min), and food preference (i.e., fat and taste's explicit liking, explicit wanting, implicit wanting, and relative preference) was assessed at baseline and 180 min using computerized visual test (i.e., Leeds Food Preference Questionnaire). Free-living eating behavior (total energy intake and macronutrient consumption) was recorded using a weighed food diary for the remainder of the day.

RESULTS: No difference was observed for exercise intensity between Fasted-Ex and Fed-Ex (60 ± 2% vs. 61 ± 3% VO2max, $p = 0.058$). Compared to Fed-Ex, fat oxidation was higher during Fasted-Ex (27 ± 6 vs. 19 ± 5 g, $p < 0.001$), and carbohydrate oxidation was lower (62 ± 22 vs. 85 ± 26 g, $p < 0.001$). Subjective appetite (ΔtAUC0-180: Fasted-Ex minus Fed-Ex) was greater in Fasted-Ex than in Fed-Ex (hunger: 2156, $p = 0.002$; fullness: -1791, $p < 0.001$; prospective food consumption: 1925, $p < 0.001$; desire to eat: 2242, $p < 0.001$). There were no differences in food preferences immediately after exercise or dietary behaviors (first meal and total intake) in the free-living conditions. Moreover, total daily energy, carbohydrate, and protein intake were lower in Fasted-Ex (1697 ± 685 kcal; 215 ± 100 g; 70 ± 27 g) compared to Fed-Ex (2340 ± 664 kcal; 293 ± 95 g; 100 ± 36 g, all $p < 0.001$).

CONCLUSION: While fasted-exercise increases subjective appetite, it does not acutely alter food preferences or eating behavior in free-living conditions in physically active adults. Total energy intake remains lower over a 24-hour period in the Fasted-Ex due to breakfast omission.

**THE ACTIVE PREGNANCY GUIDE. BUILDING MULTILANGUAGE EDUCATIONAL RESOURCES TARGETING WOMEN, TO PROMOTE ACTIVE AND HEALTHY LIFESTYLES DURING PREGNANCY AND POSTPARTUM**

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INTRODUCTION: Current official recommendations and substantive evidence supports the maintenance of an active lifestyle during pregnancy and postpartum, which is a multigenerational public health issue. Despite strong health benefits for both mother and fetus, most women reduce exercise frequency and intensity during pregnancy and postpartum, and also many do not meet recommended activity levels. Scientific literature shows that pregnant women perceive a lack of information on safe exercise as a key barrier, while support from healthcare and exercise professionals as a facilitator. Women's health literacy is crucial for better healthcare behavior, empowerment, and self-management. Thus, creating multilingual resources that incorporate womens perspectives is essential. The objective is to present the Active Pregnancy Guide (1) and analyze health care and exercise professionals' perceptions about its use in the promotion of physical activity during pregnancy.

METHODS: The guide was first built in the Portuguese and English languages involving multidisciplinary experts and including the perspectives and experiences of women. In the second stage, it was translated to other European Languages. All versions of the Active Pregnancy Guide are made available for free download on the ResearchGate platform and other social media. During the NEPPE training, 77 participants including health care and exercise professionals were asked to rate the usefulness of the educational materials from 1 litte useful to 5 very useful.

RESULTS: The guide is an example of practical guidelines that highlight the importance of involving the perspectives and experiences of women in the promotion of a healthy life and safe training during pregnancy and postpartum. The accessibility to these guidelines makes it necessary that they be shown as a multilanguage resource to be available independently of women's country or region. It consists of ten chapters: the first four cover benefits, recommendations, health

screening, and exercise assessment; the next three focus on exercise prescription and safety; the last three address reducing sedentary behavior, promoting healthy diet and sleep patterns. A link to YouTube channel offers free Workshops, Webinars, Workouts, and Wikipicks. All versions are available for free download on the RearchGate. Participants from the NEPPE training rated the usefulness of the educational materials provided by the guide with an average of 4.7 points, as well as the global satisfaction with the training with an average of 4.5 points.

CONCLUSION: The use of educational resources may address some physical activity and exercise barriers, promote health education, and deliver effective and scalable interventions. The use of the guide is very well rated by health care and exercise professionals. The integration of the guidelines contents in an App with videos and remote monitoring allow to guide pregnant women during exercise providing a cost-effective solution to increase physical activity.

**EFFECTS OF AN 8-WEEK TOE FLEXOR STRENGTHENING PROGRAM ON JUMP PERFORMANCE**

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INTRODUCTION: The force-generating capacity of the foot is closely related to human physical performance. During the take-off phase of a jump, the heel lifts off the ground, and the forefoot supports the body while transmitting forces from the upper and lower limbs (Yamauchi & Koyama, 2022). Just before take-off, ground reaction forces increase, and toe flexor strength is associated with jump performance (Yamauchi & Koyama, 2020). This suggests that strengthening foot muscles may contribute to improved jumping ability. While cross-sectional studies have examined the relationship between toe flexor strength and jump performance, the causal link remains unclear. This study investigated the effects of an 8-week exercise program on toe flexor strength and jump performance and explored the relationship between their changes.

METHODS: Healthy adults aged 20–50 years were measured foot length, arch height, toe flexor strength, vertical jump height, and standing long jump distance. Subjects were assigned to either a training group (TR) or a control group (CON), ensuring no significant differences in age, height, body weight or any measurement values. The TR performed a multicomponent exercise training (Koyama & Yamauchi, 2023) twice weekly for 60 minutes over 8 weeks. Measurements were conducted once every two weeks, for a total of four times. Foot length, arch height and toe flexor strength in sitting and standing positions were assessed using a ruler and a dynamometer, respectively. Arch height and toe flexor strength were normalized to foot length and body weight, respectively. Vertical jump height was evaluated using both countermovement jump (CMJ) and squat jump (SJ) tests. Standing long jump distance was measured using a tape measure. All measurement variables were analyzed relative to baseline values recorded at week 0. A two-way repeated-measures ANOVA [time (four po

RESULTS: In the TR, toe flexor strength in the sitting position increased every two weeks until week 8, and in the standing position, it increased except between weeks 6 and 8. At all measurement points, both were significantly higher than in the CON. Arch height variables showed no significant changes or group differences. CMJ, SJ height, and standing long jump performance significantly improved in the TR throughout the training period. However, no significant differences were observed between the TR and CON for any jump performance variables at any measurement week. The improvement rate of toe flexor strength showed no significant correlation with the improvement rate of CMJ or SJ but had weak correlations with the improvement rate of the standing long jump at week 4 ($p = 0.091$) and week 8 ($p = 0.099$).

CONCLUSION: A toe flexor strengthening exercise training program enhanced force generation capacity of the foot and jump performance, potentially benefiting forward-directed jumps.

**PROBIOTICS & PERFORMANCE: THE HIDDEN LANGUAGE OF EXOSOMAL HSP60 IN EXERCISE**

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*UNIVERSITY*

INTRODUCTION: Heat shock proteins (Hsp), particularly Hsp60, play a crucial role in regulating the cellular stress response and have also been identified in plasma-derived exosomes (Barone et al., 2016), suggesting a potential function in intercellular signalling. Exercise, both aerobic and anaerobic, can modulate the release of Hsp60 through exosomes, thus influencing cellular communication. In our previous publication, we already described how L. fermentum influenced the NF-κB signaling pathway, inducing the expression of Hsp60 (Paladino et al., 2023). This study aims to analyze Hsp60 levels in exosomes isolated from the plasma as well as anti and pro-inflammatory cytokines levels (e.g. IL-6, TNF-α, IL-10) of three groups of subjects: sedentary, runners, and CrossFit athletes, before and after a period of supplementation with probiotics.

METHODS: Fifteen males were enrolled in our study: a sedentary control group, a runner group, and a CrossFit group. All participants underwent basal blood sampling (T0) before and after an exercise session to assess the acute response to physical activity. Subsequently, each group received supplementation of probiotic blend for two months. At the end of the supplementation period, subjects were assessed again by blood sampling before and after an acute exercise session.

Plasma-derived exosomes were isolated using standardized ultracentrifugation protocols. The presence of exosomes was confirmed by detecting specific markers by western blotting. In addition, the expression of Hsp60 within the exosomes was analyzed. In parallel, the levels of inflammatory and anti-inflammatory cytokines were quantified using MagPix® (ThermoFisher Scientific).

RESULTS: Preliminary results indicate variations overall in Hsp60 levels between groups, with differences between the activities, suggesting that the type of exercise influences the release of this protein through exosomes. Furthermore, it is hypothesized that exosome-mediated cellular communication may originate from muscle cells, contributing to the transport of molecular signals to other tissues. These results suggest that exercise may modulate the release of Hsp60 in plasma exosomes, and probiotic supplementation may play a role in regulating this response.

CONCLUSION: Further studies are needed to clarify the mechanisms underlying this modulation and its impact on intercellular communication, the inflammatory response, and the change in performance.

Reference:

Paladino, L. et al (2023). NF-kB Regulation and the Chaperone System Mediate Restorative Effects of the Probiotic Lactobacillus fermentum LF31 in the Small Intestine and Cerebellum of Mice with Ethanol-Induced Damage. Biology, 12(11), 1394.

Barone, R. et al. (2016) Skeletal muscle Heat shock protein 60 increases after endurance training and induces peroxisome proliferator-activated receptor gamma coactivator 1 α1 expression. Sci Rep 6, 19781.

**IMPACT OF SLEEP RECOVERY FOLLOWING 24-H TOTAL SLEEP DEPRIVATION ON APPETITE, ENERGY INTAKE AND FOOD PREFERENCES**

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INTRODUCTION: Sleep deprivation is well-known to induce an orexigenic behaviour that may lead to obesity and other metabolic diseases if these episodes became persistent. This problem mainly affects personnel used to work during nightshifts but could also concern athletes especially nearby and during competitions. These effects have been mostly measured at the breakfast but the impact on appetite during the total sleep deprivation (TSD) and the remaining of the day are unexplored. Moreover the effects of sleep recovery (partial, PSR or total, TSR) have never been assessed. The objective of this study was to follow the effect of TSD and investigate the efficiency of PSR then after TSR on energy intake (EI), subjective appetite, and food reward.

METHODS: 41 healthy participants lived in a laboratory designed like an apartment with 5 sleeping rooms during 4 consecutive days. After a night with normal sleep (NS, time in bed [TIB]=8 h), participants realized TSD, a night with PSR (TIB=3 h) and finally a night with TSR (TIB=8 h). During TSD and PSR, a buffet with ready-to-eat foods containing sixteen high-fat or low-fat and sweet or savory foods was proposed to participants. Subjective hunger was assessed using visual analog scales before and after each meal. Food palatability was assessed after each meal. Food reward was assessed before the night collation and the breakfast using the Leeds Food Preference Questionnaire (LFPQ).

RESULTS: Nocturnal collations were predominantly composed of fat (48±17 of EI) and induced a supplemental EI of 511±195 and 420±183 kcal during TSD and PSR, respectively. No compensatory EI reduction was observed during the remaining of the day. Thus, 24-h EI was logically higher ($p<.001$) during TSD (2931±578 kcal) and PSR (3019±657 kcal) compared to NS (2519±669 kcal) and TSR (2623±638 kcal). Moreover, the impact of the nocturnal collations was marginal on subsequent subjective appetite. Indeed, although gastric fullness before breakfast was higher ($p<.05$) in TSR and PSR compared to NS , no other appetite-related dimensions was modified. In TSR, composite appetite score before breakfast was higher compared to TSD. Moreover, the quantities served at breakfast were estimated as lower during TSR compared to TSD ($p<.05$). These results may indicate that participants had higher appetite despite having fully recovered. Concerning food reward, appeal for high-fat foods before breakfast was increased during TSD and PSR compared to NS ($p<.001$).

CONCLUSION: These results indicate that individuals during TSD may be tempted to select foods with high-fat content during a nocturnal collation. Food reward was accordingly higher before breakfast after TSD and PSR. The collation consumption marginally impacted appetite the rest of the day and strongly increasing 24-h EI. Finally, even after TSR, persistence of high appetitive responses following TSD were observed at breakfast indicating that negative sleep deprivation on appetite may last after sleep recovery.

**SIT-TO-STAND PERFORMANCE MEASURES AND THEIR ASSOCIATIONS WITH WALKING PERFORMANCE IN HIV PATIENTS**

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INTRODUCTION: Advances in antiretroviral therapy (ART) have increased life expectancy in people living with HIV (PLHIV). However, long-term ART use and sedentary lifestyle [1] are linked to a rise in comorbidities in PLHIV, including frailty [2], which impact functional capacity and quality of life. Given that lower-limbs power is crucial for maintaining functional capacity in aging populations, identification of valid predictors of functional capacity is particularly relevant for PLHIV. Previously, sit-to-stand test (STS) completion time and power have been associated with the functional capacity in different clinical populations, however it remains unclear whether these measures are associated with functional capacity in PLHIV [3,4]. Therefore, this study aimed to analyze the relationships between STS time, absolute, and relative STS muscle power with walking performance in PLHIV.

METHODS: Twenty-seven PLHIV (48±13 years) undergoing ART participated in the study. Muscle power was assessed through the STS. STS completion time was recorded, and absolute power, and relative power were subsequently calculated. The total distance covered during the 2-min walking test (2-MWT) was used as a measure of functional capacity. Normality was assessed and Spearman correlation analysis was conducted in R-Studio, with significance set at $p < 0.05$.

RESULTS: Spearmans correlation analysis showed that STS completion time did not correlate with total distance walked in the 2-MWT ($p > 0.05$). However, absolute STS power (rho = 0.494, p = 0.009) and relative STS power (rho = 0.448, p = 0.019) showed moderate significant correlations with walking performance.

CONCLUSION: Lower-limbs muscle power is a better predictor of functional capacity than time to complete STS in PLHIV. These findings support the use of power over time-based measures when evaluating functional capacity in PLHIV.

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2. Ramírez et al., 2023, Medwave.

3. Baltasar-Fernandez et al., 2021, Exp Gerontol.

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**EFFECTS OF HELMET VENTILATION ASSISTANCE ON MUSCLE OXYGENATION IMPROVEMENT DURING ECCENTRIC EXERCISE IN COPD PATIENTS: AN EVALUATION USING NEAR-INFRARED SPECTROSCOPY**

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INTRODUCTION: While eccentric exercise may cause muscle damage and inflammation, some studies suggest it does not necessarily impair oxidative function. Additionally, non-invasive ventilation (NIV) can enhance muscle oxygenation, prolong exercise duration, and increase oxygen uptake ($VO_2$). Further research is needed to clarify its direct effects on muscle oxidative function and the potential benefits of NIV in COPD patients.

METHODS: Patients diagnosed with COPD were recruited from outpatient clinics and randomly assigned to either the control group (CON, n=14) or the experimental group (EXP, n=12). Participants in the EXP group performed eccentric cycle exercise (ECE) with the assistance of non-invasive helmet ventilation. All participants engaged in 40-minute eccentric cycling sessions twice a week for a total of nine weeks, including a one-week familiarization period. The exercise intensity was set based on the peak oxygen uptake ($VO_2$peak) measured during a graded exercise test (GXT) before training. Measurements were taken during exercise sessions in the 2nd and 9th weeks to assess hemodynamic status and tissue oxygenation. Additionally, the Borg scale was used to record post-exercise leg fatigue and dyspnea levels.

RESULTS: In the CON group, $O_2$Hb and tHb in the vastus lateralis increased significantly from the first to the last session (p=0.035). No significant differences in muscle oxygenation were found between EXP and CON. However, in the first session, EXP had a greater increase in cardiac output (p=0.036) and stroke volume (p=0.018). EXP also reported higher dyspnea than CON (p=0.013), but leg fatigue was similar between groups.

CONCLUSION: After nine weeks, $O_2$Hb and tHb in the eccentric exercise group increased significantly. Tissue oxygenation remained stable in both groups, unaffected by helmet-assisted ventilation.

**SEX-ASSOCIATED DIFFERENCES IN PHYSICAL ABILITY IN PATIENTS WITH SICKLE CELL DISEASE**

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INTRODUCTION: Sickle cell disease (SCD) is a genetic disorder leading to the production of abnormal haemoglobin (HbS). Deoxygenated HbS may polymerize, causing sickling of the red blood cell (RBC) and haemolysis. Patients are subjected to severe anaemia, endothelial dysfunction and often hypoxaemia. Because oxygen transport is seriously compromised, patients' physical ability is strongly reduced compared to healthy subjects. To date, no study investigated sex specificities in physical ability impairment in SCD. This question is of interest because females, with higher anaemia (lower HbS content), nitric oxide bioavailability, vasoreactivity and foetal haemoglobin (Gladwin et al., 2003), may display lower repercussions of SCD on their physical ability than males. Therefore, the aim of this study was to evaluate the sex-associated differences in physical ability in SCD patients.

METHODS: Thirty-three SCD patients (18 males and 15 females) were studied. They were subjected to i) a blood sampling to measure haemoglobin level, HbS and HbF percentages (HbS% and HbF%) and viscosity, ii) a submaximal exercise test to measure physical ability markers such as oxygen uptake at the lactate thresholds 1 and 2 expressed in percentage of theoretical values (LT1%TheorValue and LT2%TheorValue, respectively) (Myers et al., 2017), and iii) a muscle biopsy (vastus lateralis) to analyse the microvascular network, muscle fibre size and energetic enzyme activities.

RESULTS: LT1%TheorValue was higher in females than in males (p=0.020) (a tendency was noticed for LT2 TheorValue, p=0.098). Females also had lower muscle fibre perimeter (p=0.025). No significant sex-associated differences were noticed on the microvascular network, enzyme activities and blood characteristics excepted for haemoglobin level (p=0.012). In females (but not in males), LT2%TheorValue correlated with haemoglobin level (p<0.001, r=0.770), HbS% (p=0.004, r=-0.720) and viscosity (p=0.033, r=0.552) on the one hand, and with capillary cross-sectional area (p=0.003, r=0.729), perimeter (p=0.001, r=0.766), diameter (p=0.007, r=0.683) and length of contact capillary-fibre over fibre perimeter ratio (p=0.001, r=0.779). In males (but not in females), LT2%TheorValue was associated with capillary density (p=0.005, r=0.628) and number of capillaries in contact with one fibre (p=0.018, r=0.558).

CONCLUSION: Physical ability (in percentage of predicted value) has been found to be lower in males than females. In females, physical ability seems to be influenced by blood parameters (haemoglobin level, HbS% and viscosity) and mor-

phologic characteristics of capillaries (diameter, perimeter, area), whereas in males, physical ability was associated with microvasculature density. Even if the implicated physiological mechanisms remain to be explored, SCD repercussions on physical ability 1) differs between males and females with SCD, and ii) does not seem to be limited by/associated to the same parameters.

**AN EVALUATION OF THE FOOD, EXERCISE, STRESS AND SLEEP (FESS) ONLINE TOOL FOR SUPPORTING POSITIVE BEHAVIOUR CHANGE IN CLINICAL EXERCISE PHYSIOLOGY SERVICE DELIVERY**

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INTRODUCTION: Lifestyle factors including diet, exercise, sleep and psychosocial stress are important for prevention and management of chronic disease. Health professionals such as Clinical Exercise Physiologists (CEP) can support people in making positive changes, however this can be time consuming and challenging. Online tools such as the Food, Exercise, Sleep and Stress (FESS) may be able to help educate people about key health behaviours and support positive change but there is limited research evaluating this approach. This study aimed to assess changes in key health behaviours in people accessing CEP services following 12 weeks of regular use of the FESS tool.

METHODS: This study used a pre - post single group design to assess changes in key health behaviours in response to accessing the FESS online tool that scores and supports change. People receiving Clinical Exercise Physiology services for treatment of existing chronic illness or injury were invited to access the survey comprised of 23 questions about their dietary intake, exercise participation, sleep hygiene and quality, and psycho-social stress on 3 - 7 days per week for 12 weeks. The survey platform provided real time scoring of their overall health behaviour and within each category and links to advice and supports to modify areas where the score was low. Scores were coded and change in median score analysed using a Wilcoxon signed-rank test.

RESULTS: Thirty-five participants (18 Female:17 Male; Age 60 +/- 14SD) completed the 12 week intervention. Overall the participant group scored well at baseline in most questions. Of the question that were not scored well at baseline, there were significant ($p<0.05$) improvements in: number of serves of vegetables, likelihood of undertaking resistance training, hours of sleep, severity of stress experienced.

CONCLUSION: Twelve weeks of participation in a structured online health behaviour support tool was associated with improvements in a range of key health behaviours. These are encouraging data but need to be validated in a larger sample with a comparator control group to confirm causality. Online tools are a potentially cost effective means to support people make positive behaviour change leading to better disease prevention and management.

## Conventional Print Poster Presentations

### CP-MH35 Health and Fitness IV - Mixed

**PROLONGED CHANGES IN FUNCTIONAL AND METABOLIC MEASURES AFTER ECCENTRIC EXERCISE INDUCED DAMAGE OF THE TRUNK EXTENSOR**

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INTRODUCTION: Regular exercise reduces the risk of chronic diseases such as coronary artery disease and type 2 diabetes [1]. Resistance training, including both concentric (muscle shortening) and eccentric (muscle lengthening) actions, enhances muscle function and metabolic health [2]. However, the prolonged effects of eccentric exercise on functional and metabolic measures remain unclear. This study investigates the long-term impacts of eccentric training on muscle function and metabolic markers, hypothesizing that eccentric exercise induces beneficial adaptations.

METHODS: Eighteen healthy males, without eccentric training for six months prior, were randomly assigned to either an eccentric (ECC, n=9) or concentric (CON, n=9) training group. Each group performed a single bout of maximal voluntary contractions of the trunk extensor muscles per week for eight weeks. Measurements of muscle function, soreness, blood lipid profiles, and glycemic markers were pre-exercise, immediately post-exercise, and 48 hours post-exercise in weeks 1 and 8. Repeated measures ANOVA were used for analysis.

RESULTS: ECC participants showed increased muscle soreness and plasma creatine kinase (CK) levels in week 1, which significantly decreased by week 8, indicating adaptation. Both training types improved muscle function; however, ECC training led to significantly greater increases in resting isometric torque ($p<0.05$). ECC training also reduced total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), and triglycerides (TG), while increasing high-density lipoprotein cholesterol (HDL-C) by week 8 ($p<0.05$), whereas CON training improved only TG ($p<0.05$). In terms of glycemic response, acute ECC exercise initially increased glucose, insulin, and homeostasis model assessment (HOMA) values in week 1. However, chronic ECC training significantly reduced fasting insulin, glucose, and HOMA values by week 8 ($p<0.05$), along with decreased glycosylated hemoglobin (HbA1c), indicating improved insulin sensitivity. CON training did not significantly alter these metabolic markers.

CONCLUSION: Eccentric exercise has been demonstrated to enhance muscle function, lipid metabolism, and glycemic control. Despite the initial muscle damage that occurs, prolonged ECC induces adaptations that reduce soreness and improve muscle performance. These observations align with the findings of previous research, which demonstrated that eccentric training improves metabolic health via neuromuscular and molecular adaptations [3]. Future studies should explore ECC exercise in clinical populations to optimize training strategies for disease prevention and rehabilitation.

**EFFECT OF AMILORIDE ON SALT TASTE SENSITIVITY DURING EXERCISE-INDUCED DEHYDRATION**

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INTRODUCTION: This study examined the link between exercise-induced dehydration and salt taste sensitivity in humans, focusing on the role of epithelial sodium channels (ENaC). Previous studies suggested that increases in blood pressure and angiotensin II with exercise enhance the sodium (Na) uptake via ENaC, changing salt taste sensitivity in rodents. However, rodents differ from humans in salt taste mechanisms, requiring human studies for a definitive conclusion.

METHODS: Ten male subjects participated in a two-condition, single-blind, crossover study involving amiloride (AM), an ENaC inhibitor, and water. The measurements included salt detection and recognition threshold (DT, RT), urine specific gravity (UG), blood pressure (BP), heart rate, rating of perceived exertion (RPE), thirst, hunger, and taste of oral rehydration solution (ORS). DT, RT, UG, and BP were assessed before and after 40-minute running at 70% maximal oxygen uptake. Thirst and hunger were assessed 2 h before, immediately before, and after the exercise. ORS palatability was assessed 2 h before and after the exercise. Subjects were rinsed with 10 μM amiloride hydrochloride solution between salt solution rinses for the DT and RT tests during the AM condition. The DT and RT were assessed using the whole-mouth method. The six salt solutions for the DT and RT tests ranged from 0.1-3.2 g/L. These solutions had arithmetic concentration gradients. After the exercise, the subjects drank 500 ml of ORS ad libitum.

RESULTS: Subjects lost 2.4 ± 0.5% of their body weight after the exercise. A decrease in DT was noted after the exercise ($p = 0.06$), but RT remained unchanged. Thirst significantly increased immediately before the exercise. Hunger increased before exercise but decreased after the exercise. ORS palatability significantly increased after the exercise.

CONCLUSION: No significant differences were found between the two conditions for any measured parameter, indicating that amiloride had no effect on ENaC. However, increased thirst and enhanced ORS palatability after exercise were likely related to increased thirst due to dehydration. A limitation of this study is that the assessment times were different to prevent taste interference between the salt taste threshold and the ORS. Future studies should design experiments that can evaluate these parameters simultaneously. This study suggests that 10 μM amiloride does not affect salt taste sensitivity after exercise, but increased thirst after exercise enhances ORS palatability.

**EATING DISORDERS AND EXERCISE THERAPY: A SCOPING REVIEW ON OUTCOME MEASURES IN EATING DISORDER AND EXERCISE RESEARCH.**

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INTRODUCTION: Exercise is increasingly recognised as a complementary therapy in Eating Disorder (ED) treatment, with high prevalence of dysfunctional exercise behaviours and emerging evidence of the psychological and physical benefits of exercise therapy in ED. Despite increasing access to exercise therapy in ED, there is currently limited guidance on implementing assessment within exercise therapy and ED. The aims of this scoping review are to 1) report on outcome assessments used in exercise research in ED, and 2) outline the general outcomes of exercise interventions in ED.

METHODS: This study employed a scoping review methodology with a literature search consisting of ED and exercise terms conducted on Embase, MEDLINE, and PsycINFO. Articles included at full text review were data extracted for study and intervention characteristics, aims, assessments implemented, and outcome change.

RESULTS: Twenty-six studies were included at full text review with diagnostic populations including Anorexia Nervosa (AN; n=7), Binge Eating Disorder (BED; n=5), Bulimia Nervosa (BN; n=1), and mixed diagnosis (e.g., AN plus BN; n=13). When examining broad health domains, body composition (n=26) and eating disorder psychopathology (n=21) were assessed at the greatest frequency in included studies, followed by subjective physical activity (n=13), exercise assessment (n=12)—including strength (n=7) and cardiorespiratory fitness (n=7), co-occurring psychopathology (n=11), exercise beliefs (n=10), and objective physical activity (n=9). For individual assessment tools, body mass index was the most frequently used body composition tool (n=26), followed by the Eating Disorder Examination (n=13) for ED Psychopathology. One repetition maximum (n=5) and the Balke protocol (n=4) were the most frequently implemented exercise tests, with actigraphy (n=8), the Compulsive Exercise Test (n=7), and the Beck Depression Inventory (n=6) the most frequently used tools for the assessment of objective physical activity, exercise beliefs, and co-occurring psychopathology. There were no reported adverse events in assessment in the included trials.

CONCLUSION: The results of this review outline that maximal and submaximal exercise assessment within ED contexts have been conducted safely and should be considered where appropriate within clinical practice. Comprehensive exercise assessment as part of therapeutic exercise interventions may provide additional health information beyond measures used in current practice to provide a greater holistic assessment of ED patient health and function. The results of this review, in addition to prior research indicate that exercise therapy in ED contexts can be effective in improving patient health and importantly, appears to be safe with no deleterious effects on weight status – a commonly held belief. The

results of this review may provide guidance on the appropriate assessment for exercise professionals to conduct within ED services.

**PSYCHOLOGICAL RESPONSES TO THREE DISTINCT LOW-VOLUME INTERVAL TRAINING PROTOCOLS**

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INTRODUCTION: Physical inactivity (PA) is a major public health issue, representing 7.2% of all-cause mortality (1). Time constraints and limited access to equipment are common barriers to exercise (2). Low-volume interval training, particularly sprint interval training (SIT) and high-intensity functional training (HIFT) are time-efficient alternatives (3,4). Various psychological factors are associated with long-term adherence to PA , and despite higher ratings of perceived exertion (RPE), interval training may induce better affective valence, self-efficacy, intention, and enjoyment than continuous training (5). However, its psychological responses are underexplored across HIFT regarding SIT. This study aims to compare psychological responses to three high intensity protocols.

METHODS: Fourteen adults (age: 25.6 ± 5.6 yr; body mass index: 24.5 ± 3.9 kg·m$^{-2}$; VO2max: 47.1 ± 7.9; males: 9 and female: 5) participated in the study. First day, they were familiarized with all protocols and validated psychological questionnaires (ie., RPE, Feeling Scale [FS], Self-Efficacy, Intention and Physical Activity Enjoyment Scale [PACES]). From the second to the fourth day, they performed the protocols (10 bouts × 5 s all out effort: 35 s passive rest) of SIT, burpee interval training (BIT) (6), and SIT+BIT in randomized order, with a 72–96 h of recovery. RMANOVA was used to compare responses across protocols. If interaction effect was significant ($p \leq .05$), Bonferroni post hoc tests were applied and effect size (ES) reported as Cohens d.

RESULTS: Significant protocol × time interaction presented in RPE ($p=.001$; $\eta^2p=.399$); RPE was significantly higher in SIT compared to BIT only ($p<.01$; ES=.923), whereas BIT and SIT-BIT showed no difference ($p=.976$). Affective valence also showed a significant protocol × time interaction ($p=.01$; $\eta^2p=.274$); FS scored lowest in SIT ($p<.04$; ES>.516), while BIT and SIT-BIT remained similar ($p=.181$). Self-efficacy, intention and PACES showed no significant protocol × time interaction ($p=.336$; .693; and .074, respectively). Finally, a strong preference emerged for SIT-BIT (n=10, 71.4%).

CONCLUSION: The main results show that SIT being perceived as more strenuous and less tolerable than BIT or SIT-BIT. While, SIT-BIT emerged as the clearly preferred choice, further supporting multimodal training as a promising alternative for long-term adherence.

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**INDIVIDUALIZED EXERCISE PRESCRIPTION: HOW CAN THE SUBMAXIMAL TEST HELP US?**

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INTRODUCTION: Exercise intensity is the most critical component of the exercise prescription process. Different methods to determine exercise intensity, deriving from maximal or submaximal protocols have been critically compared1. No studies have related an approach based on ventilatory thresholds (VT) with the corresponding intensity relative to reserve anchors. Therefore, the aim of this study was to understand how the exercise intensity at VT derived from a test to exhaustion (CPET) be equated to a workload derived from a submaximal test (SUB).

METHODS: Subjects included twenty-four healthy adults (14 M, 10 F; age: 23.2±2.8 yrs; BMI: 22.1±3.0 kg·m-2; RMR: 3.4±0.5 mL·kg-1·min-1). Oxygen uptake (VO2), heart rate (HR) and rate of perceived exertion (RPE, CR-10) were measured at rest and during SUB and CPET, both performed using a cycle ergometer and a metabolic cart. VO2max was obtained: 1) at the end of the CPET ramp protocol (VO2maxCPET), and the VO2 at first and second VT (VO2@VT1 and VO2@VT2) was calculated, 2) by submaximal test (VO2maxSUB), based on YMCA protocol, and extrapolated to predicted maximum HR (HRP, 208–0.7·age). VO2 reserve (VO2R) was calculated considering resting VO2, and %VO2R corresponding to VO2@VT1 and VO2@VT2 was extrapolated.

RESULTS: No significant differences were found between estimated or measured variables (VO2maxSUB 43.7±9.3, VO2maxCPET 44.7±8.7 mL·kg-1·min-1), p=.444; HRP 191.8±2.0, HRmaxCPET 187.8±10.2 bpm, p=.065), except, as expected, for the RPE recorded at the end of each test (RPESUB 4.9±2.1, RPECPET 9.2±1.6, p<.001). The VO2@VT1 (26.4±4.9 mL·kg-1·min-1) and VO2@VT2 (36.1±7.8 mL·kg-1·min-1) corresponded to 54.4±13.9% and 82.4±13.7% of VO2R, respectively.

CONCLUSION: To our knowledge, this is the first study which attempt to compare VT intensity from CPET to the corresponding percentage of VO2R based on submaximal test. Exercise intensity at VT1 and VT2 can be considered as moderate and

vigorous, respectively, compared to the physical activity guidelines2. This approach is important to enhance trainers and physicians' ability to understand and customize an effective exercise prescription in a non-clinical setting.

1 Jamnick. Sports Med. 2020 Oct;50(10):1729-1756.

2 ACSMs Guidelines for Exercise Testing and Prescription,11thed. LWW, 2021.

**IMPACT OF DANCE CLASSES ON PHYSICAL FITNESS, BMI AND GUT MICROBIOTA IN PATIENTS WITH MULTIPLE SCLEROSIS**

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INTRODUCTION: Sclerosis multiplex, or multiple sclerosis (MS) is a chronic disease of the central nervous system. Studies report that MS causes impairment in physical fitness, motor and cognitive function and shifts in gut microbiome. Therefore, the aim of this study was to investigate the effect of dance classes on the cardiovascular system and fitness of MS patients.

METHODS: In this randomized controlled trial, 42 patients were randomly divided into two groups: the experimental group (n = 21) and the passive control group (n = 21). Sports dance classes included the ballroom dances (waltz, tango, Viennese waltz, quickstep) and Latin American dances (samba, chacha, rumba, jive) were performed for 12 weeks at a frequency of three times a week. Body composition was measured by bioelectrical impedance machine and cardiovascular fitness was evaluated by bicycle spiroergometry before and after the intervention. Fecal microbiota were categorized using primers targeting the V3–V4 region of 16S rDNA.

RESULTS: Our results revealed significant differences in body composition weight (kg), body fat percentage (%) and body mass index (BMI) (kg/m2) compared to the control group. In the cardiovascular fitness assessment, we observed a significant improvement in max. load (W), VO2/kg, ventilatory equivalent (VE), forced expiratory volume in 1 second (FEV1) and peak expiratory flow (PEF) compared to the control group. Furthermore, we observed, however, only a modest shift in gut microbiota composition.

CONCLUSION: Our randomized control trial investigating the effects of a 12-week dance class training program on MS patients revealed significant improvements in body composition and physical fitness. As a result, dance class training is likely to provide a variety of physical and psychosocial benefits, making it enjoyable for MS patients.

**THE GUT MICROBIOTA IN COLLEGE ATHLETES INDUCES SPONTANEOUS ACTIVITY OF ITS FECAL TRANSPLANTED MICE**

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INTRODUCTION: Gut microbiota in humans comprises 100 to 1000 trillion microorganisms. It has been reported that these bacteria are implicated in a variety of diseases (inflammatory bowel diseases, obesity, diabetes, fatty hepatitis, systemic chronic inflammatory diseases, cardiac diseases and neurodevelopmental disorders) and behavioral disorders. On the other hand, it has been suggested that gut microbiota could be crucial for exercise performance in athletes. Also, exercise might produce changes in the gut microbiota, which may have health implications for athletes. Although changes in the gut microbiota and physical performance by FMT from exercise trained mice have been reported, their relevance to the gut microbiota from human athletes remains unclear.

To evaluate the functional role of gut microbiota in athletes, mice were colonized them with the fecal microbiota of the athletes or healthy control subjects, and monitored spontaneous and forced exercise performances.

METHODS: The athlete group (n=17, males, aged 19-22 years) and the control group (n=15 males, aged 19-24 years) were recruited. All subjects were asked to answer questions (height, weight, age, smoking habits, drinking habits, medical history, antibiotics taken in the past 6 months, International Standard Physical Activity Questionnaire (IPAQ), simple measurement of maximal oxygen uptake, etc.)). Fecal samples were collected using a simple fecal collection kit, and then, to analyze the fecal microbiome of subjects, we use 16SrRNA gene next generation sequencing (NGS). Gut microbiota were identified using Qiime2 software (ver. 2023 2). Remains the collected fecal samples were used the next study. C57BL/6J male mice (4 weeks old, n=25) were treated with antibiotics for 7 days and then the mice were randomly divided into two groups: athletes fecal transplant group (ATP, n=13) and control fecal transplant group (CTRL, n=12). The fecal samples of the human subjects were transplanted once a week (for three times in total). Spontaneous wheel running (WR) and forced exercise on treadmill were assessed. After these exercise tests, the cerebrum and hippocampus in each of the mice were removed under anesthesia, and then analyzed for Bdnf expression using real-time RT-PCR.

RESULTS: Although physical activity level in Athletes was significantly higher than that in Control group, no significant difference between in Athletes and control groups was observed in both the characteristics of subjects. Alpha diversity and beta diversity were no different between the athletes and control subjects. However the αdiversities of fecal transplanted mice from ATP were showed lower than that of CTRL mice. Furthermore, the WR in the ATP group at 7 days was shown to be significantly higher than that in the CTRL group ($p<0.05$), but not forced exercise

CONCLUSION: Hence, changes in the gut microbiota in athletes may have an induction of spontaneous activity of fecal transplanted mice.

**A SYSTEMATIC REVIEW OF EXERCISE, AEROBIC FITNESS AND THE NEUROACTIVE POTENTIAL OF THE GUT MICROBIOME: MINING MICROBES FOR GUT-BRAIN AXIS HEALTH**

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INTRODUCTION: The brain health benefits of exercise are increasingly appreciated as are the implications of the gut microbiome for the regulation of brain function and behaviour. While research has investigated relationships between exercise and the gut microbiome, results are variable and the interface between aerobic fitness, the gut microbiome (and its neuroactive potential) and brain health remain poorly understood. By systematically re-analysing prior exercise and gut microbiome research via in silico pipelines, we aimed to explore the relationship between the functions of the gut microbiome and aerobic fitness. Elucidating the details of the relationship between exercise and the gut microbiome can help uncover mechanisms of action and pave the way for increased uptake of exercise to support gut and brain health.

METHODS: This review (PROSPERO CRD42024480951) included human studies with gut bacterial data, VO2max, or studies implementing an aerobic exercise intervention with pre-post data. 16 studies were included with 1,230 individual samples (473 females and 433 males; 27.8±10 y, 24.1±3.9 kg/m2, VO2max 40.4±11.5 ml/kg/min). Study data was downloaded and assessed via bioinformatics pipelines, with statistical analysis conducted in R covering bacterial diversity, abundance and functionality assessed via the gut-metabolic and gut-brain modules (predicted via PICRUSt2 on 16S samples).

RESULTS: While alpha-diversity was not related to VO2max (all $p>0.05$), significant associations were observed between five gut brain modules and VO2max (all $q<0.05$), including a positive association of 'Propionate Synthesis III', a short chain fatty acid of importance for gut-brain axis signalling [1]. 10 bacterial genera were also associated with VO2max (all $q<0.05$).

CONCLUSION: This research indicates that VO2max and functional gut bacterial measures, or relative abundance of specific genera, are related. Positive associations between VO2max and propionate synthesis is consistent with prior research showing exercise induced lactate is converted by Veillonella bacteria to propionate, a feature associated with endurance performance in mice [2]. These data show that aerobic fitness may be associated with the metabolic and neuroactive potential of the gut microbiome. Further analyses of studies reporting the impact of aerobic interventions on gut bacterial composition and function over time are underway. Together, this information may be used to better inform the prescription of physical activity interventions towards enhancing performance and brain health.

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## Conventional Print Poster Presentations

### CP-PN18 Cardiovascular Physiology

**MICROVASCULAR (DY)SFUNCTION CORRELATES TO HIGHER CARDIOVASCULAR DISEASE RISK**

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INTRODUCTION: Cardiovascular disease (CVD) is one of the major causes of death in the industrialized countries[1]. CVD results from the interaction of multiple genetic, behavioral, metabolic, environmental and socio-economic risk factors, including age-related alterations in the elastic properties and integrity of arterial walls[2]. Nitric oxide (NO) plays a pivotal role in the cardiovascular system and reduced NO bioavailability has been linked to increased susceptibility to atherosclerotic lesion progression, hypertension, hypercholesterolemia, thrombosis and stroke, suggesting microvasculature can contribute to the whole CVD process[3]. The objective of this study was to examine the microvasculature integrity of older individuals with different CVD risk, whilst also investigating the modulating effects of cardiorespiratory fitness and physical activity.

METHODS: Twenty-two healthy old adults (age:74±5yrs; 9 females) were recruited. CVD risk was assessed based on the American Heart Association Life's Essential 8 algorithm[4]. Blood samples and blood pressure (BP) were collected in resting condition. Habitual physical activity was monitored by accelerometry for 7 days. An incremental cycling test up to exhaustion was performed to measure peak oxygen uptake (VO2peak). Microvasculature integrity was assessed by doppler-ultrasound on femoral artery during passive-leg movement (PLM) and by near-infrared spectroscopy (NIRS) on the vastus lateralis muscle during vascular occlusion test (VOT). Hyperemic response from PLM was quantified analyzing blood flow parameters as area under curve (AUC) and changes from baseline to maximal hyperemia (ΔPeak). The 10s change in tissue saturation index during the reperfusion rate from prolonged ischemia (Slope2) was used as index of microvasculature responsiveness.

RESULTS: Among all subjects 25% were smokers, 72% did not meet the recommendation to eat five fruits and vegetables per day, and 40.8% had a high level of sedentary behavior. Blood-related parameters and BP confirmed differences in CVD risk among the old individuals. VO2peak ranged from 15.4 to 45.3ml/min/kg. Average AUC and ΔPeak values were 175±95ml and 436±115ml/min, respectively. Slope2 ranged from 0.98 to 2.75%/s. PLM and VOT parameters were directly correlated with CVD risk (r=0.45 and r=0.42, respectively; all $p<0.05$) and VO2peak (r=0.59 and r=0.47 respectively; all $p<0.05$). Adjusted for VO2peak and sedentary time, CVD risk still correlated to indexes of microvasculature responsiveness.

CONCLUSION: In addition to clinical parameters classically used to estimate CVD risk, microvascular dysfunction assessed by passive-leg movement and NIRS correlates to higher CVD risk. Individual aerobic fitness correlated to indexes of microvasculature responsiveness, suggesting that during aging an active lifestyle can reduce CVD risk also through changes in small vessels.

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**EVALUATION OF SKELETAL MUSCLE VASCULAR FUNCTION AND HEALTH BY FAST TIME-DOMAIN NEAR INFRARED SPECTROSCOPY: A CASE STUDY**

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INTRODUCTION: Physical exercise increases shear stress in the vasculature leading to better vasodilator and constrictor responsiveness, reducing arterial stiffness and oxidative stress. Acute hemodynamic adaptations to exercise lead to changes in both endothelial and vascular smooth muscle cell functions. Regular exercise training improves nitric oxide (NO) availability. We propose a method for evaluating the muscular tissue's vessel stiffness, endothelial and vasomotor function, based on the oscillations of the hemodynamic parameters measured by fast Time Domain (TD) near infrared spectroscopy (NIRS).

METHODS: A fast TD NIRS [1] acquisition on a healthy subject was performed employing a device previously developed at the Department of Physics, at Politecnico di Milano [2]. The tibialis anterior muscle was chosen due to its thin adipose tissue thickness (ATT), which allows to analyze data using the solution of the photon diffusion equation for homogeneous media. A subject was set down with the ankle fixed onto a holder and connected to a load cell for measuring the traction force exerted. He performed a 400 s long dorsiflexion, which was preceded and followed by 400 s of baseline and recovery, respectively. The protocol was chosen based on numerical simulations previously performed. The acquisition lasted 1200 seconds with an acquisition rate of 20 Hz and a 4 cm interfiber distance. The time course of the exerted force from the dynamometer was obtained to control the exercise execution. Absolute values for the time courses of oxy- (O2Hb) and deoxy- (HHb) hemoglobin concentrations were obtained. A blood volume pulse (BVP) sensor located on the same muscle and a respiration band (RESP) were also employed to record physiological signals. After a 3rd order polynomial detrending, the power spectral density (PSD) was calculated for all the parameters. The mean power in six frequency bands related to peculiar physiological origin was derived [3]: Endothelial (VI), NO-related Endothelial (V), Neurogenic (IV), Myogenic (III), Respiratory (II) and Cardiac (I) activity.

RESULTS: During rest, most of the PSD power for the TD NIRS parameters is contained in the endothelial bands, in particular in band VI for HHb and band VI and V for O2Hb. The PSD of BVP is similar to the one of O2Hb and HHb, while a strong contribution to band II is found for RESP, as expected. During the contraction and the recovery, it is possible to notice clear differences in the power measured in bands VI, V and III for both hemoglobin, while in band II and I the changes are negligible.

CONCLUSION: In this pilot study we have verified the possibility to employ fast TD NIRS to underline skeletal muscle vascular functions during contraction and recovery, for what concern the endothelial and myogenic activity. We are acquiring more subjects (up to 20) to perform statistical analysis.

Reference: [1] Torricelli et al., Neuroimage 85, 2014. [2] Re et al., Sensors 23, 2023. [3] Kvernmo et al., Microvascular Research 56, 1998.

**THE EFFECTS OF 4-WEEKS OF ISCHAEMIC PRECONDITIONING AT THE ANKLE ON THE OXYGENATION OF THE FOOT IN PEOPLE WITH DIABETES**

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INTRODUCTION: 4.4 million people are living with diabetes in the UK, which can be associated with serious health complications including 184 lower-limb amputations per week. This typically stems from the development of diabetic foot, resulting in a loss of a vascularisation from damage to nerves and blood vessels. Diabetic foot is associated with a 25% chance of developing a diabetic foot ulcer within their lifetime for people with diabetes, with a 40% risk of reoccurrence within 1-year and long-term impacts on healthcare services. Therefore, this study aimed to apply a 4-week ischaemic precondi-

tioning (IPC) intervention to assess the health of the foot in people with diabetes. IPC involves the application of repeated cycles of alternating occlusion and reperfusion, typically prior to exercise, which may improve the microcirculation and endothelial function.

METHODS: With institutional ethical approval, 14 participants volunteered (8 males, 6 females; 9 type 1 diabetes, 5 type 2 diabetes; age: 39.9 ± 24.1 years; height: 171.4 ± 6.5 cm; body mass: 80.6 ± 15.1 kg). Participants visited for a pre- and post-testing session involving an incremental step test performing 30 repetitions of isotonic plantar flexion and dorsiflexion at an increasing resistance on the isokinetic dynamometer. Participants were randomly assigned to one of two groups: IPC or SHAM. The training sessions involved 2 sessions per week for 4-weeks with three occlusion cycles of 5-minutes at an individualised arterial occlusion pressure (Mean ± SD: 190 ± 30 mmHg) for the IPC groups and 20 mmHg for the SHAM group. The health of the foot was assessed during every session using near-infrared spectroscopy to assess the oxygen saturation (SO2), oxygenated (O2Hb) and deoxygenated haemoglobin (HHb) in the abductor hallucis muscle.

RESULTS: There was a significant effect of time on SO2max ($F(1,12) = 13.261$, $p = 0.003$), with post-hoc analysis showing a significant increase in SO2max from 67.84 ± 6.19% to 72.86 ± 6.74% in the IPC group at post-testing ($F(1,6) = 11.539$, $p = 0.015$). There were no significant differences in peak oxygen uptake ($p = 0.085$), O2Hbmax ($p = 0.513$), HHbmax ($p = 0.348$) or maximum torque ($p = 0.077$). The average O2Hb showed a significant interaction effect between time and group at each workload increment ($p < .05$).

CONCLUSION: The aim of this intervention was to assess whether 4-weeks of IPC resulted in any improvement in NIRS-derived variables as an indicator of the health of the foot in people with diabetes. The results showed a significant increase in SO2max evidencing an improvement in the oxygenation of the foot, which could have important health benefits in potentially limiting complications. This study is one of the first known to apply a repeated IPC intervention with an ankle occlusion, which offers an isolated foot intervention which could be an alternative for people living with diabetic foot who are unable to exercise or weight-bear.

**EXPLORING THE COMBINED IMPACT OF TRPV4 ACTIVATION AND ENDURANCE TRAINING: A DUAL APPROACH TO BOOST MITOCHONDRIAL EFFICIENCY AND AEROBIC PERFORMANCE**

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INTRODUCTION: Angiogenesis, the formation of new capillaries, is a tightly regulated process involving numerous factors that promote the expansion of the microcirculation. Exercise drives angiogenesis through mechanical stimuli and shear stress, thus improving cardiovascular hemodynamics and metabolic activity. The increase in oxygen supply and delivery allows mitochondria to sustain a high level of aerobic respiration without relying on anaerobic pathways. Thus, supplementary stimulation of angiogenesis remains a crucial target for enhancing endurance performance and, more importantly, for preventing chronic diseases. Calcium ions (Ca2+) are essential as signal transducers in several cellular processes, including cell proliferation and migration. Transient Receptor Potential cation channel subfamily Vanilloid member 4 (TRPV4) is moderately permeable to Ca2+ and is highly expressed in endothelial cells, which form the inner lining of blood vessels. Activation of TRPV4 via channel-specific agonists (GSK1016790) has not been extensively studied. This study aimed to find a synergistic effect of endurance exercise and TRPV4 activation on angiogenesis to increase capillary density, thereby providing implications for enhancing functional aerobic capacity and mitochondrial efficiency.

METHODS: Two to three-month-old C57Bl/6 mice were randomized into a control, an agonist treatment (GSK), an exercise-only (EXCI) and a combined agonist treatment with exercise (GSK+) group. Exercise intervention groups underwent 6 weeks of moderate-intensity continuous training (MICT) 4 days a week on a treadmill after 2 weeks of acclimation. Intensity started at 60% of maximum aerobic capacity (MAC) for 40 minutes, with weekly increases of 5% in intensity and 5 minutes in duration. Baseline MAC was calculated using a functional aerobic capacity ramp test and was repeated bi-weekly to test aerobic capacity and adjust training intensity. Following the 8-week intervention, high-resolution respirometry was done using an Oroboros Oxygraph-2k with the vastus lateralis to assess cellular oxygen consumption using a substrate uncoupler-inhibitor titration (SUIT) protocol.

RESULTS: Compared to the baseline, the GSK+ group had an increase in mean maximal treadmill speed corresponding to a rise in MAC at weeks 4 and 6 (2.5 ± 0.14 km/h) relative to the control group (1.73 ± 0.23 km/h, 1.80 km/h). Additionally, an increase in mean maximal mitochondrial oxygen consumption in the GSK+ group at (27.10 ± 6.76 pmol/(s*mg)) relative to control (24.09 ± 6.66 pmol/(s*mg)), following the addition of ADP was observed.

CONCLUSION: This study provides compelling evidence that MICT coupled with TRPV4 activation can be a target for vascular remodelling via angiogenesis, offering valuable insights to advance cardiovascular function, oxygen consumption and exercise physiology. Current research aims to solidify the findings by analyzing capillary density via capillary staining and detecting specific angiogenic growth factors via immunoblotting.

**MECHANISMS REGULATING CEREBRAL PERFUSION DURING EXERCISE: INFLUENCE OF FOOT-STRIKE INDUCED PULSATILITY OSCILLATIONS AND CO2 REACTIVITY.**

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INTRODUCTION: During running exercise, cerebral blood flow (CBF) does not exhibit the typical biphasic response observed with cycling. The mechanism(s) driving this divergent response to cycling are unknown.

METHODS: We assessed middle cerebral artery blood velocity (MCAv), end-tidal carbon dioxide (ETCO2), and MCAv pulsatility variability at rest, during an incremental running test, and fixed workloads running under three conditions: 1) free running, 2) diastolic stepping, where the foot-strike was synced to the diastolic phase of the cardiac cycle, 3) Cerebral responses to hypercapnia and hypocapnia (i.e. CVRCO2) at rest and during free running at a pace just prior to the decrease ETCO2 observed during VO2max testing. In a 2nd study, hypocapnic CVRCO2 testing was performed at rest and during steady-state running exercise, and thereafter during steady-state cycling at an intensity whereby heart rate and mean arterial blood pressure (MAP) were matched. Finally, we had the opportunity to measure MCAv in a high level junior cyclist (VO2max, 5.92 L/min) during a maximal exercise test.

RESULTS: STUDY 1. Young, healthy males (n=26) and females (n=17) exhibited progressive increases in MCAvmean during incremental running (BL, Females: 49.9±11.3, Males: 45.9±10.8; VO2max, Females: 65.7±11.7, Males: 67.1 ± 13.0cm/sec; ANOVA P<0.0001) despite reductions in ETCO2 at higher exercise intensities (BL, Females: 36.41±5.1, Males: 38.6±4.5; VO2max, Females: 28.2±5.1, Males: 32.5±9.0 mmHg; ANOVA P<0.0001). Diastolic stepping reduced beat-by-beat variability in MCAv pulsatility (0.14±0.04 a.u.) compared to free running (0.29±0.09 a.u, P<0.0001); however, MCAvmean was not different (Free running: 56.1±8.1; Diastolic stepping 58.0±8.7 cm/sec; P=0.211). CVRCO2 to hypercapnia increased from rest to exercise (1.26±0.29 vs 1.58±0.54 cm·sec-1/mmHg; P=0.049), whereas CVRCO2 to hypocapnia was reduced (Rest: 0.65±0.31 vs Exercise: 0.11±0.38 cm·sec-1/mmHg; P=0.002). STUDY 2. At rest hyperventilation caused a reduction in ETCO2 (33.9±3.4 vs 22.2±5.8, mmHg, P=0.02) and MCAvmean (56.3±10.4 vs 40.8±5.6, cm·sec-1, P=0.02). During running (Δ14.7±2.9, mmHg, P=0.03) and cycling (Δ13.0±2.2, mmHg, P=0.02), the reduction in ETCO2 was similar to rest, but the reduction in MCAvmean was blunted. Importantly, when exercising heart rate (running, 148±20 vs cycling, 150±17, bpm, P=0.26) and MAP (running, 106±17 vs cycling, 107±14, mmHg, P=0.74) were matched, the reduction in MCAvmean during hyperventilation was similar between running and cycling (Δ-9.6±5.5 vs -9.5±6.3, cm·sec-1, P=0.02). CASE STUDY. MCAvmean increased during cycling (rest, 44.1; 40%, 59.9; 60%, 62.2; 80%, 63.6; VO2max 62.2, cm·sec-1) and did not show the bi-phasic pattern.

CONCLUSION: Foot-strike-induced oscillations in cerebral pulsatility do not influence MCAvmean responses. Cerebrovascular responsiveness to hypocapnia is blunted with exercise, but seems independent of exercise modality and likely dependant on the prevail MAP and magnitude of autoregulation.

**TIME-SERIES ANALYSIS OF CEREBRAL CIRCULATION AND CARDIORESPIRATORY RESPONSES TO ACUTE CENTRAL BLOOD VOLUME REDUCTION**

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INTRODUCTION: Central blood volume (CBV) reduction challenges circulatory and respiratory homeostasis, particularly during the initial compensatory phase (0-2 min) where rapid physiological adaptations occur.

METHODS: This study examined dynamic cardiorespiratory response to CBV reduction using lower body negative pressure (LBNP) in eleven healthy males. Participants completed three standardized 2-minute LBNP trials at -45 mmHg, with respiratory variables assessed via flow measurement and breath-by-breath gas analysis, while cardiovascular and cerebral blood flow were monitored using ECG, blood pressure, and transcranial Doppler ultrasonography.

RESULTS: During LBNP exposure, an indicator of CBV reduction thoracic admittance decreased by 13.4% ($p < 0.001$), indicating significant CBV reduction. Time-series analysis revealed that mean blood pressure (Mean BP) temporarily decreased during the initial phase (0-30 s), while heart rate progressively increased (16.4%, $p < 0.001$). end-tidal PCO2 showed a consistent reduction (5.9%, $p < 0.001$), and minute ventilation decreased by 9.3% ($p = 0.041$). Middle cerebral artery mean blood velocity (MCA Vmean) showed a slight decrease (-5.0%, $p = 0.372$). Analysis revealed a significant negative correlation between Mean BP and tidal volume (VT) ($r = -0.78$, $p = 0.004$) and heart rate and MCA Vmean ($r = -0.68$, $p = 0.022$) both in the first 30 s and VT and MCA Vmean ($r = -0.62$, $p = 0.042$) in the next 30 s.

CONCLUSION: These phase-specific correlations, together with individual variability, suggest rapid cardiorespiratory and cerebrovascular interactions during orthostatic stress, demonstrating dynamic cardiovascular and respiratory responses during CBV reduction, with distinct response patterns providing insights into physiological mechanisms maintaining homeostasis during gravitational stress.

**TOBACCO SMOKING AS A BLOOD VOLUME EXPANDER**

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INTRODUCTION: Tobacco smoking is the worlds leading cause of avoidable premature mortality. Among the inhaled substances lies carbon monoxide (CO), a gas that binds to hemoglobin to form carboxyhemoglobin (COHb) and thus acutely reduce arterial oxygen content. Repeated exposure to CO has been shown to increase hemoglobin mass (HbM) in non-athletes (1). Whether regular tobacco smoking could accordingly act as an alternative erythropoietin-stimulating agent in trained individuals was examined in the present study.

METHODS: Thirty young males were split in four independent groups based on smoking status (CS- chronic smokers and NS- non-smokers) and aerobic fitness level (MT- moderately trained and UT- untrained) (CS-MT, CS-UT, NS-MT and NS-UT; n=8 for all but the first group). CS had been smoking >10 cigarettes/day for the last three years and scored a Fagerstrom test for nicotine dependence value > 4 (2). Peak oxygen consumption (VO2peak) and running speed were evaluated using

an incremental running exercise test to exhaustion. An age-adjusted VO2peak deemed as above "superior" or below "fair" was considered as a prerequisite for the participation in the MT and UT groups, respectively, according to the latest ACSM standards. The carbon monoxide-rebreathing method was performed using a fully automated instrument (OpCo; Detalo Instruments) to assess hemoglobin mass and intravascular blood volumes. %COHb was continuously monitored with participants connected to a pulse CO-oximetry sensor (Rad-57, Masimo). A two-way ANOVA was performed to detect differences in means.

RESULTS: Despite the fact that VO2peak was only affected by fitness level ($p < 0.001$), smokers attained lower maximal running speed and higher HbM values (main effects of smoking status: $p = 0.004$ and $p = 0.001$, respectively). Specific differences were located in CS-MT (978±147 g) demonstrating a higher HbM compared to NS-MT (800±78 g, $p = 0.05$). When intravascular volumes were normalized to body mass, CS were characterized by a higher red cell volume ($p = 0.013$) reflected in CS-MT (37.2±4.9 mL/kg) possessing marginally higher values compared to NS-MT (31.9±1.7 mL/kg, $p = 0.08$). Total blood volume tended to be higher again in CS ($p = 0.06$). Main effects of fitness level ($p < 0.05$) but no interaction effects ($p > 0.05$) were noted for all investigated parameters.

CONCLUSION: Tobacco smoking and exercise training seem to act additively to enhance hemoglobin mass, red cell volume and total blood volume. A homeostatic regulation of hematocrit is implied in smokers. Given the observed deficit in aerobic performance, the described adaptive erythropoietic response could be alternatively serving to protect human body from CO poisoning.

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**EVALUATION OF VASCULAR RESPONSIVENESS AFTER PROLONGED ISCHEMIA: COMPARATIVE ANALYSIS BETWEEN CONTINUOUS WAVE AND TIME-DOMAIN NIRS DEVICES**

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INTRODUCTION: Near-infrared spectroscopy (NIRS) is a non-invasive tool used to evaluate heme and other chromophores concentration changes occurring within biological tissue according to near-infrared light absorption and scattering [1, 2]. At skeletal muscle level, NIRS has been used to monitor changes of heme indexes during vascular ischemia and reperfusion, leading authors to draw conclusions about endothelial function with physiological and clinical significance [3]. However, changes in oxy-[heme] and deoxy-[heme] that occur during vascular ischemia and reperfusion affect tissue scattering characteristics, possibly worsening accuracy of NIRS indexes [4].

In this study, we compared parameters obtained by a time-domain (TD) NIRS device, which directly measures both absorption and scattering coefficients, with continuous wave (CW) NIRS, which assumes constant tissue scattering. The hypothesis to be tested is that absolute and functional indexes assessed during vascular ischemia and reperfusion could differ between NIRS technologies due to changes in tissue light scattering.

METHODS: Healthy active male participants (n=9; 23±4 years, 79±7 kg) with adipose tissue thickness values lower than 10mm were recruited. Tissue saturation index (TSI) of quadriceps muscle was monitored using CW (Train.Red Plus, Train.Red BV) and TD (NIRSBOX, PIONIRS srl) devices during the vascular occlusion test (VOT). Baseline (BAS), minimum (MIN), and maximum (MAX) absolute values were recorded. Desaturation rate (Slope_1) and reperfusion rate (Slope_2) were estimated. Differences between CW and TD estimates were evaluated by two-way RM ANOVA (time x device). Slopes were compared by paired student t-test. Statistical significance was declared when $p<0.05$.

RESULTS: TSI determined by CW was significantly lower at BAS (CW: 67.4±3.9%; TD: 75.3±2.8%), MIN (CW: 34.7±11.5%; TD: 57.9±5.4%) and MAX (CW: 74.8±1.5%; TD: 79.9±2.3%), compared to TD (all $p<0.05$). Slope_1 (CW: -0.25±0.17 %.s-1; TD: -0.13±0.07 %.s-1) and Slope_2 (CW: 1.97±0.60 %.s-1; TD: 1.10±0.40 %.s-1) resulted significantly different between devices (all $p<0.05$), with TD values about 45% lower than CW.

CONCLUSION: Our findings show significant differences between CW and TD NIRS measurements, suggesting caution when both absolute values and functional outcomes obtained by different devices are compared. The present data confirm previous results comparing frequency domain NIRS data with those obtained by assuming constant tissue scattering characteristics [4]. Thus, it is essential to establish a reference framework that is specific to the instrument and that can reliably distinguish between physiological and altered values. This is particularly important when these indexes are used to identify endothelial dysfunction in ageing, disuse and clinical populations.

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**EFFECTS OF A PREBIOTIC GALACTOOLIGOSACCHARIDE ON EXOGENOUS GLUCOSE OXIDATION DURING EXERCISE IN TEMPERATE AND HOT ENVIRONMENTS**

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INTRODUCTION: Heat stress has been shown to decrease exogenous glucose oxidation rates during exercise by approximately 10%. There is some evidence that manipulating the gut microbiome via probiotic supplementation may increase exogenous carbohydrate oxidation rates during exercise. We aimed to assess whether a prebiotic galactooligosaccharide supplement can increase exogenous glucose oxidation rates during moderate-intensity exercise in either temperate or hot environments.

METHODS: 22 trained cyclists (14 males, 8 females; age = 43 ± 13 years; VO2peak = 50 ± 8 mL/kg/min) completed a preliminary trial (lactate threshold, VO2peak and 1-hour familiarisation) and four experimental trials. Participants supplemented daily with 3.65 g of maltodextrin placebo (PLA) or Bimuno-galactooligosaccharide (B-GOS) mixture for 4 wk (separated by a 4 wk washout period) in a randomised, double-blind, crossover design. After each supplement period, participants completed two experimental trials, which involved 2h cycling at 95% LT1 in 21°C (TEMP) and 35°C (HOT) ambient temperatures. A glucose drink containing [U-13C]-glucose was consumed every 15 min providing 90 g/h and exogenous glucose oxidation rates were determined over a 30-120 min period. Gastrointestinal (GI) symptom scores were recorded every 30 min during exercise and were analysed individually, grouped into upper (nausea, regurgitation, fullness & cramps) and lower (gas & urge to defecate) GI categories, and as mean total scores.

RESULTS: Total exogenous glucose oxidation was lower in PLA HOT vs. PLA TEMP (19 ± 11 g/h vs. 30 ± 10 g/h; $P < 0.001$, respectively). In contrast, there was no evidence B-GOS meaningfully increased total exogenous glucose oxidation (TEMP: PLA 30 ± 10 g/h vs. B-GOS 30 ± 9 g/h; $P = 0.512$; and HOT: PLA 19 ± 11 g/h vs. B-GOS 21 ± 14 g/h; $P = 0.081$). In TEMP, GI symptom scores for nausea ($P = 0.017$), upper ($P = 0.026$), and mean total ($P = 0.020$) were lower for B-GOS. No differences were evident for all other individual symptoms or lower GI ($P > 0.05$). Total carbohydrate and fat oxidation were not different between PLA and B-GOS ($P > 0.05$); however, total fat oxidation was lower in PLA HOT vs. PLA TEMP ($P = 0.023$). Plasma insulin concentrations were not different between PLA and B-GOS, or between temperatures ($P > 0.05$). Glucose and lactate concentrations were not different between PLA and B-GOS ($P > 0.05$), but lactate concentrations were higher in the heat ($P = 0.048$).

CONCLUSION: We provide evidence that heat stress can decrease exogenous glucose oxidation rates during moderate-intensity exercise by a greater magnitude (37%) than previously seen. Therefore, athletes and practitioners should carefully consider fuelling strategies in the heat, and explore approaches to mitigate reduced exogenous fuel availability in hot environments. Whilst B-GOS supplementation may provide some symptomatic relief in temperate conditions, other strategies will probably be required to address fuel availability limitations.

**EFFECTS OF ACUTE EXERCISE FOLLOWING LATE-DINNER CONSUMPTION ON GLYCAEMIC RESPONSES THE NEXT MORNING**

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INTRODUCTION: Late-dinner eating (LD) impairs postprandial metabolism (e.g., glucose regulation and insulin sensitivity). Studies have indicated that a bout of moderate-intensity aerobic exercise can enhance glucose tolerance and/or insulin sensitivity; however, it remains unknown whether aerobic exercise can modulate the impaired metabolic responses due to LD. This study examined the effects of moderate-intensity aerobic exercise prior to LD on postprandial glycaemic regulation and gut hormone responses (GLP-1, PYY and GIP) the following morning.

METHODS: 14 young healthy men (age: 26.2 ± 4.9 years, BMI: 22.8 ± 2.5 kg/m2) completed 3 trials across 2 days including (1) regular dinner (RD at 18:00), (2) late dinner eating (LD at 21:30) and (3) 45-minute brisk walking at 60%VO2max + late dinner at 21:30 (ELD), in a randomized crossover study design. A 2-hour OGTT was conducted in the following morning, with blood (plasma) samples collected at baseline, and every 15 min following glucose ingestion. The primary outcome was total glucose area under the curve (tAUC) over the 120-min sampling period. One-way ANOVA were applied and the significant level is $\alpha = 0.05$.

RESULTS: In the ELD trial, exercise intensity was 62 ± 2 %VO2max, with an average energy expenditure of 408 ± 61 kcal during 45 min exercise. The average heart rate reached to 143 ± 10 bpm, accompanying by a RPE of 12 ± 2. During a 2-h OGTT, tAUC for glucose (833 ± 182 vs. 826 ± 133 vs. 859 ± 196 mmol/2 h/L, respectively) and insulin (27.2 ± 21.3 vs. 28.2 ± 15.7 vs. 28.9 ± 16.2 nmol/2 h /L, respectively) concentrations were not different between RD, LD and ELD trials (all, $p > 0.05$). In addition, GLP-1, PYY and GIP concentrations did not differ between 3 trials (all, $p > 0.05$).

CONCLUSION: In the healthy young males, late dinner eating did not acutely result in the impairment of glucose control and insulin sensitivity. Moreover, acute bout of exercise performed immediately prior to late dinner eating did not influence glucose control and insulin sensitivity next morning. Dinner timing with and without exercise did not affect gut hormone (GLP-1, PYY and GIP) responses.

**ADJUSTED MEAL TIMING PRIOR TO TRANSATLANTIC TRAVEL DOES NOT MAINTAIN GLYCAEMIC CONTROL UPON ARRIVAL IN HEALTHY WOMEN AND MEN**

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INTRODUCTION: Long-haul flights involving transition between time-zones may misalign the human circadian timing system and impair metabolic regulation. We hypothesised that modifying meal patterns for 7 days before departure to match destination eating times would minimise metabolic disruption evident both one day and one week following arrival. This may have implications for the metabolic health of individuals traveling long distances, including athletes who regularly cross time-zones for international competition.

METHODS: Between May 2019 and May 2022, twenty-five young women (n=18) and men (n=7) who were lean and metabolically healthy (age = 21±1 years, height = 1.70±0.11 m, body mass = 67.9±12.8 kg, body mass index = 23.3±2.6 kg·m-2; means ± standard deviation) and residing in California, USA, were randomly allocated to adhere to one of two dietary patterns over the 7 days prior to a ~10.5 h transatlantic flight to the UK. The control group ate according to their local time zone (Pacific Daylight Time; PDT), with a typical breakfast consumed from 0600-0700 h, a typical lunch from 1200-1300 h and a typical dinner from 1800-1900 h; whereas the intervention group ate in the same pattern but with timings shifted by 6-8 hours to broadly match their destination time-zone (British Summer Time; BST), with a typical lunch therefore consumed from 0600-0700 h, a typical dinner from 1200-1300 h and a typical breakfast meal from 2300-0000 h (all local time; PDT). All participants went to bed at 2300-0000 h and woke at 0600-0700 h. Oral glucose tolerance tests were completed in California 12 days prior to the transatlantic flight, then 24-h and 168-h after arrival in the UK.

RESULTS: Both groups exhibited elevated glycaemic responses to the oral glucose tolerance tests upon arrival in the UK relative to their baseline assessments in California (ANOVA time effect p=0.003), but without any significant difference in the magnitude of this effect between experimental conditions (ANOVA interaction p=0.093). Specifically, the respective blood glucose concentration incremental area under curve for the control and interventions at baseline were 210±65 and 216±107 mmol·120 min·l-1, 24 hours after arrival were 295±115 and 331±102 mmol·120 min·l-1, and 168 hours after arrival had recovered to 193±75 and 244±83 mmol·120 min·l-1. Peak blood glucose concentrations followed similar numeric patterns, broadly reflecting an increase >0.5 mmol·l-1 from baseline to 24-h (with partial recovery by 168-h), also with no difference between experimental conditions. Fasted glucose concentrations were relatively stable across all testing days in both groups.

CONCLUSION: This is the first study to examine changes in oral glucose tolerance before and after transatlantic travel, with significant impairment 24-h after the time-zone transition. This effect was not mitigated even by a relatively extreme schedule of eating according to the destination time-zone for a full week prior to departure.

**THE EFFECTS OF THE COMBINATION OF HIGH-INTENSITY FUNCTIONAL TRAINING AND SELENIUM AND ZINC CO-SUPPLEMENTATION ON PHYSICAL FITNESS AND QUALITY OF LIFE PARAMETERS IN OVERWEIGHT AND OBESE PEOPLE**

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INTRODUCTION: Both high-intensity functional training (HIFT) (1,2) and the supplementation of selenium (Se) and zinc (Zn) (3) have the potential to enhance various aspects of physical fitness and health. The purpose of this study was to evaluate, for the first time, the combined effects of high-intensity functional training along with selenium and zinc co-supplementation in overweight and obese individuals following a hypocaloric diet.

METHODS: Sixteen individuals participated in a study where they were randomly assigned to either a group receiving zinc and selenium co-supplementation (n=8, involved in HIFT and supplements) or a control group (n=8, involved in HIFT and receiving a placebo). Throughout the intervention, participants engaged in HIFT sessions twice weekly while adhering to a hypocaloric diet that reduced their caloric intake by 500 calories below their total daily energy expenditure. Those in the supplementation group received 25 mg of zinc gluconate and 200 mcg of L-selenomethionine daily, whereas participants in the control group were given placebo tablets over a period of six weeks. Measurements of resting metabolic rate, thyroid function, body composition, cardiorespiratory fitness, functional capacity, sleep quality, and overall quality of life were conducted at both the start and the end of the study.

RESULTS: The results indicated improvements in functional capacity, quality of life, and sleep quality for both groups following the intervention. Concurrently, reductions were observed in body mass, body fat, and free triiodothyronine (FT3) levels. A significant interaction was found between group and time in relation to performance in the Timed Up and Go (TUG) test, sleep quality, body mass, and selenium serum levels, suggesting that supplementation had a beneficial impact on these parameters.

CONCLUSION: In conclusion, the integration of HIFT with Zn and Se co-supplementation led to enhancements in sleep quality and functional capacity among overweight and obese individuals. Moreover, this regimen effectively contributed to the reduction of body mass. These findings suggest that such a combined approach may serve as a beneficial strategy for improving health outcomes related to physical function and metabolic health in this population group.

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**RELATIONSHIP BETWEEN VISCERAL FAT AREA AND NUTRIENT INTAKES IN JAPANESE COLLEGIATE FEMALE ATHLETES**

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INTRODUCTION: Excessive visceral fat accumulation, which leads to lifestyle-related disease, causes the risk of cardiovascular disease. We have reported that the Visceral fat area (VFA) of Japanese collegiate female athletes had a negative correlation with HDL-cholesterol. Previous studies showed that nutrient intakes, such as dietary fiber, carotenoids, alcohol, and calcium, affected the accumulation of visceral fat. However, it is still unknown whether nutrient intakes have an effect on visceral fat accumulation in daily training athletes. Considering the prevention of health and lifestyle-related diseases after retirement, it is necessary for athletes to have dietary strategies that prevent the accumulation of visceral fat from the beginning of their professional careers. This study aimed to clarify the relationship between VFA and nutrient intakes in Japanese collegiate female athletes.

METHODS: The participants were 46 Japanese female collegiate athletes (rugby player = 23, Throwing Events player = 13, Softball player = 10). Body measurements were taken in the early morning after an overnight fast. The body mass index (BMI) was calculated based on height and body weight. The VFA and Waist Circumference (WC) were measured using abdominal bioelectrical impedance analysis (Panasonic, EW-FA90). The nutrient intakes were investigated using a digital photographic method with data obtained from 3-day dietary records. The study lasted three non-consecutive days: two days (training days) and one day (off day). Each variable was examined for normality using the Shapiro-Wilk test. Then, Spearmans correlation analysis was conducted to find the association between VFA and nutrient intake. Multiple regression analysis was performed for the determinants of VFA.

RESULTS: Aged 18-22years, the participants had a median (interquartile range) height of 161.3 cm (157.2 – 164.7 cm), body weight of 61.5kg (57.3 – 68.4 kg), BMI of 24.2 kg/m2 (22.4 – 25.7 kg/m2), VFA of 45.0 cm2 (35.0 - 54.0 cm2) and WC of 78.3 cm (75.2 – 83.0cm). Their VFA was most frequently distributed within the range of 40.0-59.9 cm2, accounting for 47.8% (22/46 participants). The nutrient intakes of participants were 2,361 kcal/day (2,130 – 2,743 kcal/day), protein of 91.8 g/day (77.8 – 109.9 g/day), fat of 74.0 g/day (62.7 – 92.5 g/day) and carbohydrate 312.0 g/day (278.7 – 353.5 g/day). Negative correlations were found between VFA and energy, protein, dietary fiber, potassium, calcium, magnesium, iron, vitamin K, vitamin B2, vitamin B6 and folic acid, among which dietary fiber had the strongest correlation ($r = -0.56$, $p < 0.001$). Results of multiple regression analysis showed that protein ($\beta = -0.53$, $t = -3.16$, $p < 0.01$) and dietary fiber($\beta = -0.58$, $t = -3.62$, $p < 0.001$) were significantly associated with VFA. (Adjusted $R2 = 0.43$).

CONCLUSION: It is suggested that protein and dietary fiber may contribute to the accumulation of visceral fat in Japanese collegiate female athletes.

**THE EFFECT OF AN OMEGA-3 RICH FOOD ON REDUCING IL-6 IN PEOPLE WITH ACHILLES TENDINOPATHY: A DOUBLE-BLINDED, RANDOMISED CONTROL TRIAL.**

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INTRODUCTION: Inflammation is fundamental in maintaining health, and important in many healing processes. However, unresolved inflammation has severe health consequences, particularly in performance and recovery. The role of inflammation in tendon disorders is well established, particularly in those with chronic Achilles tendinopathy. Achilles tendinopathy is incredibly common, and each year in New Zealand it affects 1 in 300 people, and costs the New Zealand healthcare system over $25million NZD.

Studies have consistently demonstrated that increasing omega-3 consumption reduces inflammation across various disease conditions and in healthy people. Here, we explored whether consuming an omega-3-rich food product daily could reduce systemic inflammation in people with Achilles tendinopathy, and improve tendon healing and overall well-being.

METHODS: In this double-blinded, randomised, placebo-controlled clinical trial, participants with non-acute Achilles tendinopathy were randomised to consume a gel-based food product containing ~2.6g omega-3/day (n=20) or a control product where the omega-3 oil was replaced with vegetable oil (n=21). After 6 and 12 weeks of consuming the product daily, blood was taken to measure circulating levels of fatty acids, Il-6, IL-1, and TNFα, and self-reported questionnaires of tendinopathy severity (VISA-A), well-being (WHO-5), and stress and anxiety (DASS-21) were completed. A mixed effects model with post hoc Tukey's test was used to determine statistically significant changes with time and between groups.

RESULTS: Participants consuming the omega-3 product had significantly higher circulating levels of EPA, DHA, and total n-3 fatty acids after 6 weeks of treatment, which was maintained throughout the rest of the study ($p < 0.0001$). There was no change in the placebo group.

Circulating levels of IL-6 were significantly lower in the treatment group compared to the placebo group following 12 weeks of consuming the test product (0.9744pg/mL vs 1.728pg/mL, respectively, $p=0.0373$). There were no differences in IL-1 and TNFα across the treatment period, or between groups.

The severity of tendinopathy, measured through a self-reported questionnaire, improved in both the treatment and placebo groups across the study period ($p=0.0293$ and $p=0.0001$, respectively). There was no difference between groups.

There were no measurable changes in well-being or stress and anxiety in either group across the treatment period, or between groups

CONCLUSION: Overall, consuming ~2.6g omega-3/day reduced circulating Il-6 levels in people with Achilles tendinopathy. While no improvements in tendon healing were observed compared to the placebo product group, this study has again demonstrated the ability of omega-3 consumption to regulate systemic inflammation in people with disease. Increasing omega-3 consumption can therefore be considered a viable lifestyle alternative to managing unresolved chronic inflammation.

**DARK CHOCOLATE SUPPLEMENTATION ATTENUATES ARTERIAL STIFFNESS INDUCED BY HIGH-INTENSITY RESISTANCE TRAINING DURING THE EARLY FOLLICULAR PHASE IN WOMEN**

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INTRODUCTION: High-intensity resistance training (HIRT) enhances strength and muscle mass but may also increase arterial stiffness. Women in the early follicular phase of the menstrual cycle exhibit reduced vascular elasticity, potentially compounding these effects. Flavanol-rich dark chocolate has been shown to exert cardioprotective effects, yet its impact on vascular function during HIRT in this menstrual phase remains unclear. This study investigates whether 85% dark chocolate supplementation mitigates arterial stiffening induced by HIRT and the early follicular phase.

METHODS: Twenty-nine healthy eumenorrheic women (age: 21.17 ± 2.54 years) were randomly assigned to a placebo (PBO) or dark chocolate (DC) group. For four weeks, participants consumed 25 g of 85% dark chocolate or an equivalent placebo daily in a double-blind manner. The HIRT program included three exercises, performed at 75% of one-repetition maximum (1RM), with six repetitions per set, five sets per session, and three sessions per week. Vascular and cardiovascular parameters, including finger-toe pulse wave velocity (ftPWV), arterial pressure-volume index (API), arterial velocity pulse index (AVI), heart rate (HR), systolic blood pressure (SBP), and diastolic blood pressure (DBP), were assessed at pre-intervention rest (pre-rest), post-intervention rest (post-rest), immediately post-exercise (post-T0), and 30 (post-T30) and 60 minutes (post-T60) post-exercise.

RESULTS: At pre-rest, there were no significant differences between the two groups in any parameter. After four weeks of intervention, ftPWV significantly increased in both groups compared to pre-rest (DC: $p < 0.05$; PBO: $p < 0.001$), while only the PBO group showed a significant increase in AVI ($p < 0.001$). Additionally, post-rest HR was significantly higher than pre-rest in both groups ($p < 0.05$). Notably, ftPWV and AVI were significantly lower in the DC group compared to the PBO group at post-rest, post-T0, post-T30, and post-T60 ($p < 0.05$). SBP, DBP, and API showed no significant changes between the groups.

CONCLUSION: HIRT-induced arterial stiffness was mitigated by 85% dark chocolate supplementation, suggesting a potential protective effect on vascular function during the early follicular phase. Future research should explore additional vascular markers (e.g., flow-mediated dilation, nitric oxide levels) and muscle adaptation indices (e.g., muscle cross-sectional area, 1RM). Further investigation into cocoa concentration, dosage, and supplementation timing may optimize dark chocolate's cardioprotective role while preserving strength adaptations, offering a non-pharmacological strategy for cardiovascular health in resistance-trained women.

**HIGHER ENERGY-DENSE FOOD INTAKE IS LINKED TO COGNITIVE DECLINE IN SCHOOLCHILDREN: THE MODERATING ROLE OF CARDIORESPIRATORY FITNESS AND EMOTIONAL WELL-BEING (PACH STUDY)**

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INTRODUCTION: Cognitive skills are essential for learning, problem-solving, and adapting to new information and daily life situations, allowing children to process and retain knowledge efficiently. Well-developed cognitive functions also contribute to emotional regulation, decision-making, and academic achievement, forming the basis for future personal and professional growth. This study aims to examine the effects of dietary habits, emotional status, and cardiorespiratory fitness (CRF) on cognitive functions in schoolchildren.

METHODS: Prospective longitudinal study involved 106 pupils aged 8-10 years (53.5% boys and 46.5% girls). Over 3 consecutive years dietary habits and emotional well-being were assessed by food frequency survey and revised childrens anxiety and depression scale 25 (RCADS25), accordingly. Cognitive functions were determined by Vienna test system tests – determination test (DT), visual pursuit test (VPT), reaction test (RT). For determination of CRF level pupils performed Kasch Pulse Recovery test. Latent growth curve model was used to test whether changes in cognitive functions over time are linear. Only cognitive function variables with a Comparative fit index of 0.90 or higher were included in the linear mixed model (LMM) analysis to identify influencing factors. Principal component analysis (PCA) was used to reduce food group dimensionality by creating principal components (PC). PCs were included in LMM.

RESULTS: PCA identified 2 PCs, where PC 1 represented energy dense foods, PC 2 – nutrient dense foods. LMM showed that PC2 had no effect on cognitive functions, while PC1 represented by food rich in carbohydrates showed to have an association. The increase of PC 1 score was associated with decreased correct responses in DT (mean estimate -5.72), but there was no effect on RT motor time ($p>0.005$). RCADS25 score played a moderating role between PC1 and DT correct responses, and between PC1 and RT motor time. The increase of PC1 score was associated with decrease in VPT score (mean estimate -1.70). CRF was identified as moderator between PC1 and VPT score.

CONCLUSION: Higher consumption of energy-dense foods was associated with poorer results in most of the cognitive function tests and a decline in cognitive functions. CRF level and emotional well-being played a moderating role in relationship between PC1 and cognitive functions. Findings highlight the importance of prudent eating habits, CRF and emotional health management in early childhood to support cognitive development.

**EXPLORING LOW SEX DRIVE, EATING DISORDER RISK AND EXERCISE BEHAVIOURS AMONG PROFESSIONAL AND ELITE MALE RUGBY UNION PLAYERS IN IRELAND.**

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INTRODUCTION: An athletes drive for muscularity and aesthetic satisfaction is a mediating factor of Eating Disorder (ED) symptomology and low sex drive. Rugby Union exhibits large variations in expected physique profiles norms across positional groups of backs (low body mass, low body fat) and forwards (high body mass, high body fat). The pursuit of established typical positional norms and physique ideals may increase body image concerns that could influence ED symptomology and risk exposure to Low Energy Availability (LEA). The aim of this research was to explore the prevalence of ED, low sex drive and exercise behaviours among male Rugby Union players.

METHODS: Participants were recruited from male professional Rugby Union teams and elite Rugby Union pathway squads in Ireland. Athletes were eligible for inclusion if they were over 18 years of age and training at least 4 times per week. Participants completed an online survey which included 71 questions (Q) comprising the Eating Disorder Examination Questionnaire (EDE-Q) (Q = 28), the Exercise Addiction Inventory (EAI) (Q = 6) and the sub-section relating to sex drive from the Low Energy Availability in Males Questionnaire (LEAM-Q) (Q = 4). A further 33 questions related to nutrition support (Q=8) and the participant background (Q=25) were also included.

RESULTS: 97 Rugby Union players participated (55% professionally contracted; 45% non-professional elite pathway players). The mean age of participants was 21.8 (± 4.7) years. The highest competitive playing levels of participants included senior international (n=10), senior provincial (n=36), national age grade (n=55), national sevens (n=4), club adult (n=1) and university (n =1). Nine percent (n = 9) of participants scored above the threshold for the EDE-Q Global score of 1.68 indicating the presence of disordered eating risk. Twenty percent (n = 20) reported a low sex drive score. Sixteen percent (n=16) of participants scored above the cut off on the EAI suggesting the presence of exercise compulsion. All participants reported they had access to a professional nutritionist. Participants who played in the forwards, regardless of professional status, showed higher EDE-Q eating concerns (p = 0.03). There was no significant difference between professional status or position when determining sex drive status.

CONCLUSION: The practical application of these findings points to increasing the awareness of practitioners and stakeholders within the elite and professional rugby context to drive screening and intervention. Further research is needed to understand the contextual risk factors that may be associated with this symptomology in male Rugby Union players.

**EFFECT OF DIETARY FIBER INTAKE ON MOTIVATION FOR PHYSICAL ACTIVITY**

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INTRODUCTION: Although it is a well-known fact that exercise habits and a well-balanced diet are essential for the maintenance and improvement of health, it is very difficult to keep on regular exercise. One of the factors affecting human health involves the gut microbiota, which has also been shown to be affected by exercise. In addition, altered gut microbiota caused by exercise quickly returns to its level before exercise, suggesting that the gut microbiota, or the short-chain fatty acids (SCFAs) produced by the gut bacteria, may influence exercise motivation and exercise capacity. The purpose of this study was to investigate the effects of dietary fiber intake, which strongly induces the production of SCFAs derived from the gut microbiota, on the motivation to exercise in mice.

METHODS: Eight-week-old C3H/HeN male mice (n=24) were randomly divided into three dietary groups: non-fiber (NFD, n=8), 5% cellulose (Cellu, n=8) and 5% PHGG (PHGG, n=8). Body weights were measured weekly. They were measured by exercise motivation through voluntary wheel-running for 7 days and exercise capacity by forced treadmill exercise after each food-intake period. Then, we collected their fecal samples for analysis of the gut microbiota.

RESULTS: The change in body weight after 6 weeks of food consumption was significantly higher in PHGG compared with Cellu ($p<0.05$). Fecal pH, a measure of organic acid production by the gut microbiota, was significantly higher in Cellu compared with NFD, but showed no significant change with PHGG. The voluntary wheel-running in Cellu was significantly higher than that in both NFD and PHGG groups. The exhaustion time by forced treadmill running, however, was not affected by those dietary fibers. The alpha diversity of the gut microbiota in Cellu mice was significantly higher than that in NFD groups ($p<0.05$).

CONCLUSION: The increased voluntary wheel-running in Cellu might not depend on exercise capacity such as skeletal muscles and/or circulatory functions. It appears that the wheel-running requirement suggested a change in brain function. In other words, Cellu intake affects the formation of the gut microbiota, which acts on the brain via changes in SCFA production and influences the motivation to exercise. This may have stimulated gene expression in the brain, resulting in an effect on the amount of voluntary physical activity. This hypothesis may be consistent with the "gut-brain axis" hypothesis already proposed. We previously reported that ingestion of PHGG, a highly fermentable soluble fiber, leads to the formation of a characteristic gut microbiota and increased SCFA production. However, this study suggests that this may

have a negative effect on exercise motivation. In contrast, our collaborator already showed that wheel-running activity was increased by cellulose nanofiber intake. Accordingly, intake of cellulose, which is not easily metabolized by the gut microbiota, might be useful for keeping to a program of regular exercise.

## Conventional Print Poster Presentations

### CP-PN20 Amino acids and Proteins

**EFFECTS OF CONCURRENT EXERCISE AND PROTEIN SUPPLEMENTATION ON WORKING MEMORY, BODY COMPOSITION, AND MUSCLE STRENGTH IN SARCOPENIC OVERWEIGHT WOMEN: A 12-WEEK INTERVENTION STUDY**

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INTRODUCTION: The loss of muscle mass and cognitive function in sarcopenic overweight women is a public health concern. The relationship between exercise, protein supplementation, and cognitive function remains a key research area. This study examined the effects of concurrent exercise and high-protein supplementation on sarcopenic-overweight women.

METHODS: Forty women (mean age: 66.63 ± 7.23 years, BMI: 24.86 ± 2.64 kg/m², and waist circumference 83.16 ± 6.95 cm) participated in a 12-week intervention. They were randomly assigned to one of four groups: Exercise without supplementation (EG), Exercise with supplementation (ESG), Control with supplementation (CSG), and Control without supplementation (CG). Assessments included working memory (N-back task), body composition, and muscle strength (Biodex 4 Pro), measured pre- and post-intervention.

RESULTS: (1) Behavior performance of working memory: The study found that as task difficulty increased, reaction times became slower ($F(3,9) = 779.81$, $p < 0.01$), confirming that more complex tasks require more significant cognitive effort. No significant effect on reaction time or accuracy rate was found ($p < 0.05$). However, task-specific improvements were observed that SG improved in simple response tasks (N-back 0), reducing reaction time (638.85 ± 109.88 ms vs. 564.63 ± 62.38 ms, $p = 0.01$), while EG showed gains in high working-memory tasks (N-back 2)(1386.15 ± 311.99 ms vs. 1157.11 ± 337.75 ms, $p = 0.04$). (2) Body composition: The intervention significantly improved fat mass, fat percentage, and lean mass, with ESG achieving the best results. The most significant fat mass reduction (pretest 20.04 ± 8.61 vs. posttest 18.46 ± 7.43 kg, $p < 0.01$), fat percentage reduction (pretest 33.53 ± 7.97% vs. posttest 31.53 ± 8.02%, $p < 0.01$), and the highest lean mass gain (pretest 21.01 ± 1.23 vs. posttest 21.57± 1.47 kg, $p < 0.01$) were found in ESG. BMI and total weight remained stable, suggesting muscle gain may have balanced fat loss. (3) Muscle strength showed significant improvement over time for flexion ($p < 0.01$, partial $\eta^2 = 0.38$) and extension strength ($p < 0.01$, partial $\eta^2 = 0.28$), particularly in ESG, while it showed the most significant gains (knee flexion: pretest 23.96 ± 10.93 Nt, posttest: 43.01 ± 12.93 Nt; knee extension: pretest 45.50 ± 16.87 Nt, posttest: 66.07 ± 20.35 Nt).

CONCLUSION: Concurrent exercise with supplementation effectively reduced fat mass, increased lean mass, and improved muscle strength in sarcopenic-overweight women. While the behavioral performance of working memory did not show substantial overall improvement, supplementation enhanced reaction speed, and exercise improved working memory. Targeted interventions integrating concurrent exercise and supplementation may optimize body composition and muscle strength. Future research should examine long-term metabolic and neurocognitive effects to refine strategies further.

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**TOTAL PROTEIN AND BRANCHED-CHAIN AMINO ACID INTAKE ARE ASSOCIATED WITH LEAN MASS, SKELETAL MUSCLE FUNCTION AND STRENGTH IN ADULTS WITH MUSCULAR DYSTROPHY**

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INTRODUCTION: Muscular dystrophinopathies (MD) are a heterogenous group of inherited neuromuscular disorders characterised by progressive declines in skeletal muscle strength, size and function. Despite progress in potential drug treatments in pre-clinical models, few have transitioned to widespread clinical usage. As such, identifying interventions that maintain and/or slow declines in function and quality of life (QoL) are essential. Nutritional interventions, including protein and creatine supplementation, have shown efficacy in specific MD populations i.e. paediatric Duchenne MD [1]; however, little is known about the dietary habits of the broader adult MD population[2, 3]. Therefore, the aim of this study was to evaluate nutritional status and habits in adults with MD and probe for associations between nutritional outcomes, functional/physiological parameters and QoL.

METHODS: Adults with MD (n=39;FSHD=8, LGMD=9, Other=22, body mass index (BMI) 26.8±5kg/m2,61±14yrs) and non-dystrophic controls (CTRL)(n=15, 28.5±5.9kg/m2, 38±12yrs) completed: (1) 2x three-day food diaries, separated by 8 weeks, (2) a set of validated questionnaires assessing perceived functional ability and QoL; (3) strength and functional testing comprising body composition, forearm muscle thickness, elbow flexor, arm abduction and grip strength, and muscle function (10m walk, timed up and go). Group differences were probed using independent t-tests or Mann-Whitney

U and associations were tested using Pearson's r or Spearman's Rho tests, depending on normality. Values are reported as mean ± SD and significance was set at p<0.05.

RESULTS: No differences between CTRL and MD were found for BMI or self-reported physical activity (p>0.05). MD reported a lower protein intake (PI) as a percentage of recommended daily intake (%RDI)(0.76 g/kg/day)[4] when compared to CTRL (150±35%RDI vs 186±15%RDI,respectively, p=0.022), while reporting a higher overall energy intake (MD=139±48%, CTRL=114±32%, p=0.023). PI (g/kg/day) was positively associated with lower limb function (rs=0.43), Barthel Index (ability to perform daily tasks)(rs=0.43) and elbow flexor strength(rs=0.37) in the MD group (all p<0.05). MD also reported lower branched-chain amino acid (BCAA) intakes (CTRL=8225±961mg,MD=6274±474mg, p=0.049) which were associated with lean mass% (r=0.45, p=0.015) and arm abduction strength(r=0.37, p=0.036).

CONCLUSION: These data show MD adults have reduced total protein and BCAA intake compared to the average UK adult, whilst consuming a greater relative energy intake. Importantly, protein and BCAA intake were associated with various measures of muscle strength and function, suggesting interventions targeted at increasing such intakes may benefit this population.

1. Davidson, Z.E., et al., Clinical Nutrition, 2021. 40(7): p. 4702-4711.

2. Motlagh, B., et al., Muscle Nerve, 2005. 31(6): p. 713-8.

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**RELATIONSHIPS AMONG SKELETAL MUSCLE CROSS-SECTIONAL AREA, INTRAMUSCULAR ADIPOSE TISSUE CONTENT, AND PROTEIN INTAKE IN YOUNGER AND OLDER ADULTS**

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INTRODUCTION: Skeletal muscle size decreases and intramuscular adipose tissue (IntraMAT) content increases with aging, which induces decline of skeletal muscle strength and physical function (Goodpaster et al, 2006; Tuttle et al, 2012). IntraMAT content is known to be associated with metabolic diseases such as type Ⅱ diabetes (Goodpaster et al, 2000). Therefore, it is important to take measures to prevent the decrease in skeletal muscle size and the accumulation of IntraMAT. One of the factors that may affect changes in the amount and proportion of skeletal muscle and adipose tissue is habitual dietary intake. It has been clarified that protein intake helps maintain and increase skeletal muscle size; however, it is not well known how protein intake affects adipose tissue. Previous studies examined the relationships among skeletal muscle cross-sectional area (CSA), IntraMAT content, and protein intake (Sjoholm et al, 2016; Dicks et al, 2020); however, a consistent consensus has not been observed in these relationships. A possible cause of the inconsistency in these relationships is the difference in age. Therefore, the purpose of this study was to clarify the relationships among skeletal muscle CSA, IntraMAT content, and protein intake in younger and older adults.

METHODS: Twenty-three young women (19.9 ± 1.6 years) and 25 older women (72.4 ± 3.2 years) participated in this study. Skeletal muscle CSA and IntraMAT content (%) of the quadriceps femoris (QF), hamstrings (HM), adductors (AD), and total thigh (i.e. sum of QF, HM, and AD) at the mid-thigh were measured using magnetic resonance imaging. The percentages of energy from protein were assessed using a simple self-administered dietary history questionnaire. Protein was classified into total protein, animal protein, or plant protein.

RESULTS: No significant correlations were observed between skeletal muscle CSA and percentage of energy from protein (i.e. total protein, animal protein, and plant protein) in both groups. In younger group, IntraMAT content of the QF significantly correlated with the percentages of energy from total protein ($r = 0.528$, $P < 0.05$) and animal protein ($r = 0.484$, $P < 0.05$). In older group, IntraMAT content of the three skeletal muscle groups (i.e. QF, HM, and AD) and the total thigh were inversely correlated with the percentages of energy from plant protein ($r = -0.538$ to $-0.455$, $P < 0.01$).

CONCLUSION: These results suggest that the relationship between IntraMAT content and protein intake varies with age, and particularly in older group, a higher percentage of energy from plant protein affect reduce the accumulation of IntraMAT content.

**EFFECTS OF ANIMAL AND PLANT FOOD INTAKE ON FATIGUE AND SATIETY DURING VOLLEYBALL PRACTICE**

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INTRODUCTION: Practicing volleyball involves various exercises and requires sufficient calorie intake. Fats are energy-loaded macronutrients both in plants and animals. Plant-based (PB) foods are rich in unsaturated fatty acids, which reduce LDL cholesterol accumulation in the blood, while animal-based (AB) foods have high saturated fatty acid levels. Consuming PB foods before exercise reportedly reduced arterial stiffness and increased maximal oxygen uptake in adult men. Thus, consuming PB foods before volleyball practice facilitates exercising during practice and affects fatigue. This study aimed to determine how PB foods before volleyball practice affect satiety, fatigue, and ease of movement.

METHODS: We involved eight womens volleyball club members and conducted measurements from July to September 2024. We applied a crossover method and a one-week washout period. The energy intake and fat-to-energy ratio of the PB and AB meals were 661 and 601 kcal and 50 % and 49 %, respectively. The measurement items included physical characteristics, energy consumption during practice by acceleration sensor, and feelings of fatigue and fullness. We

measured the following physical characteristics: height, weight, and body fat percentage. Fatigue and fullness were assessed using a Visual Analog Scale (VAS). The fatigue items included difficulty in breathing and heaviness in the legs. We assessed the feeling of fullness seven times: right after eating , 20, 50, 80, 140, 200, and 260 min. We assessed fatigue after warming up. We used paired t-tests to compare the energy expenditure, and fatigue levels when consuming PB and AB foods. We compared satiety between time, PB, and AB using repeated measures two-way ANOVA. When we identified significant differences, we assessed time using multiple comparisons and the differences between the PB and AB groups using paired t-tests.

RESULTS: On average, the participants were 158.8 cm tall and weighed 54.8 kg with a body fat percentage of 21.7%. There was no significant difference in exercise intensity or energy expenditure during the four-hour volleyball practice in this study. The energy expenditure was about 893 Kcal and the exercise intensity was about 3.7 METs. In terms of fatigue, there was no significant difference between the groups in the vas of PB and AB (difficulty breathing: about 4.3, feeling heavy in the legs: about 6.5).We observed no significant differences between the PB and AB groups with respect to leg heaviness or breathlessness during practice. Feelings of fullness was significantly r in the PB group (compared to the AB group) at 140 min and 260 min postprandial.

CONCLUSION: These results suggest that when performing moderate-intensity exercise, ingesting PB before exercise gradually reduces the feeling of fullness, reduces the feeling of hunger even in the latter half of exercise, and although the legs feel a little heavy, it is possible to concentrate on high-intensity exercise from 2 hours after eating.

**EIGHT-DAYS OF FAVA BEAN PROTEIN SUPPLEMENTATION IMPROVES THERMOREGULATION WITHOUT EXACERBATING GASTROINTESTINAL SYMPTOMS DURING EXERCISE IN A HOT ENVIRONMENT**

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INTRODUCTION: Exercise in hot environments can lead to gastrointestinal disturbances, which may impair performance (1). Single amino acid supplementation has been reported to attenuate gut damage (2) and enhance exercise tolerance (3); however, the effectiveness of amino acid blends from plant-based proteins remains underexplored. With increasing interest in plant-based protein sources as a sustainable option for athletes, further research is crucial to understand their potential to reduce markers of exercise-induced gastrointestinal syndrome (EIGS). This study aimed to investigate the effects of an eight-day supplementation with a novel fava bean-derived plant protein and amino acid blend on thermoregulation, endurance performance, and EIGS during exercise in a hot environment.

METHODS: Twelve, healthy, euhydrated, non-heat acclimated participants (7 females, 5 males; 31 ± 5 years) completed an eight-day supplementation protocol with either fava bean protein (ATURA; 60 g/day) or a placebo in a randomised, double-blind, placebo controlled cross-over design. On day eight, participants walked on a treadmill for 10 min, followed by a 40 min run at a fixed heat production (H ̇prod), followed by a graded exercise test to exhaustion (35°C, relative humidity 40%). Whole-body sweat rate (WBSR), local sweat rate (LSR), pulmonary gas exchange, skin temperature, core temperature, and perceptual responses were monitored. Venous blood-samples were collected pre- and post-exercise.

RESULTS: Whole-body sweat rate (WBSR; 11%; p=0.03) and back LSR (11%; p<0.001) was higher in the ATURA condition compared to placebo. Core body temperature was lower in the ATURA condition (ATURA; 38.8 ± 0.5°C, placebo; 38.7 ± 0.5°C; p=0.04). There was no effect on mean skin temperature (p=0.61), ratings of perceived exertion (p=0.91) or thermal comfort (p=0.12); however, thermal sensation was greater in the ATURA condition (p=0.05). Gastrointestinal symptoms were 34% lower in the ATURA condition, but not significantly different (p=0.257). There were no differences in time to complete the graded exercise test and peak oxygen consumption (p>0.05). The pre- to post-heat shock protein 70 difference was higher in the ATURA group (12%, p=0.05), and no difference for pre- to post-interleukin-6 (ATURA; 29%, placebo; 51%; p>0.05).

CONCLUSION: Fava bean protein supplementation increased WBSR and LSR, as well as core body temperature during exercise, suggesting enhanced thermoregulation. Importantly, the supplement did not exacerbate gastrointestinal symptoms, indicating tolerance of fava bean protein during exercise. Whilst no improvements in exercise performance were observed, further investigation into the mechanisms underpinning the enhancements in thermoregulation, gastrointestinal function, and exercise adaptation is warranted.

**COLLAGEN PEPTIDE SUPPLEMENTATION REDUCES POST-EXERCISE ENERGY INTAKE IN FEMALES**

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INTRODUCTION: Dietary protein ingestion via a single bolus or over several days has been shown to decrease energy intake through increased subjective fullness and/or increased concentrations of satiety hormones. To date, research has focused on the effects of complete proteins (e.g., whey and casein) and not those with different amino acid profiles. Collagen peptides (CP) are rich in glycine, proline and hydroxyproline, and are increasingly consumed by physically active populations for health, recovery, and performance benefits. However, the impact of CP on post-exercise appetite regulation is unknown. Thus, the primary aim of this study was to examine whether consuming CP influences subjective appetite, plasma hormone responses and ad libitum energy intake after a bout of exercise in healthy active females.

METHODS: In a randomised crossover design, 15 physically active females (23±3 y; 60.5±10.1 kg; 41±8 ml/kg/min V ̇O2max) completed two experimental trials following 6 days of supplementation (15 g/day of CP or a flavour-matched placebo (water; CON)), with a ≥7-day washout between trials. On day 7, participants cycled for 45 min at ~55% Wmax, before consuming their final dose of the supplement. 60 min post intake an ad libitum meal was provided, and energy intake recorded. Subjective appetite and satiety were measured daily for 6 days (pre- and 30 min post-supplement), and pre (0 min) to 280 min post-exercise on day 7. Blood glucose and plasma hormone concentrations (total ghrelin, leptin, insulin, total glucagon-like peptide 1 (GLP-1), total peptide YY (PYY,), cholecystokinin (CCK), dipeptidyl peptidase-4 (sDPP-4) were measured fasted at baseline (day 0), then pre-breakfast (0 min), post-exercise (100 min), post-supplement (115, 130, 145, 160 min) and post-meal (220, 280 min) on day 7.

RESULTS: Ad libitum energy intake was ~10% lower in the CP trial (CP 356 ± 125 kcal; CON 397 ± 120 kcal; P=0.037). There were no differences in heart rate (CP 153 ±18 bpm; CON 152 ± 18 bpm) during exercise (P≥0.682) and no differences in gastrointestinal symptoms or subjective appetite and satiety throughout the trial (P≥0.412). Post-exercise intake of CP increased GLP-1 (area under the curve 0-280 min; CON: 6369 ± 2330; CP: 9064 ± 3021 pmol/L; P<0.001) and plasma insulin concentrations (130-160 min; P<0.001). Plasma ghrelin was ~6% lower and leptin ~7% lower in the CP trial on day 7 (condition effect; P≤0.032). PYY, CCK, sDPP-4 and glucose were not different between conditions (P≥0.100). There were no between condition differences in subjective appetite or hormones in the 6 days prior to the exercise trials (P>0.05).

CONCLUSION: A 15 g bolus of CP consumed post-exercise increased circulating insulin and GLP-1 concentrations and reduced ad libitum energy intake in physically active females after exercise. These findings suggest that if consuming CP after exercise for health or recovery benefits, there may be a compensatory decrease in energy intake at the next meal.

**POLYPHENOL SUPPLEMENTATION ATTENUATES ACUTE EXERCISE INDUCED INCREASE IN GLUTAMINE AND ACYL-CARNITINE AFTER RESISTANCE TRAINING: PRELIMINARY RESULTS**

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INTRODUCTION: While resistance-based training (RBT) is recognized for its role in mitigating the decline in physical function, its impact on inflammation, oxidative stress, and mitochondrial function in older adults remains less well understood. The aim of this ongoing study is to investigate the effects of RBT and polyphenol supplementation on systemic blood metabolites in individuals at the onset of aging.

METHODS: Forty subjects (20 males, 20 females) between 55 and 70 years of age (mean: 61.3 ± 4.3 years) were randomly assigned to either a polyphenol supplementation (PS) or placebo (PLA) group. All participants underwent a 12-week RBT protocol. Before and after RBT, subjects performed a 45-minute cycling test at 70% $VO_2$max. Blood plasma samples were collected at baseline and during the final minute of the acute exercise session.

Metabolite analysis was performed on plasma samples. Metabolite extraction followed a methanol-based protocol, and quantification was carried out using a liquid chromatography-mass spectrometry (LC-MS) workflow. Separation was achieved via hydrophilic interaction liquid chromatography (HILIC), and detection was performed using a high-resolution Orbitrap Exploris 120 mass spectrometer. Over 70 metabolites were quantified using external standard calibration curves and isotopically labeled internal standards. Preliminary data from 12 subjects (six from each group) are presented.

RESULTS: Plasma concentrations of several metabolites changed in response to the acute cycling test. Notably, a significant increase in glutamine and acetylcarnitine concentrations was observed ($p < 0.05$). After 12 weeks of RBT, the increase in glutamine during the acute cycling test was less pronounced in the PLA group, whereas in the PS group, glutamine levels remained elevated. A similar trend was observed for acetylcarnitine, a marker of mitochondrial fatty acid oxidation. Specifically, after 12 weeks of RBT, the increase in acetylcarnitine during the acute cycling test was attenuated in the PLA group, while it remained more pronounced in the PS group.

CONCLUSION: Polyphenol supplementation during 12 weeks of resistance-based training attenuates the acute exercise-induced increase in metabolites, most notably glutamine and acetylcarnitine, in the blood. The possible mechanisms, along with data from all 40 subjects, will be explored in the coming months and presented in greater detail at the congress.

**MUSCLE MATTERS: A CASE STUDY ON RESISTANCE EXERCISE AND PROTEIN INTAKE TO PROTECT LEAN MASS DURING WEIGHT LOSS**

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INTRODUCTION: Energy restriction-induced weight loss can accelerate lean mass decline in older adults with obesity, contributing approximately 25-35% to total weight lost. This reduction in lean mass during weight loss in older adults has implications for muscle strength and physical performance deterioration and poorer metabolic health. Combined resistance exercise training and a higher protein intake may attenuate energy restriction-induced lean mass loss, but data in older adults with obesity are limited.

METHODS: In this case study analysis of an ongoing larger randomised, parallel groups clinical trial, an older female (aged 68 y) with obesity underwent four weeks of energy restriction-induced weight loss (-30% estimated energy requirement) with partial (50%) controlled food provision. Our participant completed supervised exercise (3 x/week), including whole-body resistance exercise and high intensity aerobic training on a stationary bike. Protein intake was 1.5 g/kg/day,

including twice daily whey protein supplementation (2 x 0.3 g/kg/day). Body composition (via dual-energy X-ray absorptiometry), resting energy expenditure (via indirect calorimetry), strength, and physical performance were assessed before and after weight loss.

RESULTS: Body mass index (BMI) at baseline was 30 kg/m2. After the four-week intervention, body weight and BMI decreased by 3.1 kg and 1.2 kg/m2, respectively. Fat mass decreased by 2.0 kg and lean mass decreased by 0.3 kg, contributing 11.0% to total weight lost. Resting energy expenditure modestly decreased from 1786 to 1717 kcal/d. Chest press 1-repetition maximum (1RM) and knee extension 1RM increased by 10.4% and 30.0% from baseline (24 vs. 27 kg and 37 vs. 49 kg), respectively. Chair stand test performance improved by 25.7% (10.1 vs. 7.5 sec) while handgrip strength increased by 16.7% (24 vs. 28 kg) from baseline.

CONCLUSION: This case study highlights multi-modal resistance exercise training and a higher dietary protein intake as a strategy with the potential to optimise 'healthy' weight loss in older adults with obesity during short-term energy restriction.

## Conventional Print Poster Presentations

### CP-PN21 Hydration and Nutritional Practises

**INDICES OF HYDRATION STATUS AND PHYSICAL FUNCTION CAPACITY VARY BY ETHNICITY AMONG A CROSS-SECTIONAL COHORT OF AMERICAN WOMEN**

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*UNILEVER*

INTRODUCTION: There are well-understood ethnic differences among Americans in hemodynamics and metabolic health, while NHANES fluid intake data suggests certain ethnic groups are at greater risk for hypohydration. Recent evidence suggests that young African American (AA) adults may be more likely than young Caucasian adults to be hypohydrated, with reduced urine output, increased urine specific gravity, and elevated copeptin (1). It is generally accepted that dehydration is associated with diminished exercise performance, but less is known about the potential impact of hypohydration on non-exercise physical exertion. Therefore, we evaluated physical function capacity, hydration status and Quality of Life indicators in a multi-ethnic cohort of American women.

METHODS: Healthy women (n=114) aged 19-70 yrs were enrolled from the San Francisco metropolitan area without preference for ethnicity. Health was defined as absence of chronic disease and no recent use of associated medications (e.g., insulin, diuretics, corticosteroids). Vitals were measured, and participants completed the PROMIS-29 QoL questionnaire. Fasted blood was collected and glucose, ADH, and copeptin were analyzed. Twenty-four-hour urine volume was collected, and urine was analyzed for osmolality, specific gravity, and creatinine. A two-way ANOVA was used to detect differences in means between ethnicities. All data are expressed as mean ± SEM.

RESULTS: The cohort was comprised of Asian (n=51), African American (n = 24), Caucasian (n=21), and Hispanic (n=18) ethnicities. AA women had the highest BMI (33.25; $p<0.0001$) and highest systolic BP (124.54±3.18 mm Hg), while there were no differences in glucose or urine volume. There were group effects for ethnicity on PROMIS Physical Function ($p=0.007$), urine specific gravity ($p=0.007$), urine creatinine ($p<0.0001$), and ADH ($p<0.001$). AA women had the lowest aggregate score on the physical function domain (13.58±1.63), indicating more difficulty with activities of daily living . AA women had higher urine specific gravity (1.02±0.01) and markedly elevated urine creatinine (161.11±19.77 mg/dL). AA women had elevated ADH (27.31±2.53 pg/mL), and while not statistically significant, the highest mean level of copeptin.

CONCLUSION: In this cross-sectional sample, AA women reported the lowest physical function capacity, while displaying multiple indicators of hypohydration and possible renal insufficiency. These findings could be in part related to differences in body composition. Hydration interventions targeted to specific ethnicities may have potential to improve free-living hydration status, kidney function, and capacity for physical activity.

1. Robinson AT, et al. Am J Clin Nutr. 2023 Oct;118(4):822-833.

**DRINKING BEHAVIOR AND HYDRATION EFFECTS OF WATER, CARBONATED WATER, AND SPORTS DRINK CONSUMPTION FOLLOWING EXERCISE IN THE HEAT**

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INTRODUCTION: Several studies have examined the effects of hydration, identifying optimal solutions for maintaining hydration status. However, these studies controlled the amount and timing of fluid intake, thereby excluding the behavioral component. In real-world situations, drinking behavior plays a crucial role in determining fluid intake patterns, ultimately influencing hydration efficacy—yet this aspect remains insufficiently explored. In this context, our previous research demonstrated that carbonated water ingestion can alter perceptions such as exhilaration, sleepiness, and/or stimulating feeling both at rest (Fujii et al., 2022) and following exercise (Kajiki et al., 2024) in the heat. These perceptual changes may influence drinking behavior and, consequently, hydration effectiveness. However, this relationship has not been directly investigated.

METHODS: Eight healthy young adults performed repeated 10-min cycling bouts at 50% peak oxygen uptake in a hot environment (35°C), interspersed with 3-min passive recovery periods, until a 2% reduction in body mass was achieved. Twenty min after the exercise, participants were transferred to another room maintained at 25°C. They then freely consumed one of three beverages: (1) water, (2) carbonated water, or (3) a sports drink, over a 30-min period. Each beverage trial was conducted on separate days and the order was randomized and counterbalanced. Venous blood samples were collected pre-exercise, immediately post-exercise (0 min), and at 30 and 60 min after the commencement of drinking. Urine samples were obtained pre-exercise, immediately post-exercise, and at 30 min, 1 h, 2 h, 3 h, and 4 h following the onset of drinking.

RESULTS: During the initial 5 min of the 30-min ad libitum drinking period, the volume of beverage consumed was lower for carbonated water compared to the other two beverages. Similarly, the total volume ingested over the entire 30-min period tended to be lower for carbonated water than for water or the sports drink. Despite the differences in fluid intake, no significant differences were observed in urine output, plasma volume, plasma osmolality, or vasopressin levels among the three beverage conditions at any time point.

CONCLUSION: In healthy young individuals, carbonation of beverage reduces initial beverage consumption, likely due to sensory effects associated with carbonation (e.g., oral stimulation). However, despite this attenuation in early fluid intake, hydration efficiency appears comparable to that of water and sports drinks. Carbonated water may serve as a potential strategy to mitigate overhydration, particularly in individuals with lower sweat rates, though this hypothesis requires further investigation.

**IMPACT OF CAFFEINE AND ELECTROLYTE LEVEL ON MEASURES OF HYDRATION OVER A 4HR PERIOD IN HEALTHY MEN AND WOMEN**

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INTRODUCTION: The Beverage Hydration Index (BHI) allows comparison of fluid retention profiles for different beverages relative to water. The impact of caffeine with and without electrolytes on hydration status over 4 hours is not well characterized. The effects of commercially available caffeinated beverages were compared to water (W) on hydration measures to understand the impact of various formulations on hydration status over 4 hours in a sedentary & euhydrated state. This study aimed to provide more clarity on the impact of different caffeinated products and their ability to promote fluid retention or diuresis.

METHODS: 28 healthy adults (14M/14F; age 22.6±3 y) participated in a BHI protocol. Participants arrived to the lab in a euhydrated state which was confirmed by urine specific gravity. Beverages were then administered in a randomized order of four 250mL aliquots over 30min: 500ml of caffeinated beverage (CAF) with 280mg, CAF of 280mg plus electrolytes (CAF+E) or CAF with 100mg+E & carbohydrates (CAF+CE) along with 500ml W (1st & 4th aliquot). Urine output was recorded over 4hr.

RESULTS: W & CAF+CE averaged a more positive net fluid balance (NFB) ($p<0.001$, 0.001) compared to CAF & CAF+E, ranging from 120 to 175ml greater overall fluid balance. From 60–240min, CAF+CE exhibited significantly higher NFB when compared to CAF & CAF+E ($P<0.05$). From 120-240min, CAF+CE had significantly higher BHI scores when compared to CAF & CAF+E ($P<0.05$). CAF+CE had significantly lower urine output when compared to CAF & CAF+E from 90-240min ($P<0.05$).

CONCLUSION: A low carbohydrate-electrolyte beverage with moderate levels of caffeine (CAF+CE) had similar hydration properties compared to water and both were significantly greater than CAF and CAF+E. Based on BHI, CAF+CE retained ~10 and 15% more fluid when compared to CAF+E and CAF, respectively, which has practical implications for caffeine containing products. This data suggests that a low -carbohydrate- electrolyte beverage with added caffeine may attenuate diuresis in a hydrating energy drink solution.

**POST-EXERCISE REHYDRATION: A COMPARISON OF A NATURAL FRUIT-BASED BEVERAGE, A GLUCOSE-BASED SPORTS DRINK, AND WATER**

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INTRODUCTION: Exercise-induced hypohydration may negatively affect aerobic performance, cognitive performance, and mood. Effective rehydration after exercise is paramount, with previous research demonstrating beverage retention can be improved by including carbohydrate and electrolytes. Fruit-based hydration beverages could provide comparable concentrations of carbohydrate and electrolytes to sports drinks, whilst also providing beneficial antioxidants and phytochemicals. The present study compared the effectiveness of a fruit-based hydration beverage (FRU), versus a glucose-based sports drink (SPO), versus water (WAT) at rehydration, following exercise-induced hypohydration.

METHODS: After familiarisation, six active males (age: 21 ± 1 y; Wpeak: 209 ± 53 W) completed three experimental trials in a randomised cross-over design. Participants cycled in the heat (~35°C) at ~50% Wpeak to induce ~2% body mass loss (dehydration phase), and then rehydrated with a water volume equivalent to 150% of body mass losses from either FRU (per 100 mL: 5.9 g carbohydrate, 1 g protein, 0.04 g salt, 135 mg potassium), SPO (per 100 mL: 6.3 g carbohydrate, 0.12 g salt, negligible protein and potassium), or WAT. Drinks were consumed in four equal aliquots, evenly distributed over a 1 h period, and participants then rested in a laboratory (~20°C) for another 4 h (5 h rehydration phase). Blood glucose con-

centrations were measured from fingertip blood samples (0, 0.25, 0.5, 0.75, 1, 1.5 and 2 hours after rehydration) and all urine produced was collected. Parametric data are reported as (mean ± SD), whereas non-parametric data are reported as (median [interquartile range]).

RESULTS: There was no effect of trial on body mass losses at the end of the dehydration phase (FRU: -1.99 ± 0.22%, SPO: -1.96 ± 0.19%, WAT: -1.95 ± 0.18%; P = 0.560) or the water volume provided by each drink (FRU: 2173 ± 506 g, SPO: 2118 ± 458 g, WAT: 2115 ± 381 g; P = 0.563). There was no effect of trial on total urine volume produced during the rehydration phase (FRU: 1025 [929-1586] g, SPO: 1039 [962-1561] g, WAT: 1427 [1118-1783] g; P = 0.115). Whilst, there was an effect of trial (P = 0.030) on water retained from the drinks at the end of the rehydration phase, post-hoc tests revealed no significant differences between trials (FRU: 46 [33-58] %, SPO: 39 [33-48] %, WAT: 26 [23-41] %; P = 0.129). There was an effect of trial (P < 0.001) on blood glucose area under the curve following consumption of the drinks (FRU: 9.94 ± 0.52 mmol/L/2h, SPO: 12.60 ± 1.79 mmol/L/2h, WAT: 8.08 ± 0.31 mmol/L/2h), with FRU and SPO both greater than WAT (P < 0.01) and SPO greater than FRU (P = 0.033).

CONCLUSION: The results from this preliminary analysis of an ongoing study currently suggest that a fruit-based hydration beverage, a glucose-based sports drink, and water are equally effective for post-exercise rehydration but produce differential blood glucose responses, with a fruit-based beverage producing lower blood glucose concentrations than a sports drink.

**TRAINING SWEAT LOSSES, FLUID INTAKE, BODY MASS CHANGES, AND WAKING HYDRATION STATUS IN MIXED MARTIAL ARTS ATHLETES ACROSS A SIX-DAY TRAINING WEEK**

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INTRODUCTION: Large data sets exist for typical sweat rates, fluid intakes, and daily hydration status of athletes across a wide variety of sports. Despite this, few data in combat sports, and none in mixed martial arts (MMA) are available. With the importance of hydration status in both performance and health contexts, combined with the intentional dehydration practices combat athletes use to facilitate acute weight loss to 'make weight', detailed investigations are warranted.

METHODS: Thirteen professional male MMA athletes took part in a study across a normal training week (Monday to Saturday, including different technical and non-technical sessions), which assessed waking hydration status (measured via urine specific gravity (USG)) alongside training sweat losses, fluid intake, and net body mass (BM) changes. Additionally, we compared training sweat losses to a typical hot water immersion (HWI) protocol (20 min at 41 C, followed by 20 min wrapped in towels) used to induce sweat losses, to understand differences in active vs passive dehydration modalities (both commonly used to make weight). Comparison of daily USG, fluid balance variables between training sessions, and HWI vs sweat losses, were analyzed using one-way repeated measures ANOVAs.

RESULTS: Average hourly sweat losses, fluid intake, and BM changes were 1.30 ± 0.38 BM%, 898 ± 244 mL, and +0.12 ± 0.28 BM%, respectively. Significant differences with large effect sizes (d>0.8) in sweat rate and fluid intake between some sessions were found (p<0.0125), however no differences in BM changes were found between sessions. Average USG was 1.025 ± 0.004, with a significant linear trend found for USG to increase across the week (p=0.025). Differences between active and passive sweating were significant (p <0.00001). When comparing HWI to athlete's minimum, mean, and maximum sweat rates, HWI resulted in 4.09 ± 1.52 x, 2.26 ± 0.39 x, and 1.61 ± 0.26 x the BM losses, respectively.

CONCLUSION: MMA training results in sweat losses similar to average values reported in other sports. Training session type seems to affect sweat rates, however, athletes increase fluid intake in response, resulting in similar BM changes across all session types. When athletes have adequate fluid access, they are at little risk of meaningful dehydration during training. Fluid intake may be suboptimal outside of training times based on waking USG, and this may compound across a training week. However, it is not understood if confounding dietary or physical activity factors impact USG readings (e.g. proteinuria, haematuria, elevated creatinine). Finally, passive dehydration methods appear a more effective method of acute weight loss, based on the greater hourly sweat rate, and the absence of muscular fatigue induced. The caveat is that significant passive dehydration should only be implemented when athletes are provided the time to adequately recover post weigh-in, and athletes, coaches, and support staff are mindful of the heat stress associated with such techniques.

**THE ATHLETE-IQ: EVALUATING IRON KNOWLEDGE OF FEMALE ATHLETES AND STAFF; WITH INSIGHTS INTO PRACTICES AMONG DIETITIANS AND IRON EXPERTS.**

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INTRODUCTION: Iron deficiency (ID) is common in female athletes, with variable diagnostic criteria and supplementation protocols. Understanding iron rich food sources is fundamental to optimal nutritional intake. Our aim was to characterize the iron knowledge of female athletes and affiliated staff, and explore factors influencing ID practices among dietitians and iron experts.

METHODS: A cross-sectional design was employed using a web-based iron questionnaire. Part One consisted of 16 items (11 iron questions) and was completed by athletes and staff. Part Two consisted of 22 items (14 on ID practice) and was completed by dietitians and iron experts.

RESULTS: Sixty-two participants (athletes n=42; staff n=20) across 10 sports completed Part One. Iron knowledge scores ranged from 21% to 88% among athletes (46% ± 13%) and staff (60% ± 16%) . Twenty-eight practitioners (sports dietitians: n=14; other professions: n=14) across 28 sports completed Part Two. Between 10% and 56% of practitioners applied established criteria for diagnosing ID. Supplementation protocols varied between 20 to 100 mg/d or bi-daily of elemental iron for earlier stages of ID increasing to 60 to 200 mg/d or bi-daily for anaemic athletes.

CONCLUSION: Iron knowledge is highly variable in female athletes and club staff. Teams and organisations should promote valid nutritional resources when access to a sports dietitian is not feasible. Practitioners may adopt heightened criteria to categorise ID but should adjust individual thresholds based on factors underpinning fluctuations in iron status.

**INTERSEASONAL HYDRATION AND BODY COMPOSITION DYNAMICS IN YOUTH TEAM HANDBALL: INSIGHTS FROM BIOELECTRICAL IMPEDANCE ANALYSIS**

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INTRODUCTION: Team Handball is a high-intensity sport that places significant demands on both the cardiovascular and neuromuscular systems. Monitoring body composition and hydration is crucial for optimizing training and player selection among young athletes. Given the rapid physical development in this population, analyzing bioelectrical impedance variations over time can provide valuable insights into training adaptations and recovery. This study aimed to evaluate longitudinal changes in hydration status and body composition in elite under 17 (U17) male handball players using Bioelectrical Impedance Analysis (BIA).

METHODS: The body composition of 15 athletes (age: 16.44 ± 0.60 years) from the Italian U17 national handball team was assessed at four time points: the end of the competitive season (T0), the pre-season (T1), the start of the new season (T2), and before the winter break (T3). BIA measurements included stature-adjusted resistance (Rz/H) and reactance (Xc/H), phase angle (PhA), total body water (TBW), and the extracellular-to-total body water ratio (ECW:TBW). Changes in fat mass percentage (FM%) and fat-free mass percentage (FFM%) were also analyzed. Statistical analyses involved repeated measures of mixed models, with significance set at $p < .05$.

RESULTS: Rz/H significantly decreased at T2 (262.9 Ohm/m ± 26.1) compared to T1 (275.6 Ohm/m ± 27.8) and at T3 (249.7 Ohm/m ± 21.4) compared to T0 (269.7 Ohm/m ± 27.9), T1, and T2; Xc/H significantly increased at T1 (39.0 Ohm/m ± 3.7) compared to T0 (35.3 Ohm/m ± 3.6), then decreased at T2 (36.2 Ohm/m ± 3.2) and T3 (35.7 Ohm/m ± 3.4) compared to T1; TBW increased progressively from T0 to T4 (59.9% ± 3.6 to 61.1% ± 3.7, $p < .001$), while ECW:TBW decreased (41.1% ± 3.6 to 37.5% ± 1.9, $p < .001$); PhA, a marker of cellular health and membrane integrity, rose from 7.4° ± 0.5 to 8.1° ± 0.5 at T1, thus decreased to 7.8° ± 0.7 at T2 and finally increased to 8.1° ± 0.6 at T3 ($p < .001$); FM% showed a significant reduction from T0 to T3 (18 ± 4.5% to 16 ± 5.1%, $p = .006$) while FFM% exhibited the opposite trend, increasing significantly from 82 ± 4.5% at T0 to 84 ± 5.1% at T3 ($p = .006$).

CONCLUSION: Temporary dehydration patterns were observed during T1, likely due to environmental and training stressors, but these were mitigated as the competitive season progressed. Reductions in FM% and extracellular water, coupled with increases in PhA, FFM% and intracellular water, further supported improved hydration status and body composition. Changes in bioelectrical parameters reflect training stress, adaptations and recovery processes. BIA is a practical method for monitoring variations in body composition and hydration status in U17 handball players.

**THE RELATIONSHIP BETWEEN VEGETABLE INTAKE AND COOKING SKILLS IN FEMALE PHYSICAL EDUCATION COLLEGE STUDENTS**

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INTRODUCTION: The National Health and Nutrition Survey (2019) revealed that young women do not consume enough vegetables. Sasamaki et al. (2023) suggested that individuals with advanced cooking skills consume vegetables. This study aimed to clarify the relationship between vegetable intake and cooking skills in female university students majoring in physical education.

METHODS: Vegetable intake was measured in 435 participants using a vegetable check kit (Kagome Co. Ltd.) and a survey was conducted using Google Forms. The survey items included a food diversity score consisting of 10 foods (Kumagai et al. 2003) and vegetable preferences. Differences were observed in the frequency, technique, preference, and possession of cooking utensils were used for cooking. Cooking skills were according to Kasahara et al. (2023), with five points for each item and a 10-point scale for cooking skill scores. The group was divided into groups with high (n = 210) and low (n = 225) levels. High levels were classified as having an average vegetable intake level of 5.3 ± 0.9. To clarify the differences in vegetable intake levels, differences in food diversity and cooking technique scores were examined using a t-test. Differences in other items were cross-tabulated and examined using the chi-square test. The probability was < 5%.

RESULTS: Green and yellow vegetable scores (0.43 ± 0.50) in the high-level group were significantly higher than that in the low-level group ($p=0.041$); however, the food diversity score was 2.2-2.4 out of 10 ($p=0.159$) with no significant difference between the two groups. Vegetable preference differed significantly between the two groups, with 90% liking vegetables in the high-level group ($p<0.001$). Tomatoes, bell peppers, spinach, okra, paprika, asparagus, komatsuna, rapeseed flowers, lettuce, cabbage, and eggplant were significantly more disliked in the low-level group than in the high-level group. Half of participants in both groups liked cooking ($p=0.307$). In addition, cooking frequency did not differ significantly

between the two groups, and approximately 20% of the respondents cooked at least once a day (p=0.267). In contrast, measuring spoons, cutting boards, bowls, and induction stoves as cooking utensils were significantly more common in the high-level group than the low-level group. Cooking skill scores were significantly higher in the high-level group for "being able to make vegetable salads" (p<0.001), "being able to make spinach ohitashi" (p=0.033), and "overall score" (p=0.019).

CONCLUSION: Individuals with a low vegetable intake tended to dislike green and yellow vegetables. Providing cooking experiences with disliked green and yellow vegetables is necessary to increase the vegetable intake of female physical education university students along with developing cooking techniques to easily eat these vegetables.

**IS THE COMBINATION OF SODIUM BICARBONATE AND GLYCEROL BETTER THAN SODIUM BICARBONATE FOR HYPERHYDRATION?**

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INTRODUCTION: It is well established in the literature that dehydration can impair exercise performance. Hyperhydration is a strategy commonly used in sports before competing in the heat in order to increase the amount of fluids in the body before exercise, thereby delaying the onset of dehydration evoked by exercise. Glycerol (GLY) and sodium bicarbonate (BIC) have been investigated in isolation as hyperhydration agents to increase fluid retention and plasma volume expansion. However, no study has investigated the combined effect of both agents. Thus, this study aimed to compare the combined (GLY+BIC) and single (BIC) effects to a control (CON) condition on hyperhydration parameters.

METHODS: Ten healthy adults (3 females) were recruited for this randomized, single-blind study. The experimental trials consisted of three different conditions: Control (CON), sodium bicarbonate alone (BIC), and sodium bicarbonate and glycerol combined (BIC+GLY). Upon arrival at the laboratory, the subjects provided a urine sample (repeated every 20 min), a blood sample (repeated every 60 min), body mass (repeated every 20 min), and a gastrointestinal (GI) questionnaire (repeated every 20 min). For the intervention trials, the total dose of BIC (0.3g/kg) and, BIC+GLY (1.2g/kg), and 25mL/kg of body mass of water were administered in four equal aliquots every 20 minutes from baseline. The same procedures were followed in the CON condition using artificially sweetened water. A two-way repeated measures ANOVA with effect size calculations was used to identify differences between conditions across time. The Bonferroni post hoc test was used when a significant main effect was found. A two-tailed statistical significance was set at $p<0.05$.

RESULTS: No differences were observed across conditions for urine production ($F = 0.54$, $p = 0.59$, $\eta2 = 0.04$) and body mass ($F = 0.10$, $p = 0.88$, $\eta2 = 0.01$). Despite not being significant, the mean difference between conditions was substantial at 180 min (SB vs CON: 446 mL and SB+GLY vs CON: 409 mL). There was an interaction effect for urine specific gravity (USG) ($F = 5.1$, $p < 0.001$, $\eta2 = 0.34$), in which BIC+GLY presented higher values than CON after 80 min. Plasma volume was greater in SB+GLY only at 60 min (Condition: $F = 8.54$, $p = 0.002$, $\eta2 = 0.47$) (5.5 ± 8.6%) than in CON (-4.0 ± 4.7%) and SB (-3.2 ± 4.4%). Not surprisingly, SB ($F = 22.0$, $p < 0.001$, $\eta2 = 0.67$) and SB+GLY ($F = 26.9$, $p < 0.001$, $\eta2 = 0.71$) conditions reduced acidosis (pH) and improved buffering capacity ($HCO3$) during the protocol compared to CON. Mild GI discomfort was perceived during the protocol, with no effect of either condition or time (Interaction: $F = 0.81$, $p = 0.56$, $\eta2 = 0.10$).

CONCLUSION: Although SB or SB+GLY did not improve fluid retention, plasma volume was improved acutely in the SB+GLY condition, most likely induced by the glycerol. SB and SB+GLY induced significant alkalosis and improved buffering capacity compared to CON.

**AN EXPLORATORY STUDY OF SKIN CAROTENOID STATUS AS A MARKER OF FRUIT AND VEGETABLE INTAKE IN ELITE FEMALE MATCH OFFICIALS**

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INTRODUCTION: Fruit and vegetable consumption is recommended to contribute to the macro- and micronutrients required for a well-balanced diet, which serves as the foundation for effective sports nutrition strategies. Traditional methods to quantify fruit and vegetable consumption in athletes, such as dietary analysis, are time intensive and prone to error. Analysis of blood plasma carotenoid concentration is the gold-standard biomarker of fruit and vegetable consumption, however, this method is invasive. The Veggie Meter® is an optical device that provides rapid, non-invasive measurements of skin carotenoid status1,2. This study aimed to evaluate skin carotenoid status in elite female match officials using the Veggie Meter®.

METHODS: Skin carotenoid concentration was measured in three groups of elite female match officials: Football Referees (FOOT-R; n=27), Football Assistant Referees (FOOT-AR; n=34) and Futsal Referees (FUT-R; n=18). Match officials placed the index finger of their non-dominant hand onto the Veggie Meter® lens under a spring-loaded cover. The finger remained under topical pressure for ~10 seconds before removing and re-inserting twice to obtain an arbitrary score using reflective spectroscopy. Veggie Meter® scores were categorised based on fruit and vegetable intake as previously described3, anchored at 0-239 (severe shortage); 240-310 (shortage); 311-395 (average intake); 396-506 (good intake); >507 (excellent intake). Data were analysed using independent samples t-tests and reported as mean ± SD, with statistical significance set at $p < 0.05$.

RESULTS: Average Veggie Meter® score was 414 ± 92, with 1% of match officials categorized as having a 'severe shortage' of fruit and vegetable intake, 6% were categorized as 'shortage', 38% 'average', 37% 'good' and 18% 'excellent'. No differences were observed between FOOT-R, FOOT-AR and FUT-R (427 ± 92, 405 ± 78 and 410 ± 109, respectively, $p > 0.05$). Overall, 4% of FOOT-R were categorized as 'severe shortage', 7% 'shortage', 26% 'average', 44% 'good' and 19% 'excellent'. Results for FOOT-AR were 0%, 9%, 38% 32% and 21%, and FUT-R were 0%, 0%, 56%, 33% and 11%, respectively.

CONCLUSION: This is the first time that skin carotenoid concentration has been assessed using the Veggie Meter® to assess fruit and vegetable intake in elite female match officials. Whilst ~50% of match officials had 'good'/'excellent' intakes, ~50% were below the recommended classification ('good'). In addition, a greater percentage of FOOT-R were classified as 'good'/'excellent' in comparison to FOOT-AR/FUT-R. Future research is required to understand health and performance implications of low skin carotenoid scores in match officials and wider athletic populations.

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## Conventional Print Poster Presentations

### CP-PN23 Thermoregulation Tools and Mechanisms

**EXPLORING A NOVEL PASSIVE HEAT ACCLIMATION METHOD USING $CO_2$ WATER BATHS.**

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INTRODUCTION: Heat acclimation training enhances thermoregulatory adaptation; however, it can be time-consuming and physically demanding for athletes. As an alternative, passive methods such as hot water immersion have gained increasing attention (1). In particular, $CO_2$ hot water bathing imposes greater thermal stress than tap hot water bathing (our unpublished data), leading us to hypothesize that it may be effective for heat acclimation. Therefore, this study explores the feasibility of $CO_2$ water bathing as a novel heat acclimation method.

METHODS: Participants were 10 male college athletes. The acclimation trial consisted of whole-body $CO_2$ hot water bathing (40°C, 1000 ppm) for 10 min and resting for 5 min × 3 sessions × 3 days. During the trial, rectal temperature (Tre), skin temperature (Tsk), subjective indicators (thermal sensation (TS), and thermal comfort (TC)), heart rate, whole-body sweat loss (WBSL) and sweating sodium concentrations (Na) were measured. To assess heat acclimation, a heat stress test was conducted before and after the acclimation trial, in which participants cycled at 50% $VO_2$max until their rectal temperature reached 38.5°C. Heat acclimation effects were evaluated based on the time required to reach 38.5°C.

RESULTS: Mean exercise duration increased slightly but not significantly (Pre 38.7 ± 6.1 min, Post 39.6 ± 7.7 min, $p = 0.70$). WBSL and Na also showed slight improvements, but the changes were not significant (WBSL, Pre 1369.5 ± 387 g, Post 1394.5 ± 483.5 g, $p = 0.80$; Na, Pre 1619.0 ± 538.6 mmol/L, Post 1379.4 ± 454.8 mmol/L, $p = 0.099$). There was also no interaction effect for Tre; however, Tsk was significantly lower in the Post condition during exercise ($p < 0.05$). TS and TC were also significantly lower in the Post condition ($p < 0.05$).

CONCLUSION: A short, three-day acclimatation bath reduced Tsk, TS and TC during exercise. Since a decrease in Tsk is associated with a lower TS (2), this short acclimatation with CO2 baths may have contributed to a reduced subjective indicator during exercise in hot environment. These improvements in subjective indicators are important for athletes competing in sports (3).

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**HEAD, FACE AND NECK COOLING FOR PERFORMANCE: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Cooling the head, face and neck can have strong perceptual effects that contribute to improved performance. The aims of this systematic review were to; i) determine the effect of cooling strategies targeting the head, face and neck on physical and cognitive performance; ii) determine any associated physiological and perceptual responses; iii) synthesize any reported adverse events following the use of these strategies; and iv) provide practical applications for the use of these strategies to improve performance.

METHODS: We conducted a systematic review and multi-level meta-analysis, adhering to the PRISMA guidelines. Studies that investigated the effect of cooling strategies targeting the head, face, or neck on a physical or cognitive task using a controlled trial design were included.

RESULTS: Sixty-three studies were identified, involving 618 participants (86.6% male). Cooling strategies included water-perfused devices (18.7%); phase change neck collars (17.3%); fanning/cold air (14.7%); phase change headwear (13.3%); ice/gel packs (13.3%); cold towels (5.3%); menthol application (4.0%); water spraying/dousing (4.0%); or a combination of strategies (9.3%). The effect of cooling on both self-paced and fixed-intensity exercise tasks was inconclusive; the 95%CI of the pooled effect was compatible with no effect and medium beneficial effects, but not harmful effects. We were unable to pool cognitive data. Cooling reduced the skin temperature at the target site and improved thermal sensation and thermal comfort. Effects on heart rate, and core and mean skin temperatures were negligible. Adverse events were rare, and no intervention subgroup was superior.

CONCLUSION: The effect of cooling the head, face and neck on self-paced and fixed-intensity exercise tests was inconclusive, with both no and medium beneficial effects possible. We found no evidence of harmful performance effects. Cooling the head, face and neck reduced the skin temperature at the target site and improved thermal sensation and thermal comfort. There was no effect on heart rate, and effects on core temperature and mean skin temperature were so small they were considered physiologically negligible. Adverse events associated with the interventions were rare, and there was no report of any cooling strategy making a participant feel cooler and then pushing beyond their thermal limits, causing exertional heat illness. No intervention subgroup was superior, and hence, athletes are recommended to experiment with a range of rule-compatible and available head, face and neck cooling strategies, including different doses and timings, to determine the optimal strategy for their individual and sport context.

**EFFECT OF MUSCLE TEMPERATURE-INDUCED CHANGES IN BLOOD FLOW AND STIFFNESS ON MAXIMAL STRENGTH**

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INTRODUCTION: Athletes strive to achieve optimal performance in competitions, with warm-up or passive warming being commonly employed to enhance muscle function. Previous studies indicate that elevated muscle temperature can increase maximal muscle strength (1). This effect is hypothesized to result from increased blood flow to active muscles through vasodilation and enhanced contractility due to reduced muscle viscosity (2). Although this suggests that blood flow and muscle stiffness are related to maximal muscle strength, the direct relationship between muscle temperature-induced changes in blood supply, muscle stiffness, and performance enhancement remains unclear. Therefore, this study aimed to examine whether variations in maximal muscle strength following muscle temperature modulation through cold water immersion (CWI), hot water immersion (HWI), and neutral-warm water immersion (NWI) are attributable to changes in muscle blood flow and muscle elastic modulus.

METHODS: 12 healthy males participated in three conditions: CWI (10°C), HWI (40°C), and NWI (34°C). Lateral vastus muscle temperature, muscle shear wave velocity, and femoral artery blood flow were measured pre- and post-immersion. In addition, isokinetic maximal knee extension muscle strength was also measured post-immersion. Repeated-measures correlation analysis was conducted to assess intra-individual relationships between muscle temperature, blood flow, shear wave velocity, and maximal muscle strength in paired measurements collected multiple times across individuals.

RESULTS: The muscle temperature and femoral artery blood flow decreased in the CWI and NWI conditions, and increased in the HWI condition (all $P < 0.05$). The shear wave velocity showed no differences between conditions, as well as no main effects of time or interactions ($P > 0.05$). The maximal knee extension muscle strength was lower in the CWI condition than in the HWI and NWI conditions ($P < 0.05$). Additionally, repeated-measures correlation analysis revealed positive associations between muscle temperature and blood flow ($r = 0.66$, $P < 0.05$), muscle temperature and muscle strength ($r = 0.76$, $P < 0.05$), and blood flow and muscle strength ($r = 0.59$, $P < 0.05$), while there was no relation between muscle strength and shear wave velocity ($P > 0.05$).

CONCLUSION: These results suggest that the increase in maximal knee extension muscle strength induced by muscle warming may be attributed to enhanced blood supply to active muscles. In contrast, muscle stiffness remained unchanged with muscle warming and was not associated with maximal knee extension strength.

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**THE EFFECT OF A HIGHER AIR VELOCITY IN REDUCING THERMAL STRESS DURING EXERCISE IN HIGHER ABSOLUTE HUMIDITY CONDITION.**

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INTRODUCTION: Given that previous research has demonstrated that higher air velocity can reduce thermal stress during exercise in hot, dry conditions, it raises the question of whether this observation would hold true in more humid environ-

ments, where the evaporative capacity of the environment (Emax) is reduced due to higher absolute humidity, potentially limiting the cooling benefits of increased. The purpose of this study was to examined the effect of a higher air velocity in mitigating thermoregulatory stress under varying vapor pressure conditions.

METHODS: Twelve trained heat-acclimated males cyclists performed a 60 min of fixed-intensity cycling at 65% VO2peak across a high (HVP: 3.37 kPa) and moderate (2.69 kPa) vapor pressure conditions. The HVP environment was set at 310C and 75% RH. While the MVP was made up of two different conditions of MVP1: 310C and 60% RH, and MVP2: 250C and 85% RH. In each of these three conditions, participants performed trials at two air velocity settings: high velocity (HV: 4.5 m·s−1) and low velocity (LV: 2.8 m·s−1). Thermoregulatory and perceptual responses were recorded during exercise.

RESULTS: Tre was significantly lower in the HV compared to LV trial within each environmental conditions (HVP: 38.6±0.2 vs 38.4±0.2; P=0.004; MVP1: 38.5±0.2 vs 38.3±0.3; P=0.002; MVP2: 38.5±0.2 vs 38.4±0.2; P=0.007). Comparison between HVP and MVP1 also demonstrated the ability to lower Tre in HV trials (P=0.010). Tsk was significantly lower in the HV as compared with the LV trial in the MVP1 (33.54±0.53 vs 33.95±0.56; P=0.008) and MVP2 (30.78±0.80 vs 31.69±0.39; P=0.006) conditions. However, there was no significant difference in Tsk between HV and LV within the HVP condition (34.10±0.42 vs 34.39±0.52; P=0.061). Forehead sweat rate was significantly lower at HV compared to LV in the MVP1 condition (P = 0.046). However, in HVP conditions, no significant differences were observed in forehead sweat rates between HV and LV (P = 0.131). HR was significantly lower in the HV trial compared to LV in both MVP1 and MVP2 conditions (P = 0.010 and P = 0.021, respectively). Contrary, HR was not significantly (P = 0.970) different between HV and LV trials within the HVP conditions. Air velocity had no effect on perceptual responses of thermal sensation and thermal comfort during the fixed-intensity cycling (both $P \geq 0.057$).

CONCLUSION: This study highlighted that a higher air velocity was less effective in reducing thermoregulatory and circulatory strain in the higher vapor pressure. It was evident that higher air velocity significantly reduced thermal and cardiovascular strain in both MVP1 and MVP2 conditions. These observations are consistent with the earlier report by Saunders et al. (2005). This supports the notion that high humidity presents a formidable barrier to effective heat dissipation.

**A DIGITAL TWIN AND DECISION SUPPORT TOOL FOR EXERTIONAL HEAT-RELATED ILLNESS**

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INTRODUCTION: Exertional heat-related illnesses (HRI) such as heat stroke (EHS) continue to be a public health concern for recreational, athletic, and occupational sectors, with increasing incidence expected due to global warming. While the combination of high metabolic heat production and hot environments exacerbates the risk of HRI, potentially fatal EHS can still occur in cooler climates. Rapid recognition and management of individuals experiencing EHS is pivotal for improving patient outcomes. However, the multi-organ dysfunction and overlapping symptoms with other comorbidities makes early diagnosis of potentially fatal HRI challenging. The objective of this systematic review was to investigate the signs and symptoms associated with exertional HRI from published cases to inform the development of a decision support tool for HRI diagnosis and treatment.

METHODS: In accordance with the 2020 Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) and registering the review a priori (PROSPERO; CRD42024560456), a systematic search of relevant databases returned a total of 212 publications describing 463 cases of HRI occurring between 1932 and 2023 (EHS: n=333).

RESULTS: 70% of the reported EHS occurred during occupational tasks, with the majority during military training (50%). Wet bulb globe temperature ranged from 2.0 – 36.0°C (22.5±7.1°C). Sex was not reported in 7% of the cases and most EHS cases were male (male: 87%, female: 7%). Signs and symptoms (n=397) were identified among nine organ systems: cardiovascular (27%), nervous (24%), digestive (13%), respiratory (10%), urinary (10%), muscular (6%), integumentary (5%), endocrine (3%), and lymphatic (2%). Core temperature was reported in 93% of diagnosed EHS cases and exceeded 40°C in most (71%). Irrespective of core temperature, the most reported signs and symptoms were altered conscious state or unconsciousness (59%), tachycardia (55%), elevated levels of aspartate transaminase (44%), rhabdomyolysis (31%), hypotension (27%), sweating (25%), seizures/convulsions (23%), metabolic acidosis (22%), and tachypnea (20%).

CONCLUSION: Overall, heterogeneity of signs and symptoms between cases was observed. To address this, an interactive tool was developed to dynamically generate a HRI "digital twin" highlighting the most common signs and symptoms present based on user defined case characteristics (age, environment, activity, intensity, etc.). The digital twin HRI phenotype also provides a 'signs and symptom' map layer illustrating their co-presences and associations. This innovative decision support tool has the potential for ameliorating EHS recognition and reporting, to hasten the implementation of appropriate treatment strategies, and improve patient health outcomes.

**EFFECTS OF MID-COOLING VIA SINGLE ARM IMMERSION IN CARBONATED COLD WATER ON INTERMITTENT EXERCISE PERFORMANCE IN THE HEAT**

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INTRODUCTION: Intermittent sport athletes have been shown to experience hyperthermia (38.5°C to ≥ 39.5°C) during competitions (1), which may adversely impact muscle force output (2) and complex motor-cognitive function (3). Arm immersion in cold water is a practical mid-cooling intervention for intermittent sports. Adding CO2 to 25°C water induces

vasodilation, potentially increasing heat loss and hence the robustness of this cooling modality (4). We investigated the effect of half-time cooling via single arm immersion in cold CO2 water during intermittent exercise in the heat.

METHODS: In a repeated measures design, 8 men and 1 woman (maximal oxygen uptake: 46.4 ± 9.4 mL/min/kg) completed 3 trials of 2 × 39 min sprint cycling in the climate chamber (35°C, 54% relative humidity [RH]), interspersed by a 13-min single arm cooling outside the chamber (22°C, 65%RH): (1) cold water immersion (CWI, 9.6 ± 0.6°C); (2) cold CO2 water (CO2, 9.4 ± 0.5°C); and (3) control condition (CON). Rectal (Tre) and skin temperature (Tskin), heart rate (HR), working memory (serial 7), mean (MPO) and peak power output (PPO), thermal sensation (TS), thermal comfort (TC), rating of perceived exertion (RPE) and whole-body sweat loss (WBS) were assessed. Analyses were performed using linear mixed models with restricted maximum likelihood. Multiple pairwise comparisons following significant effects ($p \leq 0.05$) were performed using Tukey method.

RESULTS: During half-time, reductions in Tre were greater in CWI (-0.67 ± 0.34°C) versus CON (-0.52 ± 0.30°C, $p = 0.005$), but similar between CO2 (-0.63 ± 0.37°C) and CON ($p = 0.379$). Reductions in Tskin were greater in CO2 (-3.98 ± 1.02°C) than in CON (-2.95 ± 0.80°C, $p = 0.192$), but similar between CWI (-3.62 ± 1.07°C) and CON ($p = 0.080$). Decreases in MPO (CO2: -6.1 ± 4.5%; CON: -6.4 ± 3.8%; CWI: -2.7 ± 3.1%, $p = 0.112$) and PPO (CO2: 5.4 ± 6.8%; CON: -4.4 ± 6%; CWI: -1.7 ± 4.8%, $p = 0.280$) during the second-half were similar between conditions. WBS were similar between conditions (CO2: 2299 ± 692 mL; CON: 2341 ± 842 mL; CWI: 2347 ± 773 mL, $p = 0.777$). Whilst TS and TC were lower during half-time ($p < 0.001$), these were not based on condition ($p = 0.875$ to 936). The halftime cooling did not affect HR, working memory or RPE ($p > 0.05$).

CONCLUSION: Mid-cooling via CWI or CO2 did not decrease Tskin (difference of 0.66-1.03°C) or Tre (difference of 0.1-0.14°C) appreciably more than CON. Hence, there was minimal influence on cognitive accuracy (i.e., working memory) and physical performance during high-intensity exercise in the heat. Mid-cooling should be reconsidered when half-time are undertaken in cooler environments.

**FATIGUE INDUCED BY WORKING IN HOT CONDITIONS: A SCOPING REVIEW**

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INTRODUCTION: Fatigue is a common symptom in occupations with high physical and/or cognitive demands. It not only reduces work productivity but also heightens the risk of workplace injuries. Environmental factors such as temperature and humidity can contribute to the development of fatigue or its exacerbation. The combination of increasingly hotter temperatures that expose workers to heat strain and the relation between heat stress, fatigue, and occupational injuries provide a strong rationale for a thorough and timely review aiming to map existing knowledge on how fatigue induced by working is influenced by hot condition.

METHODS: A search was conducted in 10 databases to identify relevant studies on fatigue during work in the heat. Included studies focused on fatigue in an occupational context under hot environments (≥25°C), with fatigue triggered by a fatiguing task and a subsequent impact on an occupational-specific/related performance outcome. Data about the (i) study, (ii) participants, (iii) fatiguing task, (iv) environmental conditions, and (v) performance task characteristics were extracted.

RESULTS: A total of 29 experimental studies were included, with 24 studies conducted in laboratory settings and 5 in field conditions. Of these, 57% included a temperate control condition. Most studies (90%) were conducted in countries with a high development index and involved 406 participants (87% males, 13% females). Average age of participants was 31±7 years old (range: 20-50) and only 6 studies included employed workers. Concerning the fatiguing tasks, 89% of studies used physical tasks, only 1 used a cognitive task, and 2 used subsequently cognitive then physical tasks. The average duration of tasks was 119±215 minutes (range: 30-720), with an average ambient temperature of 34±4°C (range: 26-46) and relative humidity of 42±10% (range: 24-60). To attest of the presence of fatigue, most studies (85%) used subjective variables (e.g., increased perceived fatigue). Concerning the performance tasks, only 4 studies used occupational-specific tests (e.g., box lifting), while others employed non-specific tests. Approximately 33% of studies evaluated both cognitive and physical performance, 10% focused on cognitive performance only (e.g., Stroop test), and 57% assessed physical performance only (e.g., maximal force). Only 46% of all studies reported a significant decline in performance after fatiguing tasks, and 31% found a significantly greater decline in performance in hot conditions compared to temperate conditions.

CONCLUSION: This review highlights that relatively few studies have focused on fatigue induced in hot environment on performance outcome related to work. Most studies have been conducted in high development index countries within laboratory settings. The results identify a need to employ more occupationally-relevant simulations in laboratory settings or conduct additional field studies to further understand how hot environments might affect fatigue in occupational contexts.

**THE COOL FOREARM – MECHANISMS OF SKELETAL MUSCLE HYPOPERFUSION DURING COLD STRESS.**

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INTRODUCTION: Cold exposure reduces blood flow to exercising skeletal muscle. However, whole-body cold stress induces hypometabolism and systemic hemoconcentration thereby increasing oxygen content. This study aimed to determine whether restoring oxygen content normalizes exercise blood flow to normothermic levels.

METHODS: In an environmental chamber (terraXcube, Italy), 12 healthy individuals were cold stressed (ambient temperature, 10°C; relative humidity, 55%) for a period of 24h. Physical activity, clothing, nutrition, and fluid intake were controlled. Participants performed rhythmic (1:2 work rest ratio) handgrip exercise at 25% of their maximal voluntary contraction for 3 minutes. At baseline and after 24 hours of cold stress, mean skin (8-site thermocouples) and core temperature (rectal thermistor) were measured. Thereafter, brachial blood flow (ultrasonography) in combination with antecubital venous blood samples were measured at rest and during handgrip to calculate forearm blood flow, oxygen delivery, A-VO2diff and oxygen consumption. Blood pressure (finometer, electrosphygmomanometer) was measured at rest and during exercise to calculate forearm vascular resistance. In a subset (n=6), muscle temperature (hypodermic needle thermocouple) was assessed and targeted hemodilution (PV; Sterofundin®) was performed to reverse the expected cold induced hemoconcentration and normalize oxygen content.

RESULTS: 24h at 10°C reduced mean skin (Δ-4.6°C; p<0.001; n=12), rectal temperature (Δ-0.8°C; p<0.001; n=12), forearm skin (Δ-4.13°C; p=0.002; n=12) and muscle temperature (Δ-4.61°C; p=0.027; n=6). Moreover, hemoglobin and thus arterial oxygen content increased (p <0.001; n=10). 24h at 10°C reduced forearm oxygen consumption during exercise (p=0.033, n=7), Surprisingly, 24h at 10°C had a variable effect on exercising muscle blood flow (p=0.16; n=11), albeit it was statistically reduced in the subsample (p=0.04; n=5) as was a trend in oxygen delivery (p=0.06; n=5) whereas A-VO2diff (p=0.40; n=5) remained at thermal neutral values. Hemodilution effectively restored hemoglobin concentration to normothermic values (BL, 14.9±1.4; Cold, 16.2±1.1; hemodilution, 15±0.7, p<0.001; n=5), yet had almost no impact on forearm blood flow (211±106 vs. 205±88 mL/min, p=0.71; n=5).

CONCLUSION: During prolong periods of whole-body cold stress, muscle temperature is reduced and the reduction in muscle blood flow during exercise seems primarily due to cold induced hypometabolism and not the systemic hemoconcentration.

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**SELF-PACED PHYSICAL WORK IN THE HEAT: THE HIGHS AND LOWS OF CORE BODY TEMPERATURE INDICES**

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INTRODUCTION: Measurement and monitoring of core body temperature (TCore) in field-based settings is fundamental to understanding the magnitude and consequences of excessive heat exposure. Rectal temperature (TR) and gastrointestinal temperature (TGI) are accurate and well-correlated indices of TCore in laboratory-based studies yet are either incompatible (TR) or have logistical and interpretive challenges (TGI) with use in the field. Subsequently, estimating TCore from continuous heart rate measures (TECT) is an attractive alternative. However, it is unclear how typical in situ responses to heat stress such as self-pacing, fluid intake and rest influence TGI and TECT measures. Therefore, this study aims to examine the influence of a rest and hydration intervention on TGI, TR, and TECT indices of TCore during self-paced work in the heat.

METHODS: In a pseudo-randomised crossover order, 8 participants (23 ± 2 yrs; 5 male; VO2max: 45.7 ± 7.7 mL/kg/min) completed two 2-h cycling time trials in hot conditions (38°C, 30% relative humidity), one with a mandatory rest (REST; 10-min seated rest after 1-h, access to cool water [~8°C]) and one without (NO-REST; no mandatory rest, access to room temperature water [~33°C]). In both trials participants were asked to cycle as far as possible while maintaining an RPE of 12-14 and could rest at any time with water available by dismounting the bike. TCore indices were continuously measured via rectal, gastrointestinal (pill ingestion ~54 min prior by design) and estimated from continuous heart rate measures. Paired t-tests (REST vs. NO-REST) and two-way RM ANOVAs (trial [REST vs. NO-REST] x core [TR vs. TGI vs. TECT]) were performed.

RESULTS: Distance covered was greater in NO-REST compared to REST (41.7 ± 6.1 km vs. 39.1 ± 5.0 km; p<.01), although mean power output when cycling was similar (NO-REST: 101 ± 37 W, REST: 99 ± 34 W; p=.20). Maximum TCore differed between TCore indices (core: p<.01), irrespective of trial (trial: p=.10; core x trial: p=.98). Maximum TECT was higher than TGI (+0.58 ± 0.44 °C; p<.01) and TR (+0.39 ± 0.40 °C; p=.02), but was similar between TGI and TR (p=.40). Average TCore differed between TCore indices (core: p<.01), irrespective of trial (trial: p=.10; core x trial: p=.29). Average TGI was lower than TR (–0.38 ± 0.37 °C; p=.05) and TECT (–0.69 ± 0.55 °C; p<.01), with no difference between TR and TECT (p=.12). Following drinking, TGI nadir was similar between trials (p=.13), decreasing below resting TGI by –0.7 ± 1.0 °C and –1.3 ± 1.2 °C during NO-REST and REST, respectively.

CONCLUSION: Despite fluid consumption strongly influencing measures, maximal TCore appeared to be reliably captured via TGI. Conversely, while TECT overestimated maximal TCore, average TECT matched TR during exercise in the heat. This introduces interpretive considerations when conducting field-based heat strain assessments, as the assessment's aim (i.e., cumulative strain vs. exertional heat stress risks) may determine the most appropriate measurement method.

Conventional Print Poster Presentations

CP-SH10 Mentoring / Coaching II - Elite Athletes

**UNDERSTANDING RELATIONSHIP QUALITY IN SPORT PSYCHOLOGICAL COUNSELING: A LONGITUDINAL STUDY ON THE ROLE OF RELATIONSHIP-INFLUENCING ATTRIBUTES IN ADOLESCENT ELITE SPORTS**

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INTRODUCTION: The relationship quality between an athlete and a sport psychology practitioner is regarded as a critical factor for successful sport psychological counseling (e.g., perceived improvement of performance or well-being) [1][2]. However, there is limited understanding of specific mechanisms underlying it. In the psychotherapy setting, certain relationship-influencing attributes of the practitioner–such as perceived trustworthiness, expertness, and attractiveness–have been shown to influence relationship quality [3]. Thus, this study aims to examine the extent of perceived relationship quality and relationship-influencing attributes in sport psychological counseling (i.e., athletes' perception of trustworthiness, expertness, and attractiveness) and their stability over time.

METHOD: As part of a longitudinal study, 14 adolescent elite athletes from German state teams (15.14±1.29 years; 57.1% female, 42.9% male) participated in a survey following their first and fifth counseling sessions. The sample is expected to reach N = 60 by the time of the conference. Relationship quality was assessed using the QS17 scale [4], measured on a 4-point Likert scale while relationship-influencing attributes were evaluated using the CRF scale [3] on a 6-point Likert scale with a maximum score of 24. Paired-sample t-tests analyzed changes over time.

RESULT6

Following the first session, the mean relationship quality was 3.76±0.25, and 3.84±0.21 after the fifth session. Mean CRF scores after the first session were 23.36±1.01 for trustworthiness, 22.79±1.25 for expertness, and 22.93±1.64 for attractiveness. After the fifth session, mean scores were 22.71±1.90, 22.57±1.70, and 22.71±2.02, respectively. Paired-sample t-tests showed no significant changes over time in either relationship quality (p=.37) or relationship-influencing attributes, including trustworthiness (p=.24), expertness (p=.68), and attractiveness (p=.65).

DISCUSSION: Preliminary findings (n = 14) suggest that relationship quality and relationship-influencing attributes may remain stable over time in sport psychological counseling in adolescent elite sports. This stability could indicate that initial impressions form early and persist, aligning with psychotherapy research [5]. This study is the first to longitudinally examine relationship quality and relationship-influencing attributes; however, additional data (expanding from n = 14 to N = 60) is required to further support these initial findings. Understanding the mechanisms behind the initial impression is essential for optimizing sport psychological counseling, particularly by strengthening the initial practitioner-athlete interaction in terms of trustworthiness, expertness, and attractiveness.

1. Kleinert (2014) 2. Andersen & Speed (2010) 3. Corrigan & Schmidt (1983) 4. Kleinert & Ohlert (2014) 5. Bowker et al. (2024)

**DEVELOPING A METHOD TO SUPPORT COACHES' PRACTICAL KNOWLEDGE ACQUISITION: A CASE STUDY OF YOUTH TENNIS COACHING**

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INTRODUCTION: The knowledge required of coaches includes professional knowledge, interpersonal knowledge, and intrapersonal knowledge [1]. Professional knowledge has long been the subject of coach education, and an environment has been developed to support its acquisition [2]. In contrast, interpersonal knowledge and intrapersonal knowledge are characterized as practical knowledge, and the development of an environment to support the acquisition of this knowledge is insufficient [3]. Therefore, the purpose of this study was to develop a method to help sports coaches acquire practical knowledge.

METHODS: This study focuses on pattern language, a methodology for systematizing and describing the practical knowledge of experts in an accessible format. In recent years, it has been increasingly applied in fields such as education, welfare, and management [4]. This study marks its first application in sports.

In this study, interviews were conducted with seven Japanese expert youth tennis coaches to explore their practical knowledge in helping players achieve their goals. The findings were systematized and documented in the form of a pattern language.

Building on this, an accompanying support program was designed and implemented with four Japanese youth tennis coaches, utilizing the developed pattern language. Specifically, one-on-one sessions were conducted approximately once a week for a total of four sessions, utilizing the pattern language. A qualitative inductive analysis was conducted on the verbal data from the sessions and follow-up interviews to examine the program's impact on the coaches.

RESULTS: The practical knowledge of expert youth tennis coaches was documented as 36 patterns. These patterns were then categorized into three categories: "Fostering a Foundational Relationship," "Leading to High Performance," and "Developing Autonomy Together."

Within the accompanying support program utilizing pattern language, changes were observed in both coaching practices and perceptions. Specifically, through the program, coaches engaged in "Practices Beyond the Limits of Individual Ideas" and "Practices That Are Important but Previously Untried." Furthermore, "Willingness to Continue Practicing" was confirmed, indicating that these practices were sustained beyond the program's completion. Moreover, changes in perceptions were observed in "Deeper Self-Understanding" and "Revision of Personal Coaching Theories."

CONCLUSION: Utilizing the pattern language developed from the practical knowledge of expert coaches was suggested as a potential trigger for coaches to acquire practical knowledge. By continuing to engage in practice after completing the program, participants are expected to further develop their practical knowledge.

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**EFFECTS OF MUSIC LISTENING ON ANAEROBIC PERFORMANCE AND MOTIVATION IN HEALTHY YOUNG ADULTS**

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INTRODUCTION: Music has long been incorporated into training sessions for both competitive and non-competitive athletes. Numerous studies confirmed its ability to enhance strength, sprint, and endurance performance, by affecting three key dimensions of human nature: psychological, physiological, and psychophysiological (1). However, conflicting evidence exists regarding the effectiveness of music, which may be influenced by differences in music selection, individual preference, and gender (2). This study aimed to investigate, from both physiological and psychological perspectives, whether motivational music influences anaerobic performance (3) in the Running-Based Anaerobic Sprint Test (RAST).

METHODS: Eighteen athletes (male = 12, female = 6) competing at a sub-elite level in track and field and football (age: 22.2 ± 2.1 (m ± SD) years; height: 175.3 ± 8.0 cm; mass: 66.4 ± 10.6 kg; BMI: 21.5 ± 2.2 kg/m²) were voluntarily recruited. The RAST procedure was conducted while participants listened to either preferred music or no music through headphones. Measurements included maximum power (Pmax), average power (Pmean), minimum power (Pmin), rating of perceived exertion (RPE), and motivational level assessed using a Visual Analogue Scale (VAS). The "music" and "no-music" conditions were compared by paired Student's t-test or by Wilcoxon signed rank test, where appropriate. Effect size (ES) was quantified using Cohen's d index for paired data.

RESULTS: No significant differences were observed between the "music" and "no-music" conditions for Pmax ($p = 0.50$, ES = 0.04, very small), Pmean ($p = 0.25$, ES = 0.28, small), and Pmin ($p = 0.053$, ES = 0.52, medium). The difference between conditions was also not statistically significant for RPE ($p = 0.71$, ES = 0.08, very small). However, VAS was significantly higher in the music condition compared to the no-music condition ($p < 0.001$, ES = 1.31, very large).

CONCLUSION: Motivational music can enhance motivation during high-intensity, repeated exercise without directly improving anaerobic performance, as supported by previous studies (3). Athletes can use music as a natural and cost-effective tool to boost motivation and strive toward higher goals while ameliorating their current performance level. Furthermore, as high-intensity exercise enhances overall well-being in the general population, incorporating music into exercise routines may play a role in improving training adherence and motivation, even in non-competitive settings.

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**EXPLORING ATHLETES' PREFERENCES FOR STRENGTH AND CONDITIONING COACHES' LEADERSHIP BEHAVIOURS IN COACHING: A MIXED-METHODS STUDY AT A BRITISH UNIVERSITY**

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INTRODUCTION: Understanding athletes' preferences for strength and conditioning coaches' leadership behaviours in coaching contributes to coaching effectiveness. While research in this area has increased in recent years, no mixed-methods (MM) research exists. Therefore, we explored athletes' preferences for strength and conditioning coaches' leadership behaviours in coaching.

Method: Informed by pragmatism, we integrated quantitative and qualitative data to evaluate a confirmation or divergence of results. A survey using the 5-point Likert Revised Leadership Scale for Strength and Conditioning (RLSSC) was completed by 49 British university athletes (male = 25, female = 24), with 13 (male = 5, female = 8) agreeing to participate in the follow-up interviews. Data analyses included summary statistics, template thematic analysis, and MM integration through primary data analysis. Cronbachs alpha coefficients, existing content, construct validity of the RLSSC, audit trail, parallel questions, and database triangulation were used to confirm reliability and validity.

RESULTS: Training and instruction, situational consideration and positive feedback behaviours ranked the highest (median = 4.0), social support and democratic behaviours ranked moderately (median = 3.5 and 3.0, respectively) and autocratic

behaviours ranked lowest (median = 2.5). Qualitative results confirm and expand quantitative findings by providing contexts in which behaviours are mostly preferred. Integrated MM analysis highlights how behaviours cannot be evaluated independently from context and that strength and conditioning coaches should exhibit adaptability and a genuine interest in developing personal connections.

Discussion: Athletes appreciate a balanced coaching style where autocratic and democratic behaviours are used selectively, recognising the value of authority but prioritising collaboration, especially in goal-setting. Positive feedback and instructions grounded upon strength and conditioning knowledge are highly valued when genuine and contextually appropriate and are provided during significant efforts, heavy lifting or learning new techniques. Additionally, athletes prefer coaches who show empathy and strong social interaction skills while maintaining professional boundaries and the ability to consider situational factors to set achievable goals. Coaches can use this knowledge to inform and adapt their practice, engage in self-reflection, and consider key behaviours contributing to their personal and professional development. Ultimately, these findings encourage coaches to approach their development and practice with curiosity, humility, and a desire for lifelong learning.

**INTUITION OR REFLECTION? COGNITIVE PROCESSING AND PERFORMANCE IN ESPORTS**

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Introduction: Esports (electronic sports) have evolved into a hyper-competitive, professionalized, and organized setting. They share similarities with other professional sports where individuals and teams strive to optimize their performance. Although cognition is essential in esports, research on the topic and its link to performance remains scarce [1]. The purpose of this paper is to examine whether cognitive processing predicts performance of professional esports athletes. In doing so, this study applies the dual-process theory framework, describing two qualitatively different modes of cognitive processing—Type 1 (intuition) and Type 2 (reflection) [2]. To the best of our knowledge, this study is the first to examine how esports athletes employ Type 1 and Type 2 cognitive processing and their relationship to performance.

Research question: Does Type 1 and Type 2 cognitive processing predict performance in esports athletes?

Methodology: The study adopts a quantitative approach by analyzing digital trace data of esports athletes during performance episodes. In doing so, videos and transcribed audio data from the esports title Teamfight Tactics will be leveraged. After coding and categorization based on criteria of cognitive processing types from the dual-process theory literature, data will be analyzed.

Results: Within the full paper, statistical analysis will be carried out to investigate the relationship between Type 1 and Type 2 cognitive processing and performance. Specifically, variables used are: frequency, strategic planning, self-reflection, and situational analysis, as well as the dependent variable game performance. In addition, the influence of variables (e.g., player experience, game state, and rank) will be investigated. Lastly, the association between game states and cognitive processing types will be analyzed.

Discussion: Key findings will be discussed in relation to existing literature. Furthermore, practical implications for practitioners will be highlighted. Furthermore, the study will suggest guidance for future research in esports and cognition, especially the potential of employing digital trace data from gaming in both fields.

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**INJURIES, INJURY TIME AND EMOTIONAL DIRECTION IN GYMNASTS AND OTHER HIGH-PERFORMANCE ATHLETES**

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Emotions play a crucial role in sports performance, being key to success at high levels. Depending on the sport practiced, coping resources vary in the face of injury. At a young age, preventing injuries is a priority, as they affect negative emotions and anxiety. As the age and level of performance increases, the severity of injuries increases, especially in artistic gymnastics, the second discipline with the highest incidence of injury.

METHODS: Participants.307 athletes aged between 8 and 18 years (M=15.11; SD= ±2.44 in individual and collective disciplines; M=12.29; SD=±2.48 in artistic gymnasts), equivalent in competitive experience (M=6.27; SD=±2.43 years) and performance level (national-international).

Instruments. Differential Emotion Scale (mDES), α=0.82, spanish version adapted to sports population.

RESULTS: In individual and team sports, the distribution of injured and non-injured is similar (ϕ=-0.17; p=0,010).In artistic gymnastics, the injured (62) significantly outnumber the non-injured (30) (z=3.34; p<0,001).In individual and team sports, Short and Long-term injuries predominate (ϕ=-0.27; p=0,014), while in artistic gymnastics Short-term injuries are significantly more frequent (z=2.98; p=0,003) than Medium and Long-term injuries (z=5.58; p<0,001).Positive and moderate

correlations were found between Number of Injuries and Negative Emotions (0.27; p=0,041). In addition, there were significant differences in Negative Emotions (F(2/204)=4,99; p=0,008; η2=0,05), with a tendency to increase with Time of injury. No significant relationships were found between Sex and Time of injury (ϕ=-0.13; p=0,190), Sex and Number of injuries (ϕ=-0,09; p=0,113), nor Field of competition (ϕ=-0,05; p=0,409), indicating similar distribution between men and women, as well as between competitive levels.

Discussion: The high incidence of injuries in artistic gymnastics coincides with previous studies, being attributed to the risks inherent to the discipline and high demand from a very early age.

However, it disagrees with research that associates a higher level of performance with longer injury time.In individual sports, injuries due to overuse and mechanical stress predominate, explaining their short duration, while in team sports, acute injuries due to contact stand out.Regarding emotions, the results are consistent with previous studies that found that individual athletes maintain stable levels of positive emotions in the face of injury, which could be an adaptive strategy in sports with greater emotional independence.On gender, the findings differ from the ones that reports higher rates of certain injuries in women due to anatomical and biomechanical differences, while in men, injuries are linked to direct contact.The results are consistent with previous studies regarding the insignificance between injury time and sex.

Further studies on high performance injuries are needed to reduce their occurrence and promoting longer and more successful sports careers

**INTEGRATING PSYCHOLOGICAL SKILLS WITH SWIFT-SMART MOTION PATTERN TRAINING ON YOUNG BADMINTON PLAYERS FOOTWORK AGILITY PERFORMANCE**

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Badminton is the fastest and most demanding racket sports globally, requiring athletes to excel in physical, technical, and psychological domains to achieve peak performance. Footwork agility is a critical physical attribute in badminton performance as it forms the foundation for executing quality technical skills. The Swift-Smart Motion Pattern (SSMP) training program was developed with a combination of shadow drills powered by the Onigoe device, a technology specifically built for badminton footwork agility. These drills are designed for badminton that encompasses the entire court, including the front, mid (side), and rear court zones. Within each zone, it addresses the two key corner positions encountered during gameplay with data-driven feedback. Although Psychological Skills Training (PST) has been established as a technique to enhance mental skills and improve sports performance, the interaction between PST and badminton footwork agility has received little attention. To address these research gaps, this study examines the effectiveness of a comprehensive PST program integrating goal-setting, self-talk, and their combination with SSMP training on badminton footwork agility. The study involves three intervention groups—SSMP with goal-setting (GS), SSMP with self-talk (ST), and SSMP with combined goal-setting and self-talk (GS + ST) and a control group (SSMP only) to establish a baseline for comparison. This study aimed to examine the effectiveness of the SSMP training program combined with psychological skills on badminton footwork agility. Eighty (N=80) participants aged 12-16 years from Duo Sparks Badminton Academy, Malaysia were randomly divided into four groups: Goal-Setting + SSMP (n=20), Self-Talk + SSMP (n=20), Combined Goal-Setting and Self-Talk + SSMP (n=20), and a Control Group that only followed the SSMP training program (n=20). There was a statistically significant difference in front court of badminton footwork agility within pre test and post test [ $F(1,3) = 22.51$, $p < 0.05$ ] and between groups [ $F(1,3) = 2484.5$, $p < 0.05$ ], mid-court of badminton footwork agility within pre test and post test [ $F(1,3) = 20.15$, $p < 0.05$ ] and between groups [ $F(1,3) = 3020.7$, $p < 0.05$ ] and in rear- court of badminton footwork agility within pre test and post test [ $F(1,3) = 20.14$, $p < 0.05$] and between groups [ $F(1,3) = 3020.7$, $p < 0.05$]. The Self-Talk group showed significantly higher performance in the front court ($M = 2.3$, $SD = 0.59$), mid-court ($M = 1.88$, $SD = 0.35$), and rear-court ($M = 2.29$, $SD = 0.51$); $p < .05$. The findings suggest that the Self-Talk intervention is the most effective psychological skills intervention in enhancing training efficacy for badminton footwork agility performance. In conclusion, this study provides valuable insights of swift-smart motion pattern (SSMP) training program with psychological skills training in enhancing badminton footwork agility.

## Conventional Print Poster Presentations

### CP-SH14 Psychology VI - Stress and Anxiety

**TSST-VR AND STRESS REACTIVITY: A MULTISYSTEM ANALYSIS OF ENDOCRINE, METABOLIC, CARDIOVASCULAR, AND PSYCHOLOGICAL RESPONSES**

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Background: The Trier Social Stress Test (TSST) is a widely used tool for inducing and measuring stress responses in a controlled environment. In this study, we aimed to explore the effectiveness of a virtual TSST (TSST-VR) in eliciting stress responses across multiple physiological and psychological markers.

Methods: A sample of 24 participants underwent the TSST-VR, during which salivary cortisol, alpha-amylase (AA), blood glucose levels, heart rate (HR), root mean square of successive differences (RMSSD) as a measure of heart rate variability (HRV), and subjective stress ratings (NRS) were collected at multiple time points.

Results: In a baseline-to-peak analysis, significant increases were observed in HR (MDiff = 13.04, 95%-CI [8.19 – 17.90], $p < .001$), RMSSD (MDiff = 17.75, 95%-CI [3.28 – 32.22], $p < .001$), AA ($p < .001$, $r = 1.07$), and NRS ($p < .001$, $r = 1.31$) measures following the TSST-VR. While no significant changes in cortisol levels were found in the baseline-to-peak analysis across all participants, a secondary cluster analysis identified distinct cortisol responders (baseline-to-peak rise > 1.5 mmol/l). Within this group, high cortisol responders (HCR) showed significantly higher cortisol (Wald $\chi^2(7) = 118.03$, $p < .001$), HR (Wald $\chi^2(8) = 17.91$, $p = .022$), and AA levels (Wald $\chi^2(7) = 17.13$, $p = .017$) compared to low cortisol responders (LCR). Area-under-the-curve analysis further confirmed a more robust cortisol stress response in HCR.

Conclusion: These findings suggest that the TSST-VR can effectively induce measurable stress responses and may provide insights into individual differences in physiological and metabolic stress reactions. The study highlights the potential of virtual stress paradigms in stress research and underscores the advantages of a virtual setting in terms of standardization and economic considerations.

**ADAPTIVE AND MALADAPTIVE FEATURES OF EXERCISE AS COPING WITH PERCEIVED STRESS - A SCOPING REVIEW OF THE UNDERPINNING RESEARCH**

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Introduction: Exercise has been suggested as relevant coping to attenuate detrimental health effects connected to perceived stress. However, research addressing exercise as coping in a healthy population is scarce. Moreover, the adaptive features of exercise as coping is usually exclusively highlighted. Few papers have addressed exercise as maladaptive coping in a healthy population, e.g. connected to the risk of exercise addiction. Thus, the literature base might be limited and polarized, with scarce literature addressing both adaptive and maladaptive features. Aim: The purpose of this study was to review the literature underpinning exercise as coping in a healthy population, including current knowledge gaps. We aimed to highlight key features and themes in the research underpinning exercise as adaptive or maladaptive coping – or both. Design and methods: In this scoping review, we conducted a systematic search in the databases Web of Science, PubMed, PsycInfo, Scopus, and SPORTDiscus. We used a combination of exercise terms (general, strength training, endurance exercise and yoga) and perceived stress terms, together with coping terms, targeting papers addressing exercise as coping with perceived stress in a healthy population. The data-base search was followed by a reference-list search in 30% of the included articles. Both quantitative and qualitative papers were included. Key information about population, design and methods, and exercise mode was collated. To further exhaust the material, an in-depth analysis was applied, generating codes and overreaching themes in the research. Results: The literature search resulted in 483 papers, of which 80 were retrieved in full text. The reference list search contributed with three additional papers. 47 papers were included in the analysis. We found that cross-sectional studies applying quantitative methods dominated the research. The papers mainly reported from mixed gender populations, addressing general physical exercise. For the specified articles, students were the most studied population and yoga the most addressed exercise mode. Overall, few papers were oriented at maladaptive features of exercise, with one paper addressing these exclusively. The rest of the research emphasized adaptive features of coping or were neutrally oriented. We identified four overreaching themes in the research: establishing exercise as adaptive coping, explaining exercise as adaptive coping, complicating exercise as coping and questioning exercise as coping. Conclusion: Our findings suggest that research addressing exercise as coping in a healthy population portray mainly adaptive features. Qualitative findings about exercise as coping, that can provide in-depth knowledge about the nuances, underlining both adaptive and maladaptive features, is lacking. Understanding exercise as coping is important in preventing negative outcomes related to perceived stress in a healthy population.

**PSYCHOBIOSOCIAL STATES IN ARTISTIC GYMNASTICS: DIFFERENCES BY TYPE OF APPARATUS**

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Artistic gymnastics (AG) is one of the main closed-skill sports where athletes perform as planned and within a stable environment. Specifically, in this discipline of gymnastics, athletes usually perform short routines on different types of apparatus that can be distinguished in floor exercises and equipment ones (i.e., balance beam, vault, uneven bars, pommel vault, high bar, etc.). Despite the stable environment, the aerial actions in AG challenge and motivate the athletes, elevate and enrich the routines, yet they can intimidate athletes (Duarte et al., 2015) sometimes discouraging them from competing in (major) tournaments. Precisely, this study aimed to unveil the differences between floor and equipment exercises in functional and dysfunctional psychobiosocial states (PBS-S) experienced by AG athletes in Italy. Ninety-eight athletes with a mean age of 29 years (SD = 8,03) were recruited. They were asked to think about their routines on the floor and the equipment and reply twice to PBS-S scale (Robazza et al., 2016). A within-subjects multivariate analysis of variance was performed using the type of apparatus (floor vs equipment) as a factor. Statistical analysis yielded significant differences in PBS-S usually experienced during floor and equipment exercises ($\lambda = 0.885$, $F(2, 96) = 6.240$, $p = 0.003$, $\eta p2 = 0.115$, Power = 0.886). Moreover, univariate analysis of variance showed significant differences both for functional_F (1, 97) = 5.604, $p = 0.020$, $\eta p2 = 0.055$, Power = 0.649) and dysfunctional_F (1, 97) = 12,589, $p = 0.001$, $\eta p2 = 0.115$, Power = 0.940)

PBS-S. In particular, AG athletes experienced higher levels of functional PBS-S during floor routines compared to equipment, while dysfunctional PBS-S seem to mainly characterize routines on the equipment. These results could be ascribed to the fact that, in the case of the floor, the gymnasts own body is "free" to perform evolutions and figures. Moreover, injuries are more frequent during the final part of the exercise —particularly during the so-called "exits" or in the jumps and landings of aerial acrobatics—because these moments tend to be unpredictable, especially when performed on gymnastics equipment. This unpredictability, as well as the use of an external apparatus, which implies an increased challenge, can contribute to dysfunctional emotions. A better understanding of functional/dysfunctional emotions, like the responses to their manifestation, can aid coaches in adopting strategies to prevent the interference of fear (for example) in the gymnast's performance.

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**PRELIMINARY VALIDATION OF AN ITALIAN VERSION OF THE ATHLETE BURNOUT QUESTIONNAIRE**

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INTRODUCTION: Burnout in athletes is a growing concern in sport environments. There is need for a psychometrically sound assessment tool to examine this phenomenon in Italian sport contexts. The purpose of the present study was to examine the psychometric properties of an Italian version of the Athlete Burnout Questionnaire (ABQ; Raedeke & Smith, 2001, 2009). The ABQ is a 15-item scale measuring the three dimensions of burnout: physical and emotional exhaustion (5 items), reduced sense of accomplishment (5 items) and sport devaluation (5 items).

METHODS: A sample of 177 high-level athletes, ranging from ages 18 to 37 years (M=23.2, SD=3.8; 44.1% women), of varied sports completed an Italian version of the ABQ along with measures assessing distress (Depression Anxiety Stress Scales-21, DASS-21) and resilience (Connor-Davidson Resilience Scale-10, CD-RISC-10). The Italian version of the ABQ was developed using a standard translation and back-translation procedure. The factor structure of the measure was inspected by comparing the fit of three confirmatory factor analysis models: (i) a first-order model with three correlated factors, (ii) a first-order model with one global factor, and (iii) a bi-factor model. Internal consistency reliability of scores on the questionnaire were inspected as was construct validity of scores.

Results

The confirmatory factor analysis showed that the first-order model with three correlated factors presented acceptable fit to the data ($X^2$ (87) = 219.42, $p < .001$, CFI=.97, TLI=.97, RMSEA=.09, SRMR=.09) and a better fit compared to the alternative models. All standardized factor loadings were >.40. The results also showed scores on the respective burnout dimensions to have good internal consistency reliability, with all Cronbach's alphas >= .80. Furthermore, the pattern of relationships of the ABQ subscales with the measures of distress and resilience supported the construct validity of the Italian version of the ABQ. As expected, the three dimensions of burnout where significantly positively correlated with distress (r = .22 to .35) and significantly negatively correlated (or non-correlated) with resilience (r = -.04 to -.31). These findings support the three-factor multidimensional model of burnout that is conceptualized by Raedeke and Smith (2001, 2009) and supported in previous research.

CONCLUSION: This study offers preliminary evidence for the reliability and validity of an Italian version of the ABQ. Future studies in the Italian athletic context should confirm and expand the findings of the present study with larger athlete samples and broadened nomological networks of constructs.

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**THE IMPACT OF HIGH-INTENSITY INTERVAL TRAINING ON ANXIETY, STRESS, AND TRAIT MINDFULNESS IN COLLEGE STUDENTS**

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INTRODUCTION: High-Intensity Interval Training (HIIT) has demonstrated advantages in reducing anxiety and stress, as well as in enhancing trait mindfulness. This study aimed to investigate the impact of HIIT on college students' psychological well-being, with a specific focus on anxiety, stress, and trait mindfulness.

METHODS: With convenience sampling method, 68 students (Males: n=21; Age: M=24.04 years old) from an academically prestigious university voluntarily attended the study. The experimental group (n=35) took an eight-week HIIT program with one-hour session biweekly, whereas the control group (n=33) did not engage in exercise. Students responded to validated scales including the State-Trait Anxiety Inventory (Spielberger, 1983), the Perceived Stress Scale (Cohen et al., 1983), and

the Five Facet Mindfulness Questionnaire (Baer et al., 2006) to measure levels of anxiety, stress, and mindfulness respectively.

RESULTS: The experimental group showed significant decreases in state anxiety (W=120.5, p <0.01), trait anxiety (W=112, p<0.01) and stress (T=-2.78, p<0.01), as well as an increase in mindfulness (T=3.44, p<0.05). The control group reported increases in state anxiety (T=2.66, p <0.01), trait anxiety (T=2.20, p<0.05) and stress (T=2.37, p<0.05), as well as a decline in mindfulness (T=-3.01, p<0.01). While before the intervention no significant differences were observed in both groups, after the experiment the HIIT group demonstrated a significantly higher level of trait mindfulness (T=3.54, p<0.01) and lower levels of stress (T=-3.26, p<0.01), state anxiety (W=331.5, p<0.01), and trait anxiety (W=324, p<0.01) when compared to the control group.

CONCLUSION: This study supported the efficacy of HIIT in reducing anxiety and stress, which could be elevated for academic and social pressures. The enhancement of trait mindfulness indicated that HIIT could improve self-awareness and present-moment focus, which are crucial for cognitive development.

**ENDURANCE RUNNING AND MENTAL HEALTH: LOWER DEPRESSION AND STRESS IN HALF AND FULL MARATHONERS, INDEPENDENT OF SEX AND TRAINING AGE**

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INTRODUCTION: Endurance running participation continues to grow, with increasing female representation and greater engagement across various age groups and distance categories. The psychological benefits of running extend beyond its physiological effects, yet the relationships between race distance (RD), training age (TA), and mental well-being remain underexplored. Understanding these associations is essential for elucidating the interplay between physical and mental health in the context of this widely practiced and adaptable form of exercise. The purpose of this study was to examine the relationships between RD history and TA with psychological characteristics, including depression, anxiety, perceived stress, autonomy, and motivation, while investigating potential sex interactions.

METHODS: Data from 210 participants (110M,100F; age:32±11yrs; TA:10±9yrs) were evaluated from a larger study of physically active individuals. Participants self-reported TA (years of regular running), sex, and RD history (longest RD completed) via electronic questionnaire. Standardized psychological assessments measured depression (PHQ-9), anxiety (GAD-7), perceived stress (PSS), autonomy (BREQ-3), and motivation (GOEM). Scores were categorized by established severity classifications for each outcome. Depending on the scale of the variable, linear or ordinal regression models or Chi-squared analyses, adjusted for sex, were used to analyze the relationships between RD history (

RESULTS: Marathoners reported lower stress (PSS:Mdn=9,IQR=5-14; beta=-.717; p=.04), and half marathoners exhibited lower depression (PHQ-9:Mdn=1,IQR=0-3; beta=-.806; p=.04) compared to those running

CONCLUSION: Regularly physically active individuals report low stress and minimal depression outcomes. History of completion of half and full marathons is associated with significantly lower stress and depression risk, irrespective of sex or TA, when compared to individuals who have only completed races

Funding: This study received funding from Samsung Electronics Co, LTD.

**EXAMINATION OF THE HUNGARIAN NATIONAL ADULT SWIMMERS' COMPETITIVE ANXIETY AND RESILIENCE IN A CONNECTION TO THEIR FAMILY OF ORIGIN'S RESILIENCE**

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Psychological resilience is the ability of a system (e.g., a family) to successfully adapt despite strong, frequent, or sudden external stressors (Masten, 1990; Garmezy, 1993). It is closely related to and has an impact on personal and intrafamiliar coping, adaptive capacity, and the attainment of optimal outcomes in challenging life situations (Werner & Smith, 1982). Family resilience refers to the collective cohesion and shared coping efforts influenced by both internal and external factors within and outside the family (Walsh, 2003). Individuals characterised by resilience also typically exhibit traits such as internal control, empathy, optimism, positive self-image, positive coping with change, and self-efficacious behaviour (Masten, 1990).

In Meggs (2016) study, it was found that resilience levels in swimmers significantly predicted their performance. Based on the results, it can be hypothesised that resilience may directly or indirectly influence athletic performance through the reappraisal of stressors (i.e., by interpreting the stressor as facilitating rather than threatening).

The aim of our study was to investigate and gain deeper insight into the family background, resilience, and dynamics of Hungarian national swimmers to help them better manage anxiety and competitive-related stress through a holistic approach.

In our research, we examined 12 adult swimmers who are part of the national swimming team, along with their family of origin—parents and siblings. The average age of the participating swimmers was approximately 25.18 years, with a standard deviation of 3.21 years. The average age of the 14 participating family members was approximately 45.07 years, with a standard deviation of 10.33 years.

To measure family resilience, we used the 10-item Connor-Davidson Resilience Scale for both families and swimmers. Swimmers also completed the Competitive State Anxiety Inventory-2 to assess their levels of competitive anxiety.

We examined the relationship between family resilience and swimmers personal resilience, cognitive anxiety, somatic anxiety, and self-confidence.

After analysing the data using SPSS, we found that family resilience was significantly associated with athletes' self-confidence and personal resilience levels. However, no significant relationship was found between family resilience and either cognitive or somatic anxiety.

**PERCEPTION OF STRESSORS AND RESOURCES IN YOUTH SPORT CLIMBING: PERSONAL AND TRAINING RELATED FACTORS**

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INTRODUCTION: How we experience stress has an impact on our health and well-being. Recently dropping out from sport became related to social factors such as perceived autonomy and task climate [1]. Sustainable and long-term development, on an athletic as well as personal perspective, and motivation of athletes are linked to basic human needs [2,3]. Sport climbing is currently undergoing significant professionalisation, which is affecting young athletes. The aim of the study was to get a better understanding of perceived stressors and resources and to identify starting points to support health-promoting sport participation.

METHODS: Three active and six non-active climbers between the ages of 18 and 25 were interviewed using a semi-structured interview approach. The inclusion criterion was the qualification for the national team. After assessment of their competitive status a retrospective reflection on their career in terms of stressors and resources followed. A qualitative content analysis was conducted [4].

RESULTS: Among other topics, training environment and personal factors were addressed. Personal stressors were self-inflicted pressure and concerns about their development. In addition, health issues and the confrontation with body weight were identified as a burden. On a personal level, coping strategies and hobbies were named as resources. The experience of autonomy and maturity were positively emphasised. Beliefs sentences were reflected ambivalently. In terms of training, stressors mentioned were lack of individualisation, insufficient communication, favouritism and inadequate comparison. Respectful interaction and interest were named as resources. A professional relationship with coaches and fun during training were highlighted as positive factors. Aspects of motivation were discussed ambivalently, especially if there was a discrepancy between experienced and externally assessed motivation.

Discussion: The perceived stress experience, expressed in stressors and resources, reflects individual and fundamental needs [3]. The results might be considered not only in sport climbing, but in the support of athletes and in exercise research. Needs-orientated interaction with athletes could promote athletic and personal processes, resulting in more sustainable participation and a reduction in dropouts. Further athletes from climbing and other sports will be interviewed.

References

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## Conventional Print Poster Presentations

### CP-SH23 Psychology - Mixed, Sociology and Sports Management

**SMR NEUROFEEDBACK TRAINING ENHANCE ATTENTION-RELATED BRAIN REORGANIZATION IN BASKETBALL ATHLETES**

CHANG, C., WU, Y., HUNG, T.

*NATIONAL TAIWAN NORMAL UNIVERSITY*

Neurofeedback training targeting sensorimotor rhythm (SMR) is a form of biofeedback that helps athletes improve their performance by reducing sensory motor interference and helping them to process their attention more efficiently. However, the changes in brain structure caused by neurofeedback training in athletes remain to be clarified by scientific evidence. Therefore, the purpose of this study was to investigate the changes in brain gray matter caused by SMR neurofeedback training to enhance basketball shooting performance, and to understand the effects of SMR neurofeedback training on the structure of attention-related brain regions. A total of 20 mens university basketball players were recruited for this study, and the participants were randomly assigned to the experimental group and the control group. The experimental group was required to undergo two weeks of 6 sessions of SMR neurofeedback training, in which the participants learned to enhance the SMR amplitude prior to executing the shooting action by using an auditory feedback method. The control group was given the same training without neurofeedback. All the participants were tested before and after the experiment, and the brain structures were scanned by 3T fMRI scanning. The results of the study showed that the experimental group not only showed a significant improvement in shooting performance, but also a significant increase in gray

matter volume in attention-related brain regions, including the right middle frontal gyrus, right supplementary motor area, and right inferior parietal lobule, but the control group did not show any significant changes in shooting performance and brain structure. This result provides scientific evidence that SMR neurofeedback training leads to structural plasticity in attention-related brain regions, and that this structural change may also be strongly associated with optimal sport performance.

**A STUDY ON THE PRACTICAL PATH OF COLLABORATIVE GOVERNANCE BY MULTIPLE STAKEHOLDERS IN COMMUNITY SPORTS FOR THE ELDERLY: A TRIPARTITE COLLABORATION MODEL INVOLVING COMMUNITY GOVERNMENTS, COMMUNITY HOSP**

WANG, J., DONG, X.
*HARBIN SPORT UNIVERSITY*

INTRODUCTION: With the intensification of population aging, community sports governance for the elderly has become an important approach to address the degradation of physical function and health issues among the elderly population. However, current community sports governance for the elderly generally faces problems such as uneven resource allocation, insufficient service provision, and the lack of a supervision mechanism. These issues severely affect the participation rate of the elderly in sports and the level of health management, and constrain the sustainable development of community social services. Therefore, exploring the practical path of collaborative governance by multiple stakeholders in community sports for the elderly has significant practical and academic value. This study is based on structural functionalism theory and collaborative governance theory, with community governments, community hospitals, and community sports organizations as the research subjects. A collaborative model involving the

**THE IMPACT OF SPIRITUALITY/RELIGION ON ATHLETES MENTAL TOUGHNESS, SPORT MOTIVATION, AND PERCEIVED COMPETENCE.**

PAIC, R., MARTON, G., KARSAI, I.
*UNIVERSITY OF PÉCS FACULTY OF SCINCES*

INTRODUCTION: In contemporary sport psychology, the role of religious behavior and psychological functioning is receiving increasing attention. Religious beliefs and practices can promote athletes emotional and psychological well-being. They can also play a significant role in enhancing sports performance and have positive effects, such as managing stress and anxiety. Our goal was to assess the impact of spirituality/religion on various psychological factors like mental toughness, sport motivation, and perceived competence. Additionally, we sought to find correlations between the strength of faith and other components.

METHODS: We conducted a survey with 182 active athletes using various questionnaires. The average age of the participants was 19.34 years (SD=5.58). We measured the strength of religious faith using the Santa Clara Strength of Religious Faith Questionnaire (SCSORF). Athletes mental toughness was assessed with the Mental Toughness in Sport Questionnaire (SMTQ), sport motivation with the H-SMS questionnaire, and perceived competence with Lintunen's Perceived Physical Competence Scale (PPCS). Additionally, we administered the Spiritual Health and Life-Orientation Scale (SHALOM). For statistical analyses, we used normality tests, the Mann-Whitney U test, and Spearmans correlation analysis.

RESULTS: Religious athletes strength of faith (M=27.72, SD=10.61) is significantly higher ($p<.01$), and the transcendent importance and realization are also significantly higher ($p<.01$). Religious athletes have higher scores in perceived competence, mental toughness, intrinsic motivation, identified and integrated regulation, and lower scores in amotivation and external regulation compared to other groups, although this difference is not significant. Religious female athletes achieved significantly higher values in intrinsic motivation ($p<.05$) and cognitive intrinsic motivation ($p<.05$) compared to non-believing female athletes. The power of faith is significantly higher among professional athletes ($p<.05$) compared to semi-professional and amateur athletes. The power of faith positively correlates with cognitive intrinsic motivation ($p<.05$) and identified regulation ($p<.01$). Additionally, among believers, perceived competence positively correlates with intrinsic and autonomous extrinsic (integrated and identified regulation) motivation.

Discussion: Clearly, the strength of faith, importance, and realization of transcendence is higher among religious respondents. Since this group has higher values of self-confidence and control, believing can help enhance sports performance on the field. Believers, especially female athletes, have higher intrinsic motivation towards their sport compared to non-believers, thus intrinsic motivation can be linked to faith. Additionally, believers have higher perceived competence, meaning that faith, or its presence, positively impacts self-confidence and intrinsic motivation needed for achieving good sports performance.

**STATUS QUO ANALYSIS OF SPORT AND LEISURE SECTOR IN EUROPE**

VÄÄNÄNEN, I., MYNTTINEN, M.
*LAB UNIVERSITY OF APPLIED SCIENCES*

INTRODUCTION: The sports and leisure (S&L) sector has a considerable role in regional development and promoting physical activity. Analysing the S&L sector improves understanding of its influence on social, economic, and cultural aspects across various geographical contexts. Although sports activities, sports and recreation education, and the manufacturing of sports goods represent 0.2 % (€60 billion) of EU total turnover, status quo analyses are lacking on a larger scale in Europe. This paper offers a status quo analysis of the S&L sector in five European provinces.

METHODS: The data consists of regional status quo reports from Castilla-La Mancha in Spain, Dalarna in Sweden, North Brabant in the Netherlands, Päijät-Häme in Finland, and Vratsa in Bulgaria. Reports were formed using a questionnaire focused on the current state of the S&L sector. In addition, the regional SWOT analysis and good practices were collected. All data was analysed by a content analysis method.

RESULTS: The reports were classified into five categories: strategies and plans, clusters and other organisations, activities, economics, and innovations. The regions emphasised sustainability initiatives, well-being, and digitalization in the S&L sector. Research, development, and innovation activities focused on projects and internationalisation. The regions leveraged strategic planning to create growth opportunities, new businesses, job possibilities and promote tourism. Despite some regions lacking specific S&L strategies, sustainable economic growth was seen as possible by supporting technology adoption and targeted upskilling programmes. In addition, national programmes enhanced the potential for regional development and prosperity. Clusters and organisations fostered innovation and cross-sector collaboration among com-panies, authorities, academia, and civil society. From the economic growth view, sports from recreational events to major annual competitions, generated millions in direct and indirect turnover. Innovations were driven by investing in recent technologies and green practices. Differences were found in specific activities and economic impacts. Some regions em-phasised more major sports events, while others focused on outdoor recreational activities and local sports infrastructure.

CONCLUSION: The S&L industry needs to adapt to the structural and behavioural challenges that a sedentary lifestyle poses for health. By providing holistic support and connecting regional S&L small and medium-sized enterprises (SMEs) to market changes and societal challenges, it is possible to strengthen S&L innovation ecosystems. Facilitating digital and green upskilling supports the S&L enterprises' competitiveness and adaptability. It can enhance significant opportunities for growth, new businesses, and job possibilities, contributing to the overall vitality and prosperity of EU regions. The S&L sector could be encouraged to use regional ecosystem services more intensively.

**EXPLORING THE INFLUENCE OF EXPLORATORY ACQUISITION OF PRODUCTS AND EXPLORATORY INFORMATION SEEKING ON EWOM AND IMPULSIVE BUYING BEHAVIOR**

WU, Y.T.
*SOOCHOW UNIVERSITY*

INTRODUCTION: Involvement in sports not only contributes to physical well-being but also promotes interaction socially, impacting individual psychological health. The popularity of modern-day technology has contributed tremendously to how individuals interact with one another, the electronic word-of-mouth (eWOM) has transformed consumer purchasing decisions, particularly in the context of sport brands. Previous studies have found individuals would seek information online before acquiring a product. This study examines the relationships between exploratory acquisition of products (EAP), exploratory information seeking (EIS) on eWOM and impulsive buying behavior, and the mediating role of eWOM toward impulsive buying behavior of sport brands.

Method: This research is grounded in the framework of exploratory behavior-based tendencies (EBBT), this research highlights the dual pathways of EAP and EIS as key precursors to eWOM and their subsequent impact on impulsive buying behavior of brand. A questionnaire was conducted among 359 individuals, after invalid response a total of 299 valid response was recorded, and the data were analyzed using Partial Least Squares Structural Equation Modeling (PLS-SEM).

Result

The results indicated a positive relationship on EAP significantly influencing eWOM; demonstrating how consumers exploratory tendencies drive their engagement and reliance on electronic word-of-mouth and toward impulsive buying behavior while EIS showed no significance with eWOM. However, eWOM showed a positive relationship toward impulsive buying behavior. Furthermore, eWOM exerts a strong positive effect on impulsive buying behavior, emphasizing its critical role in shaping consumer decisions.

Discussion: The findings delivered valuable understandings into the interaction between consumer exploratory tendencies and eWOM, contributing strategic implications for sport brand marketers aiming to foster customers engagement and drive impulsive buying through effective eWOM strategies. EIS showed no significance may focus predominantly on understanding factual or objective information about products rather than sharing or engaging in discussions about them. Consumers determined by EIS might prioritize individual information acquisition over contributing to eWOM. This study contributes to the existing literature by interpreting the pathways linking exploratory tendencies to impulsive buying behavior in the context of sport brands and highlights the significance of leveraging eWOM in modern marketing practices.

**ATHLETIC CAREER DEVELOPMENT STRATEGIES AND TRANSITION APPROACHES FROM ELITE YOUTH FOOTBALL TO ELITE FOOTBALL: COACHES BELIEVES**

KOVALOVS, A., FERNATE, A.

*RIGA STRADINS UNIVERSITY*

INTRODUCTION: The development process of successful athletes has always been non-linear, multifactorial, dynamic, and with multiple possible outcomes, suggesting that the process is multidimensional and needs to be assessed in a complex manner. In the scientific literature, the transition from youth sport to adult sport is associated with a young person (up to and including 18 years of age) starting a career in adult sport. The onset and duration of this transition period may vary depending on the sport.

The aim of the research is to find out coaches beliefs about athletic career development strategies and transition approaches from elite youth football to elite football.

METHODS: 25 football coaches took part in semi-structured face-to-face interviews online. The interview was developed to evaluate the coaches beliefs about athletic career development strategies and transition approaches from elite youth football to elite football. Open coding was used for data analysis.

RESULTS: There were main themes to find out about athletic career development strategies: talent development, support system, and motivation development. There were main themes about the transition approaches from elite youth football to elite football: challenges during transition in football and in life, strategies for overcoming transition challenges.

Discussion

The transition in a football player's career is a holistic process that involves not only skill, tactical and physical development, but also motivation, social influences, and structured strategies such as goal setting and education. Athletes undergoing transitions experience changes in both their sporting and non-sporting lives. A successful transition in a football career requires a structured, multidimensional approach that includes different skill development, motivation, social influences, and long-term career planning. By integrating individualized training, strong support systems, and mental health resources, athletes can navigate transitions effectively and achieve sustained success in and outside of sports.

**THE PROCESS OF RESOLVING COACHING DILEMMAS AND ITS RELATIONSHIP TO PLAYERS LIFE SKILLS**

YUKO, T.

*KEIO UNIVERSITY*

Background: A training environment in which players can speak freely enhances their communication skills and builds team strength (Tokairin, 2024). However, when coaches are focused solely with winning and enforce the exercise of their own coaching authority, they create an environment in which players have difficulty expressing their own opinions. This results in a decline in life skills. Communication that enables athletes to play with a common understanding is especially important in ball games, but inexperienced coaches struggle to find the right balance and are faced with a dilemma.

Purpose: In this study, we conducted a life skills coaching intervention for coaches to create a training environment that takes into account life skills, which have a complementary relationship to athletic performance (Bedir et al., 2023). The purpose of this study was to clarify how coaches change their own coaching authority and how the resulting dilemma impacts players life skills.

Methods: The subjects of the study were a university mens handball coach (27 years old, 4 years coaching experience) and 18 players (age range 18-22) on the team. The life skills coaching interventionist was a researcher (the author) with 11 years of coaching experience who specializes in life skills coaching. The study period was from September, 2024 to February, 2025. Life skills coaching was conducted through e-mail and direct dialogue based on the players current life skills scores. To validate the coaching, a life skills questionnaire (Cronin, L. D., and Allen, J., 2017) was administered to the players before and after the intervention. Semi-structured interviews were also conducted with coaches to investigate psychological changes toward life skills coaching.

Results: One-way analysis of variance analysis of life skills questionnaires before and after the intervention revealed no significant change in any of the scales, including Emotional Skills ($F(1,34)=2.344$, $P=.136$, n.s.) and Teamwork Skills ($F(1,34)=.333$, $P=.568$, n.s.). The results of the interviews with the coaches revealed: 1) Given their past successes, coaches

were very conflicted about being asked to change their coaching. 2) Coaches' mindsets changed from "The most important thing for a college coach is winning," to "While targeting winning competitions, it is also important to help athletes develop as people in order to build a team that is respected by other institutions and supported. In order for that to happen, communication must come from the coach."

Conclusion: Although it can come with conflict, it is important for coaches to be introspective and to evolve in their coaching methodology in order to achieve desirable coaching practices. By incorporating a life skills perspective, the scope of coaching may be broadened and improve both players' empathy and competitive abilities.

**THE MOMENTUM OF SOCCER MATCHES**

CHAO, Q., HIROYUKI, H.

*WASEDA UNIVERSITY*

The purpose of this study was to investigate perceptions of soccer players experiences of psychological momentum (PM) . In our study aimed to provide insights into how individual PM states and local elements of skill execution influence game momentum. Semi-structured interviews were conducted with five soccer players (three males, two females, average age: 19.8 ± 2.0 years). Interview transcripts were analyzed using an inductive qualitative approach to identify psychological and behavioral patterns associated with different PM conditions.

Findings revealed distinct characteristics across momentum states. Scoring goals, making successful passes, and executing key saves were the most frequently reported triggers of positive PM. In these moments, players experienced heightened confidence, improved concentration, and entry into the zone, leading to enhanced team coordination and decision-making. Neutral PM was associated with maintaining stability, controlling physical and psychological conditions, and preparing for potential momentum shifts. Negative PM, on the other hand, was characterized by increased anxiety, technical errors (e.g., misplaced passes, poor ball control, misjudgments), reduced communication, and a more passive playing style. Players in negative PM states often prioritized safe but less effective actions, limiting their ability to regain momentum.

Additionally, differences in playing styles and positions influenced how players experienced and responded to PM shifts. In positive PM states, the players in different position became more clearly defined, optimizing team functionality. In neutral states, players aimed to sustain consistency while anticipating momentum changes. In negative states, increased pressure often led to hesitation, disorganization, and mistakes.

Overall, findings suggest that PM is a dynamic process influenced by both technical execution and psychological factors. By understanding players experiences and perceptions of PM, coaches may develop targeted interventions to maximize positive PM, mitigate negative PM, and implement strategies to optimize PM during competition.

**SPORTS POLICIES AND MANAGEMENT: BETWEEN GROWTH AND SUSTAINABILITY**

GIRGINOV, V.

*BRUNEL UNIVERSITY LONDON*

Growth is a constitutive word in the strategies of sport organisations as they aspire to grow participation, medals and revenue. The quest for growth occurs in parallel with a raising awareness about sustainability and many sport organisations have developed dedicated strategies. The UN Sustainable Development Goals (2015) named sport as an important enabler of the aims of 2030 Agenda. The simultaneous drive for growth and sustainability of sport poses a host of management challenges. Despite new literature on sustainability and sport (Lindsey & Chapman, 2017; McCullough, et al, 2020; Tangen, 2021), debates about sustainable policies and management are still lacking. This study examines the conceptual and practical challenges facing management in making sport sustainable.

The study followed Faber, et al's (2005) conceptualisation of sustainability based on three key properties including (i) what is to be sustained; (ii) the goal orientation of sustainability (i.e., absolute vs relative perspective); (iii) relational implying that something (i.e., sport) is related to its supporting environment. Two case studies of an international (World Athletics) and one national governing body (Paddle UK) with sustainability strategies were conducted (Stewart, 2012). The results suggest that both organisations interpret sustainability differently: WA focused on the environmental dimensions while Paddle UK on the institutional one. Neither organisation offered a clear answer to the question of what they wish to sustain in sport. Visions varied from growing the number of competitions, participants and medals to protecting the environment. WA and Paddle UK showed a relative goal orientation to sustainability by committing to become carbon neutral (i.e., absolute goal) but allowed for other aspects of sport only to become better. Regarding the relationship between sports and their supporting environment, apart from general statements of the positive impact of sport on people and communities, management did not offer ideas of what and how is going to change to become sustainable. Management deals with a composite problem concerning the tensions between the unfettered growth of sport and the need for its sustainable development. The focus of management needs to be on understanding and shaping the interactions between complex adaptive natural systems and sport organisations as socio-economic entities. Sport management ought to prioritize all types of participants as citizens as opposed to treating them as consumers.

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## 13:00 - 14:15

Invited Symposium

IS-PN07 When Ageing Muscles Lose Their Nerve: The Neuroprotective Effects of Exercise

**FROM NERVE TO MUSCLE AND VICE VERSA: EXPLORING HOW EXERCISE SHAPES THE MOTOR UNIT**

BARALDO, M.
*UNIVERSITY OF BASEL*

Ageing is associated with ongoing cycles of muscle denervation and reinnervation, resulting in a decline in muscle contractility. Exercise has been shown to mitigate age-related defects at the neuromuscular junction (NMJ), enhancing collateral reinnervation and improving neuromuscular transmission. Nevertheless, elderly and sarcopenic individuals often experience mobility limitations. Consequently, understanding motor unit plasticity and the molecular mechanisms driving these exercise benefits is essential. In this presentation, Dr. Martina Baraldo will share published and unpublished findings on molecular pathways that support neuromuscular stability, particularly focusing on how changes in mechanistic target of rapamycin complex 1 (mTORC1) activity are linked to NMJ maintenance in adult and aged mice. Additionally, the presentation will examine the effects of endurance exercise on the motor unit across untrained and trained states. This research sheds light on acute and chronic responses of motor units to exercise, suggesting potential therapeutic targets for enhancing neuromuscular function in individuals with mobility impairments. These findings open avenues for innovative interventions aimed at improving the quality of life in advanced age.

**FLEXING MUSCLES AND STIMULATING NERVES – THE EFFECTS OF HEAVY RESISTANCE EXERCISE ON MUSCLE INNERVATION**

SOENDENBROE, C.
*INSTITUTE OF SPORTS MEDICINE COPENHAGEN*

Heavy resistance exercise effectively increases muscle mass and strength at all ages. However, there remains limited understanding of how, and to what extent, resistance exercise provides neuroprotective benefits, particularly in preventing or slowing the loss of muscle innervation. This presentation will cover what is known about resistance exercise-induced changes in muscle innervation in both healthy and diseased populations. Various biomarkers related to muscle innervation, assessed in either muscle tissue or blood, will be introduced and critically discussed. Special attention will be given to outlining the frontiers of current knowledge in this area, with recent studies leveraging in vitro experiments to offer insights into the cellular mechanisms by which muscle contraction can stimulate a nerve. Dr. Soendenbroe is an equal 5th-place recipient of the ECSS Young Investigator Award, with research interests in muscle innervation, adaptation to exercise and disuse, and cellular crosstalk.

**THE NEEDLE IN THE HAYSTACK: INTRAMUSCULAR ELECTROMYOGRAPHY TO UNCOVER CHANGES IN NEUROMUSCULAR FUNCTION WITH AGEING AND EXERCISE**

SARTO, F.
*UNIVERSITY OF PADOVA*

The plasticity of human motor units (MUs) has been widely assessed through in vivo evaluation of their electrophysiological properties. In this presentation, Dr. Fabio Sarto, an ECSS Young Investigator Award Winner (equal 5th) in 2022, will explore the use of intramuscular electromyography (iEMG) to reveal changes in neuromuscular function with ageing and exercise. He will provide an overview of key findings from the literature, highlighting that alterations in MU properties—including reduced firing rate, increased MU potential complexity, and neuromuscular junction (NMJ) transmission impairment—are prominent features of human neuromuscular ageing. Furthermore, several studies employing the motor unit number estimate (MUNE) technique have observed age-related MUs loss. The presentation will also examine the role of sex differences on MU properties. Finally, Dr. Sarto will discuss the controversial evidence regarding the effects of chronic aerobic training on MUNE in humans, as well as the impact of (re)training with resistance exercise on NMJ transmission and MU properties. Overall, this presentation will contribute to a deeper understanding of how neuromuscular function adapts to ageing and exercise, providing insights that complement the cellular and molecular perspectives covered by the other speakers.

Invited Symposium

## IS-AP06 Breathing monitoring in sport and exercise: mechanisms, applications and technological solutions

### CAN MEASURING BREATHING DURING TRAINING IMPROVE THE TRAINING MONITORING PROCESS?

SEILER, S.
*UNIVERSITY OF AGDER*

Athletes and coaches intuitively understand that breathing is a truth teller. They use expressions like "catching my second wind", and "I felt him breathing down my neck" that reflect the sensitivity of athletes to both their own breathing during exercise and the breathing of their opponents as vital information revealing the state of the athlete and their intensity of effort. Breathing, along with heart rate (HR) are indeed vital signs. Historically, exercise ventilation measurements have been reserved for the laboratory, while heart rate has moved into the field as a standard physiological intensity proxy in training monitoring. But do heart rate and breathing frequency provide the same information about intensity, exertion, and effort, with the same adjustment scope and sensitivity? New wearable technologies that make valid and reliable ventilation measurement in general, and breathing frequency in particular, highly accessible in the field are providing unique insight into this fundamental question. Importantly, under field conditions, using wearables that allow normal ventilation, unconstrained by changes associated with the measurement process, data collected during training among professional cyclists demonstrate that: 1) the scope for ventilatory adjustment during high-intensity efforts exceeds the scope for HR adjustment, 2) breathing frequency continues to climb during high-intensity intermittent exercise at times when HR responses become quasi-stable and 3) maximum functional breathing frequency shows substantial individual variation and reproducible peak responses, in a manner similar to maximum heart rate. We argue that breathing frequency monitoring has been successfully translated to practical use in the field, providing unique information about the acute status of an athlete during exercise that is not captured by heart rate. Currently, systematic studies are ongoing with the goal of adding ventilation and breathing frequency to heart rate, blood lactate, and rating of perceived exertion to form a more complete and complementary assessment toolbox in daily training monitoring.

### A NEW MODEL OF BREATHING CONTROL DURING EXERCISE

NICOLÒ, A.
*UNIVERSITY OF ROME*

The correct interpretation of breathing data collected in the field requires an understanding of the different mechanisms involved in modulating breathing depth and frequency. Unlike tidal volume (VT), respiratory frequency (fR) is closely associated with perceived exertion and is sensitive to changes in exercise capacity in different protocols, experimental interventions, and populations. These observations stimulated our interest in investigating the mechanisms controlling breathing during exercise, ultimately culminating in the development of a simple yet effective model that explains how fR and VT are regulated. The main feature of this model is the differential control of fR and VT; fR is substantially modulated by central command (especially during high-intensity exercise) and muscle afferent feedback (especially during moderate exercise) whereas VT is mainly modulated by metabolic inputs. Furthermore, VT is fine-tuned based on fR levels to match alveolar ventilation with metabolic requirements in different exercise-intensity domains. This model has the potential to address mechanistic and practical issues that exercise scientists and practitioners commonly deal with. For instance, it suggests that the extra increase in ventilation observed during high-intensity incremental exercise may not be primarily driven by the progressive development of metabolic acidosis. Indeed, that increase in ventilation is mainly due to the non-linear increase in fR that can only to a minor extent be attributed to metabolic acidosis. Conversely, the magnitude of central command appears to contribute substantially to the fR response observed during incremental exercise. This example shows how our breathing control model can enhance the interpretation of breathing data collected during testing, training, and competitions. Hence, the target audience of this lecture is broad, encompassing: i) researchers interested in the mechanisms underlying ventilatory control and exercise tolerance; ii) scientists and practitioners seeking insight into the physiological rationale for monitoring breathing during exercise; and iii) any researcher or company focused on enhancing the interpretation of breathing data collected in the field.

### WEARABLE SENSORS FOR BREATHING MONITORING IN THE FIELD: CHALLENGES AND SOLUTIONS

ROMANO, C.
*UNIVERSITÀ CAMPUS BIO-MEDICO DI ROMA*

The ever-growing demand for measuring breathing variables during a variety of applications has favoured the development of different wearable sensors that can be effectively used during sporting activities and exercise. From a technological perspective, this is a fruitful area for research and development because there is an abundance of solutions that can be used for this purpose, especially for monitoring breathing frequency. Among these, two contact-based methods are attracting particular attention, i.e. the measurement of breathing-induced torso movements and the extraction of breathing frequency from cardiac signals such as electrocardiogram and photoplethysmogram. Different sensors are suitable for measuring torso movements, including strain sensors that can be integrated into clothes used for training and competition. On the other hand, the extraction of breathing frequency from cardiac signals does not require the use of additional

sensors beyond those already used for heart rate monitoring. However, the suitability of the latter solution may be challenged by motion artefacts, that are sport specific. This talk will provide a state-of-the-art overview of the commercial wearable sensors that can be used in the field for monitoring breathing in different sports disciplines, with a specific focus on soccer and cycling. It will be outlined that it is essential to develop wearable sensors and related algorithms that face the specific challenges offered by different sports settings. The lecture will show how the currently available technological solutions are ready to meet the demands of the field of sport and exercise. The target audience of this lecture includes: i) researchers and practitioners interested in using available techniques to monitor breathing during sport and exercise; and ii) any researcher or company interested in developing or testing wearables specifically designed for sporting activities.

## Oral Presentations

### OP-BM10 Neuromuscular Function across the Menstrual Cycle

**VASTUS MEDIALIS AND VASTUS LATERALIS ACTIVATION AND KNEE EXTENSOR NEUROMUSCULAR FUNCTION ACROSS THE MENSTRUAL CYCLE**

NÉDÉLEC, E., O'HANLON, M.2, INNS, T.2, ANSDELL, P.1, HUNTER, A.2, PIASECKI, M.3, PIASECKI, J.2

*NORTHUMBRIA UNIVERSITY, UK <1>, NOTTINGHAM TRENT UNIVERSITY, UK <2>, UNIVERSITY OF NOTTINGHAM, UK <3>*

INTRODUCTION: Oestrogen and progesterone, the primary female reproductive hormones, have neuroactive properties, with oestrogen eliciting excitatory and progesterone inhibitory influences [1]. However, their effects on neuromuscular function across the menstrual cycle (MC) remain unclear [2]. Muscle force production is mediated by motor unit (MU) recruitment and discharge rate, the effective regulation of which is key for movement control and injury prevention. Female athletes have a higher risk of non-contact anterior cruciate ligament (ACL) injuries compared to male counterparts, which may be a result of impaired neuromuscular function [3]. Despite evidence suggesting hormonal fluctuations may influence this, no study has examined motor control and MU activation in the vastus medialis (VM) and vastus lateralis (VL) across the MC.

METHODS: Ten recreationally active, eumenorrheic females (age: 30 ± 8 years; BMI: 24 ± 2.8 kg/m²) tracked their MCs across a minimum of two consecutive cycles (mean length: 28 ± 3 days), with luteinising hormone surges detected after 14 ± 2 days. Blood samples were collected at the early follicular (EF), pre-ovulatory (Ov), and mid-luteal (ML) phases to measure 17ß-oestradiol and progesterone levels. Knee extensor maximum voluntary contraction (MVC) was recorded, motor control was assessed via isometric trapezoid contractions at 40% and 75% MVC, and via a sine wave task at 25% MVC with real-time visual feedback. A 64-channel high-density surface electromyography (HDsEMG) electrode recorded VM and VL activity at 40% MVC, with root mean square (RMS) EMG calculated as peak amplitude within a 50ms window, expressed as a percentage of max RMS EMG. One-way ANOVA and mixed-effects models were used ($p < 0.05$).

RESULTS: 17ß-oestradiol and progesterone varied significantly across the MC (17ß-oestradiol: EF, 159 pg/ml; Ov, 200 pg/ml; ML, 208 pg/ml; $p = 0.028$; progesterone: EF, 11.96 ng/ml; Ov, 12.11 ng/ml; ML, 39.27 ng/ml; $p = 0.036$). However, no significant differences were found in knee extensor maximal strength (EF, 408 N; Ov, 395 N; ML, 419 N; $p = 0.393$) or normalised VM and VL RMS EMG (VM: EF, 58%; Ov, 49%; ML, 55%, $p = 0.324$; VL: EF, 54%; Ov, 60%; ML, 50%, $p = 0.775$). Neuromuscular control remained stable across MC phases, with no differences in force steadiness at 40% ($p = 0.756$) and 75% MVC ($p = 0.895$) or motor control during the sine wave task (correlation coefficient, $p = 0.199$; normalised AUC, $p = 0.116$).

CONCLUSION: These findings suggest hormonal fluctuations across the MC have minimal influence on VM and VL activation, knee extensor neuromuscular function, and motor control. However, further research is needed to assess individual MU behaviour across different contraction intensities and dynamic tasks to better understand sex-related differences in non-contact ACL injury risk.

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**THE MAGNITUDE OF THE REPEATED BOUT EFFECT IN FEMALES FOLLOWING MAXIMAL UNACCUSTOMED ECCENTRIC EXERCISE OF THE ELBOW FLEXORS.**

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INTRODUCTION: Neuromuscular function is impaired following an unaccustomed bout of eccentric exercise, however, through the repeated bout effect (RBE) the muscle is protected from damage following a subsequent bout of eccentric exercise. As a result of unaccustomed eccentric contractions, structural muscle damage occurs in both sexes, meanwhile, the inflammatory response may be mitigated in females due to protective effects of estradiol, thereby attenuating the secondary effects of muscle damage and potentially limiting the magnitude of the RBE. We investigated the relationship

between menstrual cycle phase and oral contraceptive use on neuromuscular impairments following the first bout of exercise, and the magnitude of the RBE.

METHODS: Fifteen female participants performed two bouts of 150 maximal eccentric voluntary contractions of the elbow flexors four weeks apart. Normally menstruating females participated during the late follicular phase (day 10-14) of their menstrual cycle, as determined through cycle tracking, when estradiol is near peak, and progesterone is lower. Oral contraceptive users were tested on their placebo pill days (lower estradiol). Neuromuscular function was assessed for Bout 1 before the eccentric protocol and then again 48 hours following, and this was repeated 4 weeks later for Bout 2. The magnitude of the RBE is calculated as the difference between maximal voluntary contractions in bout 1 48hr post-eccentric protocol and bout 2 48hr post-eccentric protocol.

RESULTS: Eccentric exercise-induced muscle weakness and soreness did not differ between groups following Bout 1 ($p>0.05$), and the magnitude of the RBE ($p<0.05$) was similar between groups ($p>0.05$).

CONCLUSION: Females in the late follicular phase (classified as high estradiol) and females on combined oral contraceptives (low estradiol) had similar impairments in neuromuscular function following the first bout of eccentric exercise, and a similar RBE.

**IMPACT OF HORMONAL STATUS ON POSTURAL CONTROL AND VIBRATION EXPOSURE IN EXPERT RIDERS**

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INTRODUCTION: Equestrian sports are dominantly by women and require a highly specific posture. Performance in horse riding result from dynamic interactions between the rider and the horse, which may contribute to musculoskeletal injuries (MSIs), particularly in the spine. Vibrational forces play a key role in both performance and health, potentially exacerbating MSIs. Throughout the menstrual cycle, fluctuations in sex hormone levels primarily estradiol and progesterone are known to influence postural control. However, their specific impact on expert riders, particularly in relation to vibration exposure, has never been investigated.

METHODS: Eight female riders (22 ± 3 years) with regular menstrual cycles were tested on an equestrian simulator during two phases of their menstrual cycle: the early follicular phase (CHF) and the luteal phase (CPG). Five Inertial Measurement Units (IMUs; Shimmers) were placed along the riders spine (7th cervical, 10th thoracic, 3rd lumbar), on the head, and on the simulator. Four variables were computed to assess postural control, including trunk orientation and angular variance. Vibration exposure was analyzed using the root mean square (RMS) of accelerations at the head and along the spine, as well as the total vibration dose at the lumbar level (ISO 2631). Wilcoxon tests were performed to compare the variables between the two menstrual phases.

RESULTS: No significant differences in postural control were observed between menstrual cycle phases (p = NS). However, vibration exposure analysis revealed that the total lumbar vibration dose and the root mean square (RMS) acceleration at the cervical level were significantly lower in the CHF phase compared to the CPG phase ($p < .05$).

CONCLUSION: This study suggests that hormonal status influences lumbar and cervical vibrations in expert riders during horseback riding, while postural control remains unaffected. Specifically, vibration attenuation was observed during the luteal phase, when progesterone levels are high. Although further research is needed to clarify the underlying mechanisms, these findings provide valuable insights into both performance optimization and rider health.

**HORMONE THERAPY ATTENUATES MENOPAUSE-RELATED IMPAIRMENTS IN CORTICAL NEUROPLASTICITY**

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INTRODUCTION: Previous research has demonstrated the neuroactive effects of ovarian hormones across the menstrual cycle [1]; however, it remains less clear how the cessation of hormone production across the menopause influences motor cortical properties. Furthermore, it is currently unknown how nervous system adaptation (neuroplasticity) is mediated by endogenous and exogenous hormones across the human lifespan. Paired associative stimulation (PAS) provides a method of quantifying an individual's capacity for neuroplasticity and offers insight into the pathology of several neurological disorders [2].

METHODS: The menopausal status of 33 participants was classified according to NICE guidelines on the diagnosis and management of menopause, with 12 pre-menopausal females (age: 29 ± 7 years), 7 peri-menopausal females (50 ± 4 years), 7 post-menopausal females (59 ± 10 years), and 7 females using hormone therapy (HT, 53 ± 3 years) taking part in the study. Participants underwent a resting baseline neurophysiological assessment in the first dorsal interosseous muscle, including electrical stimulation of the ulnar nerve and transcranial magnetic stimulation (TMS) of the motor cortex to assess corticospinal excitability, intracortical inhibition (SICI), and facilitation (ICF), as well as the maximum compound muscle action potential (Mmax). Subsequently, a PAS protocol was performed with electrical stimulation at 300% perceptual threshold delivered 25 ms prior to TMS at 120% motor threshold; 200 paired stimuli were delivered at 0.2 Hz, followed by repeated neurophysiological assessments immediately, then 10, 20, and 30 minutes after PAS.

RESULTS: No differences between groups were observed at baseline for corticospinal excitability (~10% Mmax, p = 0.941), SICI (~40% unconditioned MEP, p = 0.829) or ICF (~150% unconditioned MEP, p = 0.204). In response to the PAS protocol,

the one-way ANOVA revealed a main effect of group ($p = 0.024$), whereby pre-menopausal females (+69 ± 67%, $p < 0.001$) and HRT users (+48 ± 32%, $p = 0.020$) experienced an increase in corticospinal excitability. In comparison, peri- (+13 ± 19%, $p = 0.228$) and post-menopausal (+1 ± 30%, $p = 0.401$) females exhibited no change from baseline.

CONCLUSION: The menopause appears to blunt motor cortical neuroplasticity, with peri- and post-menopausal females experiencing no facilitation of the corticospinal tract following a PAS protocol, compared to their pre-menopausal counterparts. Hormone therapy appears to mitigate this menopause-induced decline, which has implications for a range of populations in health and disease where cortical neuroplasticity is essential for the (re)learning of motor skills in midlife and beyond.

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## Oral Presentations

### OP-AP45 Coaching III - Endurance Sports

**LONG-TERM, LARGE-SCALE OBJECTIVE TRAINING LOAD DATA IN TRIATHLON REVEALS DIFFERENCES BETWEEN TRAINING PHASES AND RACE DISTANCE PREFERENCES BUT NOT SEX OR AGE**

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INTRODUCTION: Typical training load data for age-group triathletes has not been established based on long-term, objective data captured by technology. Establishing the typical TL of age-group athletes from this data may provide opportunities to improve the health and performance outcomes of athletes. Training load quantified through metrics like duration, distance, heart rate (HR), and Training Stress Score (TSS) – a load metric based on Banister's Training Impulse (TRIMP) [2], must be managed effectively to ensure performance optimisation and injury prevention [3]. Existing studies on TL are limited by reliance on subjective recall data [4], small sample sizes [5], or lack of comparison across factors like sex, age, race distance preference, and training phases. These comparisons are important to determine whether coaches may need to adjust the prescribed load across athlete categories.

METHODS: This retrospective cohort study analysed six months of objective training data exported by 95 age-group triathletes (18 female, 77 male) from the TrainingPeaks® training management system. Load metrics included weekly duration, distance, HR, and TSS. Data from 34,731 training sessions were coded for sex, age group, race distance preference, and training phase (General, Specific, Taper/Race/Post, Off-Season). A Generalised Linear Model (GLM) determined whether sex, age, race distance preference, and training phase affected load metrics.

RESULTS: Race distance preference and training phase showed significant differences between TL metrics ($p = < 0.05$), while sex and age did not. Long-course athletes had higher mean weekly TL (574 TSS, 10.25 hrs, 171 km) compared to short-course athletes (452 TSS, 8.45 hrs., 118 km). TL for all phases were significantly different ($p < 0.05$). The Specific phase showed the highest mean TL (620 TSS, 9.27 hrs, 166 km), while the Off-Season was the lowest (364 TSS, 5.67 hrs, 84 km).

CONCLUSION: Male and female athletes had similar TLs, as did athletes of different ages. Long-course athletes and those in the Specific training phase had the highest TL. Coaches and athletes can use these typical age-group loads to compare and adjust absolute TL according to the magnitude of change between training phases and race distance preference. Further research is needed to examine how variations in TL impact performance and injury risk, helping to refine TL guidelines. This study provides the first large-scale, objective TL dataset indicating typical load for age-group triathletes, offering actionable insights for training personalisation.

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**ROAD TO PARIS: TRAINING CHARACTERISTICS OF A WORLD CLASS MALE TRIATHLETES IN THE YEAR PRIOR OLYMPICS. A QUALITATIVE MULTIPLE CASE STUDY**

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INTRODUCTION: The objective of these four case studies is to describe the individual training characteristics of world-class male triathletes in the year leading up to the Olympics. Specifically, the aim is to determine whether periodization and intensity distribution follow common patterns or vary significantly based on individual needs and physiological characteristics.

METHODS: Training & physiological data from four world-class male triathletes (27 ± 4 years, $VO_2$max: 75 ± 2 $ml \cdot min^{-1} \cdot kg^{-1}$) were analyzed. Two exhibited predominantly glycolytic characteristics, with a lower %$VO_2$max at the anaerobic threshold (83.7 ± 0.3%), while the other two displayed predominantly oxidative characteristics, with a higher %$VO_2$max (86.1 ± 0.2%). Day-to-day power meter, GPS, and chronometer data from a 35-week macrocycle were retrospectively analyzed. Training volume, intensity distribution, altitude training, hypoxic exposure, competition schedule, and tapering strategies were considered. Training data were divided into two periods (General and Specific), and the three disciplines (swimming, cycling, running) were analyzed by total time spent in three physiological zones (Z1, Z2, Z3).

RESULTS: Athletes trained 676 ± 22 hours across 610 ± 34 sessions in the final macrocycle before the Olympics, with 87,0% of training below the first lactate threshold (Z1). Intensity distribution shifted from 86.7%, 8.3%, and 4.9% in the general period to 87.3%, 6.9%, and 5.8% in the specific period for Z1, Z2, and Z3, respectively. The polarized index increased from 1.72 to 1.82, indicating a greater polarization closer to the event. More glycolytic athletes exhibited a higher polarized index than oxidative athletes in both periods (1.79 ± 0.42 vs. 1.65 ± 0.00; 1.92 ± 0.11 vs. 1.81 ± 0.09). All four athletes trained at altitude for 28, 42, 23, and 25 days; two used a hypoxic tent for 21 and 25 days. Despite different pre-taper strategies, all athletes reduced training volume by 23.3 ± 8.4% in the week before Olympics without altering frequency or intensity. $VO_2$max increased by 2.3% from the general to the specific period, while the second lactate threshold improved by 1.4% (swimming), 5.2% (cycling), and 2.7% (running). Notably, two athletes reached the Olympic podium. Moreover, those who competed in fewer races during the Olympic year performed better at the Games.

CONCLUSION: This study aligns with best practices in the literature regarding training volume and intensity distribution in Olympic-level triathletes. Achieving Olympic qualification and peak performance requires high training volumes, predominantly at low intensity, regardless of physiological characteristics. The most common strategy involves increasing intensity from the general to the specific period, followed by a short taper before competition. However, these best practices must be adapted to individual athlete characteristics. Furthermore, fewer races in the Olympic year appear associated with better Olympic performance.

**FOOT STRIKE PATTERN AND SPATIOTEMPORAL VARIABLES ANALYSIS OF ELITE ATHLETES IN THE VALENCIA MARATHON 2021**

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INTRODUCTION: The Valencia Marathon is a race with the platinum distinction from World Athletics (WA), with a record of 2:01:48 as the best marathon in Spain according to the Royal Spanish Athletics Federation (RFEA).

There are various biomechanical variables that play a very important role in both running economy and athletic performance of the runners. Among these variables are the foot strike angle (FSA), duty factor (DF), ground contact time, flight time, and running cadence (1). Knowing these variables in the context of an official competition allows us to understand the reality of the athletes performance (2).

The objective of this study is to analyse the foot strike pattern and spatiotemporal variables that describe the running technique of elite marathon runners in a real competition context

METHODS: A biomechanical study of running in the sagittal plane (240Hz) was conducted on the top 48 athletes of the 2021 Valencia Marathon, with times ranging from 2:05:12 to 2:15:59. The sample was divided into two groups: from the 1st to the 24th place (G1) and from the 25th to the 48th place (G2). Two independent observers analysed variables such as: FSA (3), DF (4), running cadence, flexion time, and impulse time. To determine the differences between groups, the Students t-test for independent samples was used for parametric variables, and the Mann-Whitney U test was used for non-parametric variables ($p<0.05$).

RESULTS: Regarding the FSA, it was observed that 61.5% of the analysed athletes run with a midfoot strike (MFS), 33.3% with a rearfoot strike pattern (RFS), and only 5.2% with a forefoot strike pattern (FFS). No differences were found between groups in terms of foot strike pattern ($p>0.05$). On the other hand, differences were observed between groups in variables such as contact time (G1: 174ms ±7, G2: 183ms±12, $P>0.001$), flexion time (G1: 78ms ±6, G2: 81ms±7, $P>0.05$), impulse time (G1: 96ms ±8, G2: 103ms±8, $P>0.05$), cadence (G1: 186 spm ±6, G2: 181 spm±7, $P>0.05$). However, no differences were found in DF (G1: 37%±3, G2: 38%±2, $P>0.05$).

CONCLUSION: This study has allowed us to characterize the running technique of elite marathon runners in a real context. Regarding the foot strike technique, it was found that most runners were MFS, results similar to those obtained in other recent studies (2) and contrary to previous studies (5). On the other hand, in a very homogeneous sample of runners, differences were observed in various spatiotemporal variables such as cadence or ground contact time. This contrasts with the equality observed in DF. These results can help coaches understand how their athletes perform relative to their peers and make informed decisions for training planning.

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**HEART RATE VS. RACE PACE-BASED PRESCRIPTION TRAINING: WHICH TRAINING METHOD LEADS TO INTENDED EXECUTION IN RECREATIONAL DISTANCE RUNNERS?**

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INTRODUCTION: Various training prescription methods are employed to optimize endurance performance. Conventional methods are based on physiological responses, such as heart rate (HR) associated with ventilatory thresholds (VT1 and VT2). On the other hand, the race pace-based (RP) method offers a practical alternative by considering training zones relative to percentage ranges of maximum performance pace in specific events (1).

Therefore, the aim of the present study was to compare the time spent in prescribed intensity zones (i.e., adherence) between HR- and RP-based training prescription methods during both low-intensity continuous and high-intensity interval training (HIIT) sessions in recreational distance runners.

METHODS: Thirty-seven recreational endurance runners (20 males, 41 ± 8 years; 17 females, 37 ± 10 years) underwent an incremental test to determine VT1 and VT2, and maximal oxygen uptake (VO2max). VO2max was 56 ± 7 $mL \cdot kg^{-1} \cdot min^{-1}$ for males and 51 ± 5 $mL \cdot kg^{-1} \cdot min^{-1}$ for females. Additionally, time in a 5-km time trial (TT) performed at an athletics track was measured.

Runners completed two types of training sessions using both HR- and RP-based methods in a randomized controlled crossover order: a 45-min continuous low-intensity session and an 8x500m HIIT session with 90 sec of rest between repetitions. Intensity in the low-intensity training session was prescribed up to the HR associated with VT1 through the HR-based method and up to 80% of TT average pace through the RP-based method. For the HIIT session, intensity was prescribed at 95-100% of the maximum HR achieved during the VO2max test through the HR-based method, and at 105-110% of the TT average pace through the RP-based method. Paired t-tests and Wilcoxon tests were used to compare both prescription methods, and Cohens d was employed to analyse the effect size. The level of significance was set at $p < 0.05$.

RESULTS: HR-based training prescription of the 45-min low-intensity session yielded significantly greater adherence ($p = 0.002$, $d = 0.7$, 85% ± 23 of session time) than RP-based method (69% ± 21). Similarly, for the 5x800m session, adherence was significantly higher ($p < 0.001$, $d = 0.7$) through HR- (41.4% ± 19) than RP-based prescription (27% ± 14).

CONCLUSION: The training prescription method influences time spent in prescribed intensity zones, potentially altering the training stimulus from what was intended. The HR-based approach results in greater time spent in the prescribed intensity zones for both low-intensity continuous and HIIT sessions. In contrast, RP-based training, despite its relative simplicity in prescription, leads to a short time spent in the target intensity zones, particularly during HIIT sessions.

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**SUCCESS AND FAILURE, OUR GAIN-RESEARCH ON THE KEY FACTORS OF IMPROVING HIGH PERFORMANCE OF ROWING TRAINING**

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INTRODUCTION: Chinese rowing has only won two gold medals from Womens Quadruple Sculls in Olympic Games since 1980s. The same crew, who won gold medal in Tokyo, just got sixth place in Paris, which indicates weekpoints Chinese Rowing Coaches have not found key factors of performance enhancement in training. To finding out the key factors, this research reviews training plans between Tokyo and Paris Olmypic Games of Chinese Women's Quadruple Sculls, analyzing training load, key physical ability and W4x performance during both cycle.

METHODS: Using tracking method, this research focus on the training of Chinese Women's Quadruple Sculls for two Olympic cycle. The related rowers(age:29.1±1.4y, height:183.3±3.0cm, bodyweight:78.0±4.5kg) are all Olympic gold medalists. Training load data of 7 years (2018-2024) are recorded including rowing and rowing ergometer mileage, total training time of all kinds of training, training intensity distribution divided by low-, moderate- and high-intensity based on first and second lactate point. Key physical abilities such as maximum strength, aerobic threshold(P2) and anaerobic threshold(P4), rowing ergometer 2km performance(Erg2k) and W4x performance(W4x-2k) during both cycle are recorded too.

RESULTS: The last year of both Olympic cycle had the same length and are divided into two macro-cycles and five meso-cycles. Compared to the Tokyo cycle, 1) there were average 17.7km/week more rowing training and 1.13h/week more weightlift training while 10.8km/week less rowing ergometer training and 0.89h/week less core&functional training for a year in Pairs cycle; 2) training intensity distribution of a year both showed pyramid mode, while comparing each meso-cycle between both indicated unclear goals in Pairs; 3) maximum strength of lower and upper body were increased by 7kg (a rate of 6.07%) and 5.75kg (a rate of 6.76%) respectively, meanwhile aerobic threshold(P2) and anaerobic threshold(P4) both decreases by 22.6W (a rate of 9.27%) and 12.2W (a rate of 4.38%) respectively from Tokyo to Pairs; 4) the performance of rowing ergometer of 2km decreased by 0.8s (a rate of 0.2%) while the performance of W4x performance of 2km decreased by about 14s from Tokyo to Pairs.

CONCLUSION: 1) Rowing training volume is important but not the more the better. Rowing ergometer training should be paid more attention to develop or maintain fitness. 2) Maximal strength should not be developed continuously through the

whole year, because forces on blades have optimal range rather than bigger. Core&functional training is essential for strengthening the trunk and body posture, which can be the support for good rowing technique and applying the force on blades. 3) Problems of training intensity arrangement are hard to inspect from perspective of macro-cycle, but more easy to detect from at least meso-cycle, which means training intensity monitor should be more detailed. 4) Aerobic capacity is the most important factor of rowing performance, especially the power around first lactate point.

## Invited Symposium

### IS-PN09 Energy intake limitations in athletes: from Caloric Restriction to Time Restricted Eating

**THE EFFECT OF LOW ENERGY AVAILABILITY ON SKELETAL MUSCLE: POSSIBLY NOT WHAT YOU THINK**

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Low energy availability is typically vilified in the contemporary mainstream scientific literature as a factor negatively affecting sports performance. However, there is a lack of well-controlled, unbiased studies showing positive or negative effects of acute or chronic low energy availability on performance. Importantly, beyond the potential decrease of skeletal muscle glycogen in diets with low energy availability, there is nearly no mechanistic evidence providing explanations on how low energy availability may affect skeletal muscle, a key tissue for physical performance. To provide some insights in this under-explored area, this talk will provide an overview of the effects of low energy availability on skeletal muscle and show findings of our research on skeletal muscle proteomics of healthy exercising men exposed to pronounced low energy availability. We show that a short (5-day) exposure to energy availability of 10 kcal/kg FFM/day produces a significant shift in skeletal muscle proteome, resulting in a coordinated increase of mitochondrial proteins and key metabolic proteins, while reducing the expression of key proteins of the extracellular matrix and cytoskeleton. Is this positive or negative? Difficult to tell, though the findings are aligned with positive effects of energy restriction in maintenance of function in life-long caloric in a number of animal models, showing improved healthspan and lifespan.

**ENERGY COMPENSATION: WHERE DOES THE ENERGY GO?**

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Athletes sometimes consciously plan to induce an energy deficit in an attempt to attain a desired body mass or composition. This could involve increasing exercise energy expenditure by increasing the training load, reducing energy intake via caloric restriction, or a combination of the two. Total energy expenditure comprises the sum of various process, including resting metabolic rate, the thermic effect of food and activity energy expenditure, which includes both exercise expenditure and non-exercise activity thermogenesis (NEAT). Increasing training load in an attempt to increase total energy expenditure assumes that caloric expenditure between these processes is additive, however this assumption has been challenged, and the Constrained Model of Total Energy Expenditure posits that across the long-term, increasing activity energy expenditure may not necessarily lead to a commensurate increase in total energy expenditure, but instead, may trigger compensatory energetic savings in other processes. But could this really be true for elite athletes, whose estimated training energy expenditure may exceed all other processes combined? Within this talk, I will describe concepts related to energy constraint and compensation, from the point of view of elite athletes. Key questions to be addressed include whether total energy expenditure is additive or constrained, the mechanisms and nature of energy compensation, and the specific processes from which compensatory energy savings might arise to offset increases in exercise energy expenditure. I will also discuss the practical implications of energy constraint and compensation for athletes who purposefully increase training load in an attempt to induce an energy deficit and lose weight, along with the potential health and performance related consequences of energy compensation for athletes.

**TRAIN, EAT, FAST: TIME RESTRICTED EATING FOR ATHLETES**

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Time-restricted eating (TRE), a dietary strategy that confines food intake to specific time windows, has gained recognition as a potential approach for optimizing athletic performance and recovery. TRE has been shown to influence key physiological processes critical for athletes, including metabolic flexibility, hormonal regulation, and inflammation modulation. Thus, this time-related energy intake limitation may represent a hormetic stimuli for human organisms. This presentation reviews the latest evidence on TRE in athletic populations, focusing on its effects on performance, body composition, and recovery. Key findings include enhanced fat oxidation, preservation of lean muscle mass, and improvements in metabolic health markers, particularly when TRE is integrated into structured training regimens. Our findings indicate that, in resistance-trained athletes, long-term TRE improves inflammatory markers and increases muscle strength without significant changes in muscle mass. Additionally, preliminary evidence for our laboratory suggests that TRE may positively influence immune responses to training in endurance athletes. While TRE shows promise, its application in high-performance sports requires careful consideration of factors such as meal timing, energy intake, and training demands. This presenta-

tion also addresses a critical gap in the literature: although substantial evidence exists for the health benefits of TRE, there is limited research on its direct effects on athletic performance. To explore the rationale for using TRE in athletes, this talk will dissect the physiological and biological mechanisms—such as the repeated, moderate increase in ketone bodies during fasting periods—that may modulate the bodys responses to the combined effects of fasting and exercise. Targeted at sports scientists, nutritionists, coaches, and athletes, this work contributes to the evolving field of nutritional periodization and highlights TRE's potential role in enhancing athletic performance and overall health.

## Oral Presentations

### OP-BM11 Sprinting

**VELOCITY-DEPENDENT NEUROMUSCULAR EXCITATION OF HIP EXTENSORS IN SPRINT-TRAINED ATHLETES**

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INTRODUCTION: In running, hip extensors such as the gluteus maximus (Gmax) and the hamstrings contribute significantly to forward acceleration of the body, particularly at high running speeds (1). Among the hamstrings, hypertrophy after sprint-specific training is more pronounced in the semitendinosus (ST) and biceps femoris long head (BFlh), than in the semimembranosus (SM) (2). This can be partly explained by the different architecture of these muscles (3). However, the effect of non-uniform muscle hypertrophy on hip extensor torque has not been investigated. In addition, non-uniform distribution of muscle activation between the hip extensors may also contribute to the non-uniform adaptations to long-term training. In this study we hypothesized that the torque-angular velocity relationship would differ between power and strength-trained athletes. We also hypothesized that the excitation of Gmax, ST, and BFlh would increase with increasing hip extension angular velocity on a dynamometer, which was not expected in SM.

METHODS: Thirteen competitive track and field athletes from sprint-based disciplines and 14 matched strength-trained controls participated in this study. Hip extension torque and electromyography (EMG) activity of the Gmax, ST, BFlh, and SM were recorded during maximal intensity isometric (50 deg hip flexion) and concentric contractions at 60, 120, 180, and 240 deg/s angular velocity when the dynamometer range of motion was 70 deg to -20 deg (neutral position = 0 deg). The knee was fixed at 40 degrees of flexion. The hip joint angle was measured using 3-D motion analysis to match the hip range of motion between individuals. Torque and EMG activity for each muscle and their interactions were compared between groups and contraction velocities.

RESULTS: There was no difference in isometric torque between the groups, but concentric torque was higher in the sprinting group than in the strength-trained group, especially at high angular velocities ($p<0.05$). In the strength-trained group, EMG activity did not increase in any of the muscles with increasing contraction velocity. In the sprinting group, EMG activity increased in all muscles with increasing contraction velocity ($p<0.01$). However, there was a significant muscle*velocity interaction, with an increase in hamstring EMG activity being most pronounced in the BFlh and ST as compared to a smaller increase in the SM.

CONCLUSION: Our results suggest that the velocity-dependent neuromuscular excitation pattern of the hamstrings is unique to sprint-trained athletes, which may explain why ST and BFlh show preferential hypertrophy after sprint-specific training. It appears that the ability of hip extensors to produce torque at high running speeds is a combined result of superior muscle volume and superior muscle excitation of muscles with a relatively low pennation angle.

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**MUSCLE SHAPE COMPARISON OF THE PLANTAR FLEXOR MUSCLES BETWEEN HIGH-LEVEL SPRINT AND DISTANCE RUNNERS**

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INTRODUCTION: Plantar flexor muscles exhibit inter-individual variations in muscle bulging patterns during muscle contraction (1). Muscle shape affects its force production capacity, and different shapes may benefit the specific requirements of the sport. Sprint running requires higher propulsive forces, while distance running requires efficient muscle function over prolonged durations. While plantar flexor muscle volume has already been compared between sprinters and distance runners, these measures lack sensitivity to regional shape differences. This study aimed to compare the shape of plantar flexor muscles between sprinters and distance runners.

METHODS: Fourteen sprinters (IAAF score: 983 ± 110, 5 females) and fifteen distance runners (IAAF score: 953 ± 116, 5 females) were recruited. The 3-D muscle volume of the plantar flexor muscles was reconstructed by scanning the right leg

using T1-weighted magnetic resonance imaging. Muscle segmentation was performed manually to establish muscle boundaries and to generate the 3-D mesh of the muscles. Statistical shape modeling (2) was used to compare the differences in the group average shape of the medial (MG) and lateral gastrocnemius (LG) and the four compartments of the soleus for male and female athletes.

RESULTS: MG muscle shape was similar in the male distance and sprint runners, but female sprint runners had significantly larger proximal and distal MG (36.44% of the total vertices) compared to female distance runners. LG was more expanded across the length of the muscle on both the dorsal and frontal sides, with 30% of the total vertices showing this expansion in male sprinters compared to male distance runners. Similarly, female sprint runners had larger LG at the proximal and distal ends of the muscle (14.36% of the total vertices). We observed statistical differences in the average shape of the four compartments of the soleus at a few minor locations in both male and female runners.

CONCLUSION: This study provides novel insights into the differences in the plantar flexor muscles' shape between elite sprint and distance runners. Future research should investigate the functional implications of these differences and their relationship to performance. We further encourage longitudinal studies to understand training-induced changes in muscle shape.

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**ACUTE EFFECTS OF PLYOMETRIC, BALLISTIC, AND MIXED WARM-UPS ON KINEMATICS AND KINETICS DURING SPRINT RUNNING**

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INTRODUCTION: Plyometric and ballistic exercises incorporated into warm-up protocols have been reported to enhance sprint performance [1,2]. However, previous research often used these terms interchangeably while implementing exercises that combined both concepts [1,3,4]. These two concepts stimulate distinct neuromuscular adaptation mechanisms such as stretch reflexes in plyometric versus motor unit recruitment in ballistic exercises. Given the debated implications of isolating these concepts (e.g., non-ballistic plyometric exercises) [5], understanding their individual effects and contributions to sprint performance is important. This study aimed to investigate the acute effects of distinct plyometric and ballistic warm-ups in sprinting.

METHODS: Fifteen collegiate sprinters (height: 1.74±0.05 m, weight: 67.7±4.03 kg, personal best back squat: 130.0±21.7 kg) completed four sessions in randomized order, separated by 24 hours. Each session included 5 minutes of low-intensity jogging, followed by one of four protocols (traditional as control, plyometric, ballistic, or mixed plyometric-ballistic) and two preparatory sprints before a single 40-m sprint for data collection. Kinetic and spatiotemporal data as well as split times at 10, 20, 30, and 40 m were obtained via 54 force plates embedded in a tartan track. Repeated-measures one-way ANOVA examined effects of warm-ups, with a significance level of $\alpha$=.05.

RESULTS: Of the 13 tests conducted, only one revealed a significant effect of warm-ups: step length at 40 m ($p<.05$, $p\eta2=.21$), where step length was greater in the plyometric (2.19±0.14 m) than in the mixed protocol (2.11±0.14 m) in Bonferroni-corrected pairwise comparison ($p<.05$). No effects were found for maximum horizontal force and power output ($p=.35–.46$, $p\eta2=.06–.07$), contact and flight times at the start and 40 m, step length at the start ($p=.10–.85$, $p\eta2=.02–.14$), and any split times ($p=.38–.79$, $p\eta2=.03–.07$). Other pairwise comparisons also showed no significant differences ($p=.07–1$).

CONCLUSION: The findings suggest no clear superiority of plyometric and ballistic over traditional warm-ups. The sole statistically significant result (step length at 40 m) may reflect a type I error rather than practical relevance. Contrary to previous reports [1-4], these results question whether plyometric and ballistic warm-ups provide substantial benefits over traditional methods. The protocols employed in previous studies [1,3,4] suggest that previously observed advantages might be due to suboptimal control protocols that did not adhere to best practices. Further research is necessary to validate or refute the benefits of plyometric and ballistic warm-ups compared to well-designed traditional protocols.

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**LEG MUSCLE ACTIVATION UNDER FULL AND PARTIAL TOWING ASSISTANCE IN SPRINT RUNNING**

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INTRODUCTION: Research on sprint adaptation has focused on optimizing performance through various training methods (Van Den Tillaar & Gamble, 2017). Among these, assisted sprinting has been studied for its potential to enhance speed via neuromuscular adaptations (Cecilia-Gallego et al., 2022). However, there is concern that muscle activation during supra-maximal sprinting may not be optimal due to passive contributions from external towing forces.

The present study compared fully assisted sprinting with partially assisted sprinting, where assistance was applied until approximately 0.5 m/s below the athletes supra-maximal speed, after which the impact of the towing force diminishes to zero, allowing the athlete to continue unassisted. This technique may require greater voluntary effort. It was hypothesized that partially assisted sprinting would increase propulsive muscles activation.

METHODS: Fourteen male students from different sports (age: 21.3 ± 1.3 years, body mass: 81.5 ± 8.3 kg, height: 1.86 ± 0.06 m) performed full-assisted, partial-assisted, and unassisted (free-run, control condition) 30-m sprints in a randomized order within a single session. A motorized device provided precise assistance load. Sprint times and EMG activity of the Rectus Femoris (RF), Vastus Lateralis (VL), Semitendinosus (ST), Biceps Femoris (BF), and Gluteus Maximus (GM) were compared across conditions. Additionally, stride length, stride frequency, contact time, and flight time were recorded for each condition using Optojump.

RESULTS: Running speed over the 30-m sprint was higher in both assisted conditions compared to the unassisted condition (unassisted vs. partly assisted: $p < 0.01$; unassisted vs. fully assisted: $p < 0.001$). This increase in speed resulted mainly from a significantly greater stride length in both assisted conditions compared to the unassisted condition ($p < 0.001$ for both comparisons).

In both partially and fully assisted condition, ST ($p < 0.01$) and BF ($p < 0.001$) showed greater activation before initial contact (late swing phase) compared to the unassisted condition. Additionally, VL activation was significantly higher in the fully assisted condition during early stance (knee flexion) compared to the unassisted condition ($p < 0.05$). However, no significant differences were found between the partly and fully assisted conditions.

CONCLUSION: The absence of significant muscle activation differences between the partly and fully assisted conditions suggests both techniques provide similar neural drive, sufficient to enhance sprinting performance, as evidenced by higher sprint speed and greater stride length compared to the unassisted condition. These findings highlight how assistance levels influence neuromuscular demands and can be applied in training.

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**LOADED JUMP SQUAT EFFICACY IN FEMALE SPRINTERS**

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INTRODUCTION: Recently, an athlete's momentum, the product of change in velocity and the athlete's body mass, has gained attention in strength training literature, particularly in loaded jump squat(1) (LJS), sprinting, and agility(2). LJS can stimulates neuromuscular adaptations, while system momentum (SM), which also accounts for the lifted load, serves a useful metric for individualized training.

This study examines the relationship between position and load on the SM/Impulse ratio (jump efficacy) and system momentum (SM) in sprinters

METHODS: We recruited 10 highly trained(3) female sprinters with highly advanced resistance training status(4), and daily exposure to barbell LJS using the Smith machine. Each athlete performed three trials at individual 90-degree position with additional loads of 0.6- and 1.2- bodyweight (BW), followed by the same sequence at a parallel squat position. Positions were counterbalanced across participants, with athletes aiming to jump as fast and high as possible. A force platform synchronized with a linear encoder transducer, sampling at 1000 Hz, recorded force-time metrics and barbell velocity, respectively. The outcome measures collected were Impulse, SM, and the jump efficacy, which were processed using a customized MATLAB script. A linear mixed model (LMM) analysis was conducted using R version 4.4.2. Load and position were included as fixed effects for marginal estimates, while athletes were modeled as random effects to account for inter-individual variability

RESULTS: LMM results for jump efficacy show significant effects for both position ($t= -7.29$, $p< .001$, $d= -2.81$) and loads ($t= -8.39$, $p< .001$, $d= -3.23$) but not for the interaction ($p= .14$). Pairwise comparisons indicated that LJS90° with 0.6 BW load was the condition with the greatest efficacy ($p< .001$), whereas the LJSparallel with 1.2 BW demonstrated the lowest the least efficacy ($p<.001$). For SM, the analysis revealed a significant main effect of BW ($t= 3.30$, $p= .003$, $d=1.27$), while neither positions nor the interaction effect reached significance. Subsequent pairwise comparisons showed that SM was significantly higher in the LJS90° 1.2BW condition compared to LJS90° 0.6 BW ($p= .016$). The marginal $R^2$ values indicate that load

and position explain 84.7% of the variance in jump efficacy and 12.3% in SM. The random effects contribute 5.0% to jump efficacy and 48.9% to SM, highlighting greater inter-individual variability in SM

CONCLUSION: Although the momentum equals the athlete's applied impulse, the impulse-momentum relationship seems inapplicable to LJS at different loads. Female sprinters struggle to convert ground impulse into bar velocity, even with a guided Smith machine, supporting the idea that jump efficacy reflects short-term coordination rather than direct impulse transfer. High inter-individual SM variability highlights the complexity of momentum generation in LJS and the need for individualized training

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## Oral Presentations

### OP-AP41 Training and Testing VIII - Fatigue

**NEUROMUSCULAR FATIGUE IN RECREATIONALLY STRENGTH- AND ENDURANCE-TRAINED YOUNG MALES**

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INTRODUCTION: Neuromuscular fatigue may be defined as an exercise-induced reduction in the force-generating capacity of muscle (1). It is a complex phenomenon involving a range of neural and muscular mechanisms. Previous research has suggested that there is a difference in the functional organization of the neuromuscular system between strength-trained (ST) and endurance-trained (ET) males (2), which may lead to different neuromuscular responses to fatigue. Research into the effects of fatigue in differentially trained individuals has mainly focused on dynamic exercise, whereas studies on sustained isometric fatiguing tasks remain limited. These can provide a paradigm in which the contribution of individual mechanisms may be more easily observed. The aim of this study was to assess the neuromuscular fatigue in recreationally ST males and ET runners during a sustained submaximal isometric knee extensor contraction.

METHODS: Eleven ST (21.5 ± 2.9yr) and 11 ET (19.8 ± 2.4yr) males volunteered for the study. Participants performed maximal voluntary isometric contractions (MVICs) of the knee extensors before and immediately after submaximal isometric knee extension at 30% MVIC until task-failure. High-density surface EMG was simultaneously recorded from the vastus lateralis muscle. EMG root mean square (RMS), median frequency (MDF) and muscle fibre conduction velocity (MFCV) were estimated. RMS and MDF post-fatigue were normalized with respect to their pre-fatigue MVIC values. RMS%, MDF% and MFCV were examined at intervals corresponding to 10% of the contraction time.

RESULTS: ST were 43% stronger ($p<0.01$) than ET with a higher BMI (24.7 vs 21.1kg/m2; $p<0.001$). No differences were observed in post-fatigue MVIC (20.6 vs 22.5%) or time-to-failure between groups. However, MDF% decreased by 8.7% in ST, while it remained unchanged in ET ($p<0.05$) in post-fatigue MVIC. During the fatiguing task, MFCV was lower in ET compared to ST (4.4 vs 4.7 m/s, $p<0.05$). Moreover, the linear mixed model revealed a decrease in MFCV ($p<0.05$) and MDF% ($p<0.001$) in ST, whereas they were unchanged in ET throughout the contraction. The increase in RMS% was similar between the two groups ($p<0.001$).

CONCLUSION: In this study, both groups exhibited similar time-to-failure or reductions in MVIC%. However, ST showed a decrease in MDF% and MFCV during the fatiguing task, whereas ET remained unchanged. Additionally, MFCV was higher in ST compared to ET, suggesting that the muscle fibres with a larger cross-sectional area were recruited in ST. These findings indicate that while submaximal isometric fatiguing task induced comparable fatigue in both groups, the underlying neuromuscular fatigue mechanisms differ, likely due to a greater percentage of type II fibres and/or a greater relative area of type II fibres in ST.

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**SEX-DIFFERENCES IN THE ACUTE AND SHORT-TERM RESPONSES AFTER A RESISTANCE TRAINING SESSION IN BENCH PRESS**

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INTRODUCTION: Sex differences in performance fatigability of limb muscles are specific to the task demands, and can vary according to the contraction type, speed and intensity or the involved muscle groups (1). In this line, research has consistently shown that women experience less fatigue than men during and in response to isometric and slow, dynamic-contraction tasks (performed at the same relative intensities) (2); however, less is clear about fast-dynamic contractions. In

addition, monitoring velocity loss (VL) throughout a set provides accurate information about the level of effort generated during the training session (3). This study aimed to compare the acute and short-term mechanical and metabolic responses in women and men with similar levels of strength performance (4) after a resistance training (RT) session in bench press (BP) exercise.

METHODS: Thirty-one participants (16 women and 15 men) performed a single RT bout in BP exercise: (load: 70% of one-repetition maximum (1RM), sets: 3, velocity loss VL: 50%, rest: 3 min). Before the performing protocol a previous session was carried out to obtain the 1RM and individualized load-velocity relationship. Measurement session involved recordings at different time points: pre-exercise (Pre), post-exercise (Post), 10-minute post (Post-10), and 24-hour post (Post-24), of different variables: mean propulsive velocity (MPV) of the load of 60% 1RM in the BP (Load-60) and lactate. In addition, the number of repetitions in each set and the total number of repetitions were registered and analyzed.

RESULTS: No significant "Sex × time" interaction was found for any variable. However, the lactate displayed a tendency toward a significant "Sex × time" interaction ($p=0.07$), with higher increments for men compared to women. A significant "Time effect" ($p<0.001$) was obtained for MPV Load-60, with a similar response in women and men in Post and Post-10 with respect to Pre ($p<0.001$), and both sexes were recovered at Post-24. A significant "Sex effect" was reported for total repetitions ($p= 0.019$), women completed significantly more repetitions in set 2 (8.3 ± 2.0 vs. 6.9 vs. 1.3; $p= 0.03$), set 3 (7.6 ± 1.9 vs. 6.1 ± 1.0: $p= 0.01$), and during all session (24.8 ± 5.1 vs. 21.1 ± 2.7; $p= 0.019$).

CONCLUSION: Our results provide evidence about sex-differences in the acute and short-term fatigability after a BP training session when equalizing the strength performance level, the intensity, and volume through VL. Although no significant differences between sexes were found in the mechanical response at different time points, higher metabolic responses were observed for men compared to women, despite the higher number of repetitions performed by women.

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**COMPARING THE EFFECTS OF LOCOMOTOR MUSCLE FATIGUE AND MENTAL FATIGUE ON ENDURANCE PERFORMANCE IN CYCLISTS: A RANDOMIZED CROSS-OVER STUDY**

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INTRODUCTION: This study compared the effects of mental fatigue and locomotor muscle fatigue on endurance performance, perception of effort and physiological responses in a group of well-trained and elite cyclists.

METHODS: Seven performance level 4 and three level 5 (21.8 ± 2.7 yrs, 8 Male 68.4 ± 2.5 VO2Max and 438.8 ± 50.1 PPO, 2 Female 58.7 ± 5.4 VO2Max and 335.0 ± 14.1 PPO) have been recruited for this study. During the first visit to the laboratory, all participants performed an incremental ramp test on a cycle ergometer to determine the respiratory compensation point (RCP), VO2Max and Peak Power Output (PPO). In the subsequent three visits, participants performed TTE at the power corresponding to 95% RCP under three different conditions: 1) Mental fatigue (MF) induced by a 1-hour psychomotor vigilance task (PVT); 2) Locomotor muscle fatigue (LMF) induced by a 100-drop jumps protocol; 3) Watching documentaries was used as a control condition. The order of the three visits was randomly assigned. Physiological and psychological responses measured during the TTE test included heart rate (HR), VO2, ventilation, blood lactate concentration (La) and rating of perceived exertion (RPE). Manipulation checks included maximal voluntary contraction (MVC) of the knee extensors, PVT performance and perceived physical and mental fatigability scales. One-way (condition) or two-way (condition x time) repeated measure ANOVAs were used to analyse the data. Significance was set at $p<0.05$. The individual isotime method 1 was used to analyse the responses to the TTE test.

RESULTS: Manipulation checks revealed mixed results, with only PVT performance influenced by MF ($p<0.001$) and only perceived physical fatiguability affected by LMF ($p<0.001$). No significant differences in TTE were found between conditions (Control 989±122s, MF 1019±137s, LMF 973±145s, $p=0.876$). The RPE and HR at individual isotime in the LMF condition tended to be higher compared to the control condition but these effects were not significant ($p=0.081$ and $p=0.090$). No significant effects were found for the other physiological responses.

CONCLUSION: The results of this study confirm previous investigations 2 suggesting that well-trained and elite cyclists are resistant to the negative effects of MF. The current study also suggests that well-trained and elite cyclists may also be resistant to the negative effects of LMF experimentally induced in the laboratory. Larger studies are required to confirm these findings and to investigate the "dose" of MF and LMF that may eventually reduce the performance of high-level cyclists.

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**EFFECTIVENESS OF THE METHODS FOR ASSESSING PHYSICAL READINESS IN PREDICTING AEROBIC EXERCISE PERFORMANCE**

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INTRODUCTION: Assessing and monitoring an individuals readiness to exercise is essential for optimizing training programs, as it provides valuable insights into fatigue and fitness levels, and helps prevent overtraining [1]. Although several tools are available to assess fatigue, readiness indicators are poorly defined, with most studies focusing on their association with previous training load, neglecting their ability to predict future performance [2]. This study aims to assess whether readiness tools may predict future aerobic performance.

METHODS: 9 healthy adults (6 females, 24.7±2.7 yrs and 3 males, 28.7±2.6 yrs [mean±SD]) visited the lab 9 times (at least 48 hours between sessions). Day 1 consists of a personalized maximal incremental cycling test to determine peak power output (POpeak) and familiarize participants with readiness tools. Days 2-9 involved readiness assessments (using total quality of recovery [TQR] scale and short recovery stress scale [SRSS], counter-movement jump [CMJ], and 10-sec sprint cycling test), followed by a constant-load exercise to task failure at 70% of POpeak. The corresponding time to task-failure (TTF) was considered as the performance indicator. For each individual, Spearmans correlation coefficients (ρ) were calculated to assess the correlation between TTF and readiness indicators. One-sample t-tests (or Kolmogorov-Smirnov test for CMJ's jump height [JH], due to not normally distributed data) were used to assess if the individual ρ between readiness indicators and TFF were significantly different from 0. α was set at 5%.

RESULTS: CMJ (highest JH, peak power, modified reactive strength index) expressed as average and best of three jumps), 10-sec sprint test (5-sec peak and 10-sec average power), and TQR (0-10 and 6-20) were not associated with TTF (ρ not significantly different from 0), showing weak association (average $\rho<0.3$). Likewise, most SRSS items (physical performance capability, emotional balance, overall recovery, muscular stress, lack of activation, overall stress) were not associated with TTF. However, mental performance capability ($\rho=0.370\pm0.335$; $p=0.027$) and the negative emotional state ($\rho=-0.409\pm0.297$; $p=0.006$) were positively and negatively associated with TTF, respectively.

CONCLUSION: This study found that most readiness indicators are poorly associated with future aerobic performance. However, SRSS mental performance capability and negative emotional state seem to be able to predict future performance and may represent useful readiness indicators. Specifically, higher mental performance leads to a longer TTF, whereas a more negative emotional state results in a shorter TTF, which is clearly reasonable. In conclusion, specific self-report measures predict aerobic performance and offer insights into training predisposition and fatigue, whereas neuromuscular tests such as CMJ and sprints are less relevant for predicting aerobic capacity.

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## Oral Presentations

### OP-AP46 Sensor Technology and Monitoring

**PREDICTING GROUND REACTION FORCES FROM CHEST-MOUNTED IMU DATA USING DEEP LEARNING**

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INTRODUCTION: Wearable sensors have emerged as a viable alternative to traditional laboratory equipment for assessing biomechanical parameters. This study investigated whether data from a 6-axis inertial measurement unit (IMU) mounted on a chest-strap, along with a deep learning model can replicate the ground reaction forces (GRF) measured by a force plate, potentially broadening access to performance and injury risk assessments in sports science.

METHODS: 124 valid jumps from 12 participants with 2 years of resistance or endurance training experience were used for training. Synchronized recordings from a chest-mounted IMU and a force plate were obtained, with force plate data processed to extract the acceleration component of the GRF—normalized for body mass and with the gravitational component removed. Two deep learning architectures were employed: a vanilla auto-encoder and a recurrent auto-encoder incorporating gated recurrent unit (GRU) cells. Both models were trained for 500 epochs using 80% of the dataset, with the remaining data reserved for testing. Performance was evaluated using Mean Squared Error (MSE) as the loss metric.

RESULTS: The base MSE loss on the test set was 0.3145. Vanilla auto-encoder achieved a training loss of 0.0021 and a test loss of 0.0717, while the GRU auto-encoder recorded a training loss of 0.0057 and a test loss of 0.0774. Both models effectively reconstructed the GRF-derived acceleration signal, with the vanilla architecture showing marginally better performance on unseen data, while also being faster for training and inference.

CONCLUSION: These findings indicate that chest-mounted IMU data, when processed through an auto-encoder framework, can reliably approximate the acceleration component derived from GRF measurements. The comparable performance of both auto-encoder models suggests that even simple architectures can effectively translate the noisy data collected from a wearable sensor to GRF. This approach has the potential to facilitate on-field assessments where traditional force plates are impractical. Future research should focus on validating these preliminary results across varied athletic populations and movement patterns, as well as optimizing model parameters for real-time applications. Furthermore, additional pre-processing of the IMU signal may also lead to improved performance on this task, and requires further enquiry.

**ESTIMATING FORCES DURING PULL-UPS WITH WEARABLE SENSORS AND AI FOR FIELD-BASED SHOULDER LOAD MONITORING**

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INTRODUCTION: The shoulder is the most injury-prone area in functional fitness, particularly during high-volume movements such as kipping pull-ups (KPUs) and butterfly pull-ups (BPUs) [1,2]. Overuse and overload have been associated with these injuries [1], making joint load monitoring a promising strategy for injury prevention. However, current methods rely on highly specialized equipment, and measuring interaction forces at the pull-up bar is challenging even in lab-based conditions, with limited practical applicability. Inspired by previous work in running [3], we propose using a minimal set of wearable sensors to estimate bar reaction forces during different pull-up techniques and we validate estimates against force plate measurements. This setup can contribute to field-based monitoring of shoulder joint loads across different pull-up techniques.

METHODS: Nine experienced recreational CrossFit athletes performed one set of multiple upper body functional movements (Func), followed by sets of strict pull-ups (SPUs), KPUs, and BPUs. A pull-up rack was instrumented with two 6-DOF force transducers to measure the forces and moments at the handles. Participants wore two IMUs—one on the chest and one on the humerus. A two-step machine learning pipeline was developed. Step 1 used a multi-class classifier to distinguish between SPUs, KPUs, BPUs and other movements (Func). Step 2 applied a regression model for each technique, using raw IMU data to estimate anterior-posterior (Fap) and superior-inferior (Fsi) forces (medio-lateral forces were negligible as the movements were largely symmetric). Multiple machine learning models – including feature-based, kernel-based, and neural networks – were tested using single-sensor (chest only) and dual-sensor configurations. Validation used a leave-one-subject-out approach to ensure generalizability.

RESULTS: For movement classification, the best-performing model, Rocket classifier, single sensor, achieved 98±2% accuracy and F1 scores. In estimating forces normalized by body mass, the best model, LSTM, dual-sensor, yielded RMSE [Fsi,

Fap] in N/kg: KPU: [0.30, 0.15], BPU: [0.27, 0.11], and SPU: [0.13, 0.05]. Normalized by the full range of values, these are [Fsi, Fap]: KPU: [21%, 17%], BPU: [15% 11%] and SPU: [16%, 22%]. Linear coefficients of determination were [Fsi, Fap]: KPU: [0.70, 0.75], BPU: [0.83, 0.90], and SPU [0.59, 0.33]. Differences between measured and predicted peak forces varied largely between trials and participants.

CONCLUSION: We present a data-driven method to estimate external forces during pull-ups using 1-2 wearable sensors with strong accuracy. This setup holds promise for field-based biomechanical assessments which can be used for shoulder load monitoring, preventing overload and overuse injuries. Future work will evaluate how accurate these estimated forces can be used to compute joint moments via musculoskeletal modeling and inverse dynamics.

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**AUTOMATED DETECTION OF VENTILATORY THRESHOLDS: DEVELOPMENT AND COMPARISON TO VISUAL DETERMINATION**

STÜTZ, L., CIVELLI, N., HELFENSTEIN, P., SCHMIDT-TRUCKSÄSS, A., KNAIER, R., WAGNER, J.

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INTRODUCTION: Ventilatory thresholds (VTs) mark aerobic and anaerobic metabolic transitions in exercise physiology. Traditionally, detecting these thresholds during cardiopulmonary exercise testing (CPET) involves manual assessment of respiratory gas exchange data based on visual inspection, which is time-consuming and prone to subjectivity. To address these limitations, we developed an algorithm to automate the detection of VTs and conducted an initial analysis of its performance based on the Power at which VTs were reached.

METHODS: An algorithm was developed in Python (Version 3.13.1) to detect VT1 and VT2 from continuous CPET data based on established criteria. VT1 was detected using four parameters: (1) the ventilatory equivalent for oxygen starts rising, (2) end-tidal oxygen pressure starts rising, (3) the V-slope method, and (4) a rise in excess carbon dioxide. VT2 was detected using three criteria: (1) the ventilatory equivalent for carbon dioxide starts rising, (2) end-tidal carbon dioxide pressure starts decreasing, and (3) the V-slope method.

The algorithm was applied to respiratory gas exchange data from 210 participants under 50 years old in the COmPLETE-Health study [1]. VTs detected by the algorithm were compared to visually determined values, with performance assessed using Mean Absolute Percentage Error (MAPE) and Root Mean Square Error (RMSE) for Power at VT1 and VT2.

RESULTS: The algorithm successfully detected VT1 in 92.9% of participants and VT2 in 93.3%, respectively. Among participants with valid threshold detections, the MAPE for VT1 was 12.6%, with an RMSE of 14 Watt, while VT2 had a MAPE of 5.7% and an RMSE of 11 Watt.

CONCLUSION: The observed error rates indicate a reasonable agreement with visual determination for both VT1 and VT2, respectively. Considering that an automated detection of VTs is i) more objective, ii) better reproducible, and iii) more time and cost efficient than manual visual VT determination, this provides high potential.

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**PREDICTING SUCCESS IN OLYMPIC SPORTS: INTEGRATING SOMATOSENSORY PERCEPTION AND MACHINE LEARNING FOR TALENT IDENTIFICATION.**

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INTRODUCTION: While talent identification (TID) requires robust assessment of multiple performance-related factors, current practices often rely on subjective or physiological indices. In diving and winter sports, somatosensory perception - encompassing proprioceptive acuity (joint position sense) and visual-vestibular integration - is critical for performance but remains underexplored. This study applied advanced somatosensory analysis and an ensemble machine learning approach to examine relationships with Olympic potential.

METHODS: Participants were N = 63 (m = 24; f = 39) Olympic and aspiring Olympic athletes (27 divers, 36 winter sports), categorized as either Podium (n=27) or Emerging (n=36). A two-step somatosensory perception assessment evaluated (1) Ankle proprioception via the Active Movement Extent Discrimination Assessment (AMEDA) (Han et al., 2016); and (2) visual-vestibular function was quantified via - pupil light reflex for autonomic function, cognitive response delay, and vestibular function, measured through visual tracking error, time-to-target, and time-on-target (m/s). Statistical analysis using effect sizes and ANOVAs identified distinguishing variables between Podium and Emerging athletes. An ensemble of machine learning models (logistic regression, KNN, AdaBoost, decision tree, random forest, and CN2 rule) was evaluated for accuracy and to inform classification.

RESULTS: Podium-level divers demonstrated superior ankle proprioceptive accuracy (Ameda Left: +5.85, p=0.0159; Right: +5.90, p=0.014). Tracking error significantly predicted performance (Cohen's d = 0.31, p=0.004). Logistic regression, validated using 10-fold cross-validation, achieved strong classification (AUC=0.94), identifying 92% of Podium and 87% of Emerging athletes. Within the logistic regression model, tracking error approached significance (p=0.057), while proprioceptive measures improved group classification despite non-significant individual results (p>0.13). Lift-curve analysis

showed the model was 2.2 times more effective than random selection in identifying podium-potential athletes across probability thresholds 0.63–0.80.

Winter Sports: Podium-level athletes showed longer response delays (12.93m/s longer, p=0.007), prioritizing decision accuracy. Tracking error significantly predicted performance (Cohen's d = 0.24, p=0.003). A random forest model also validated using 10-fold cross-validation, achieved high classification accuracy (AUC=0.879), correctly identifying 93% of Podium and 100% of Emerging athletes. Within the random forest model tracking error was significant (p=0.0482). Lift-curve analysis showed the model was 2.4 times more effective than random selection at identifying podium-potential athletes at a probability threshold of 0.65.

CONCLUSION: Findings highlight the value of integrating somatosensory metrics for data-driven TID in Olympic sports. Machine learning can help organizations refine selection, optimize resources, reduce talent wastage, and strengthen pathways to success.

**A GENERALIZED DATA-DRIVEN APPROACH FOR QUANTITATIVE TECHNIQUE ANALYSIS IN SPORTS: BRIDGING SCIENCE AND PRACTICE**

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INTRODUCTION: Quantitative technique analysis is crucial for optimizing sports performance [1]. However, translating scientific findings into practical coaching remains a challenge. Traditional biomechanical analyses often fail to align with practitioners terminology and understanding, limiting their applicability in training environments. This study presents a data-driven approach that provides quantitative and visually accessible feedback on distinct technique elements within a performed movement, ensuring familiarity for athletes and coaches while maintaining scientific rigor. The objective is to investigate its potential of generalizability across various sports disciplines.

METHODS: The approach builds upon previous proof-of-concept studies [2,3]. The methodology involves: (i) Technique demonstrations and recordings: The 3D segment coordinates of highly skilled athletes are recorded while they perform purposefully overemphasized technical movement elements commonly analyzed in their sport. (ii) Extraction of technique elements as quantifiable movement components: A principal component analysis (PCA) of the recorded segment coordinates reveals principal component vectors [4], which represent different technique elements. (iii) Projection of any movement onto component vectors: Partial movements along these vectors isolate specific technique elements from the overall movement. They can be visualized and analyzed based on scores.

RESULTS: Beyond skiing [2,3], the procedure was newly tested in running (n = 20) and soccer (n = 16). In each case, the analysis yielded a set of quantifiable movement components that directly correspond to practical execution strategies, i.e., technique elements, as demonstrated and described by experts. The component vectors allowed for technique comparisons between groups (e.g., female runners exhibited less upper-body pendulum movement than males) and performance-based variations (e.g., soccer players maintained a more upright posture before ball contact when aiming for a lower goal in penalty kicks).

CONCLUSION: By structuring technique feedback around established practitioner knowledge while maintaining a robust quantitative foundation, this approach helps bridge the gap between scientific analysis and practical coaching. The new findings for running and soccer suggest that this method can be applied across various sports. Similar analyses can be conducted in other disciplines, provided that 3D kinematic data from technique demonstrations are available. Visualizing the technique elements may enhance intuitive understanding and could be integrated into modern app development for practical technique analysis.

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## Oral Presentations

### OP-MH43 Interventions II

**DOES SIX WEEKS OF LOW-VOLUME SPRINT INTERVAL TRAINING IMPROVE PEAK OXYGEN UPTAKE COMPARED TO A NON-EXERCISE CONTROL? A RANDOMIZED CONTROLLED TRIAL.**

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INTRODUCTION: Low-volume sprint interval training (LVSIT) has been reported to increase peak oxygen uptake (VO2peak) when performed thrice weekly for six weeks. However, methodological and statistical concerns have been raised that limit previous study findings. We sought to critically reassess the VO2peak response to a six week, thrice-weekly LVSIT

intervention using a randomized controlled trial design that was constructed to mitigate bias and augment reporting quality.

METHODS: The study protocol was formulated in accordance with CONSORT guidelines and registered prior to participant recruitment on the Open Science Framework (https://osf.io/7mwcj). Utilizing individual participant data from two previous studies conducted in our laboratory, we constructed a generative model of our primary outcome, VO2peak, as a function of group (LVSIT and control), age, sex, height, and body mass. Using these previous data and the model, we then conducted simulation experiments to estimate a required sample size of n=15 per group to achieve 80% power to detect a difference of 1 metabolic equivalent (MET) with a credible interval of ≤1 MET. Forty insufficiently active young adults were initially recruited and randomized; three were lost to follow-up, leaving n=37 (13 males and 24 females; 22±2 yrs) who were assigned to perform either six weeks of LVSIT (n=17) or a non-exercise control condition (n=20). The LVSIT protocol involved 3x20-s 'all out' sprints over a 10-min session that otherwise consisted of low-intensity cycling. VO2peak testing was conducted by investigators blinded to participant group allocation and performed in the absence of temporal, verbal, or physiological feedback. VO2peak was measured in duplicate at each time point and not averaged prior to modelling. Data were analyzed using a generative linear mixed-effects regression model that regressed post VO2peak on baseline VO2peak, group allocation, age, sex, height, and body mass with varying effects for participants. All data were analysed by an investigator blinded to group assignment.

RESULTS: Bayesian linear mixed-effects modelling and individual response analyses revealed that LVSIT significantly improved absolute (+370±168 mL/min) and relative VO2peak (+5.5±2.4 mL/kg/min), but there were no significant changes in the control group. A clinically meaningful increase in VO2peak of ≥1-MET occurred in 71% of LVSIT participants, with 88% exceeding a 0.5-MET + typical error threshold.

CONCLUSION: This study unequivocally demonstrates that a six-week LVSIT protocol significantly improved VO2peak in insufficiently active young adults compared to a non-exercise control group. By implementing a robust design that included pre-registration of the study protocol, concealed allocation assignment, statistical best practices and applied bayesian methods, and open data-sharing, this study addresses prior methodological critiques of similar previous work.

**COMPARATIVE EFFECTS OF SHORT HIGH-INTENSITY AND LONGER LOW-INTENSITY EXERCISE ON EXERCISE-INDUCED HYPOALGESIA: A RANDOMIZED CONTROLLED CROSSOVER STUDY.**

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INTRODUCTION: Acute physical activity leads to exercise-induced hypoalgesia (EIH). The primary aim of this study was to investigate the effects of two different exercise interventions (low intensity but longer and highly intensive but short) on EIH compared to those of a control session. The secondary aim was to evaluate potential differences in EIH regarding the used body landmarks (muscular and bony/articular).

METHODS: 20 male (age: 29.4 ± 3.5 yrs, VO2max: 52.9 ± 6.3 ml/min/kg) participants successfully underwent two exercise sessions on a bicycle ergometer (low intensity: 30 minutes at 60% of the individual anaerobic threshold; highly intensive: 90 second isokinetic all-out) and a control session on separate days in a randomized crossover design. Before (T0), post 1' (T1), and post 40' exercise (T2) pain sensitivity was determined via pain pressure thresholds (PPT, N/cm2) unilaterally at the rectus femoris (RF), knee, tibialis anterior (TA), ankle, pectoralis major (PM), and sternum. Lactate, heart rate (HR), and rate of perceived exertion (RPE, 6-20) were documented.

RESULTS: Baseline (T0) PPT values were not different between the sessions at any landmark ($p > 0.104$) indicating no carryover effects. The three-way ANOVA resulted in a significant 'time' × 'landmark' × 'intervention' effect ($p = 0.007$, $\eta 2partial = 0.095$). Post hoc analyses revealed that PPT values changed following the highly intensive exercise session with PPT_TA being significantly higher at T1 (88.4 ± 28.2) compared to T0 (78.4.2 ± 24.9, $p = 0.023$) and T2 (71.8 ± 20.3, $p = 0.001$). PPT_ankle were significantly higher at T1 (55.9 ± 26.5) compared to T2 (45.9 ± 25.4, $p = 0.007$) but not to T0 (51.3 ± 23.1, $p = 0.519$). PPT_RF were significantly higher at T1 (89.3 ± 25.4) compared to T0 (73.3 ± 20.6, $p = 0.007$) and T2 (74.2 ± 21.8, $p = 0.004$). PPT_knee were significantly higher at T1 (89.4 ± 31.9) compared to T0 (77.4 ± 27.3, $p = 0.045$) and T2 (70.6 ± 30.1, $p = 0.001$). PPT_sternum were not significantly different with values of 44.8 ± 19.1 at T1 compared to 39.3 ± 13.7 at T0 ($p = 0.065$) and 41.0 ± 17.1 at T2 ($p = 0.067$). PPT_PM were significantly higher at T1 (41.8 ± 18.2) compared to T0 (33.3 ± 13.8, $p = 0.002$) and T2 (34.6 ± 15.3, $p < 0.001$). PPT values were neither different after the low intensity nor after the control session at any landmark. Lactate (low intensity: 1.1 ± 0.2; highly intensive: 7.7 ± 2.6 mmol/L), HR (low intensity: 128.9 ± 13.0; highly intensive: 175.2 ± 13.4 bpm), and RPE (low intensity: 11.6 ± 1.9; highly intensive: 19.6 ± 0.8) were significantly higher following the all-out exercise ($p < 0.001$).

CONCLUSION: Results indicate that a 90" all-out exercise induces EIH, whereas a 30' low intensity exercise does not. This emphasizes the role of exercise intensity, rather than duration, as a key determinant of EIH, shedding light on potential dose-response relationships. EIH effects were observed across muscular and articular landmarks but consistently subsided within 40 minutes.

**RUNNING IMPROVED SOME MEASURES OF INTERVERTEBRAL DISC HEALTH IN ADULTS WITH CHRONIC LOW BACK PAIN: THE ASTEROID RANDOMISED CONTROL TRIAL**

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INTRODUCTION: Low back pain is the primary cause of global disability with up to 40% of cases attributed to intervertebral disc degeneration. (1) Cross-sectional studies (2,3) showed running was associated with better magnetic resonance imaging-derived intervertebral disc health, yet no randomised controlled trials have assessed the effect of running. Therefore, we examined the effects of running on intervertebral disc health in adults with chronic low back pain.

METHODS: This 12-week parallel (1:1) randomised control trial allocated 40 adults aged 18–45 years (mean [SD] age: 33 [6] years, female: 50%) with non-specific chronic low back pain to a running intervention or waitlist control. The running intervention involved a digitally delivered, progressive run-walk interval exercise intervention (3 days/week, 30 minutes/session). Progression was self-directed by participants and in consultation with an accredited exercise physiologist. Magnetic resonance imaging of spinal levels T11/T12 to L5/S1 was performed at baseline, 6 and 12 weeks. The primary outcome was T2 (ms), an objective assessment of intervertebral disc hydration. Secondary objective outcomes were intervertebral disc: height (mm), height-to-vertebral body ratio, volume (cm3) and nucleus-to-annulus signal intensity ratio. Higher objective values indicate better intervertebral disc health. Lastly, Pfirrmann grade (points) assessed intervertebral disc degeneration, a subjective assessment on a 5-point scale, with lower values indicating better intervertebral disc health.

RESULTS: There was no attrition or study-related serious adverse events. Mean (SD) intervention adherence was 70% (20%) and total run distance was 50 (32) km, ranging from 2–110 km over 12 weeks. The intervention improved average lumbar Pfirrmann grade (estimated marginal mean net difference [95%CI]: 0.15 [ 0.25, -0.05] points, P=0.004) and height-to-vertebral body ratio ( 0.01 [0.00, 0.02] mm, P=0.039), yet not T2 (-0.13 [-1.74, 1.48] ms, P=0.873), height (0.00 [-0.13, 0.13] mm, P=0.991), volume (-0.01 [ 0.24, 0.23] cm3, P=0.966), or nucleus-to-annulus signal intensity ratio (0.05 [-0.04, 0.13], P=0.272).

CONCLUSION: Running improved some outcomes of intervertebral disc health in adults with non-specific chronic low back pain. Importantly, no deleterious effects or adverse events were observed. To determine if these improvements are sustained, exploring the effect of a longer running intervention warrants investigation, with potential implications for treating intervertebral disc pathology and low back pain.

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**IMPACT OF 12-WEEK RESISTANCE TRAINING DIFFERING IN SET CONFIGURATION ON MUSCULAR PERFORMANCE, BODY COMPOSITION, AND POSTURAL BALANCE IN POSTMENOPAUSAL WOMEN.**

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INTRODUCTION: Resistance training is a key strategy to counteract the decline in muscle function, body composition, bone mineral density and balance control associated with postmenopause (1,2). This study aimed to evaluate the adaptations of two resistance training protocols differing in set configuration on muscular performance, body composition, balance, and bone mineral density.

METHODS: Physically active postmenopausal women (n=16) were randomly assigned to control (CON) or experimental groups: 9 sets of 4 repetitions with 45 seconds inter-set rest interval (4S), or 4 sets of 9 repetitions with 120s rest (9S), ensuring an equivalent work-to-rest ratio. This study was funded by the Spanish Ministry of Science, Innovation and University (PID2021-124277OB) and lasted 12 weeks, with participants training twice per week using 12 repetition maximum (12RM) load in leg press, bench press, leg curl and lat pull-down. Muscular performance was assessed with 12RM load and was also evaluated by the number of maximal repetitions performed with the initial 12RM load (PRE) after the intervention (POST). Body composition –lean mass (kg) and fat percentage (%)– was measured using a Bodystat Quadscan 4000. The mean velocity of the center of pressure displacement (CoP) with a Wii Balance Board under four different conditions: eyes open (EO) and eyes closed (EC) on firm surface; eyes open (EOF) and eyes closed (ECF) on unstable surface. Bone mineral density (BMD) at the calcaneus was assessed using ultrasound densitometry. A 3x2 ANOVA (3 groups and 2 time points) was used for the statistical analysis.

RESULTS: The analysis of muscular performance showed a main effect of moment (p=0.018) and group × moment interaction (p=0.049), with an improvement of the load lifted for all exercises only in the experimental groups. The improvement was consistently greater in 9S compared to 4S. The number of repetitions completed with the initial 12RM load increased in POST (p=0.004). Compared to PRE, fat-free mass increased (+0.92 kg; p=0.035) and body fat percentage showed a decreasing trend (-1.16%; p=0.067) in POST. In postural balance, a group main effect was found in EO with the 9S exhibited

higher mean COP velocities compared to 4S (p=0.048). A main effect of moment in ECF condition was found (p=0.007) with higher velocities in PRE compared to POST. No significant changes were found in BMD.

CONCLUSION: Twelve weeks of resistance training enhanced muscular performance and body composition in postmenopausal women. Long set configurations (i.e., 9S) had a greater impact on muscular performance compared to shorter ones (i.e., 4S). However, set configuration did not modulate balance adaptations, and no significant effects were observed in BMD.

These findings reinforce the importance of resistance training in postmenopausal women, with potential implications for functional performance and fall prevention strategies.

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**HOME-BASED, APP-MONITORED BODY-WEIGHT RESISTANCE TRAINING ENHANCES STRENGTH, BALANCE, AND COGNITION IN OLDER ADULTS WITH SARCOPENIA: PRELIMINARY FINDINGS FROM THE GYM STUDY**

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INTRODUCTION: Sarcopenia is an age-related condition characterized by reduced muscle strength, mass, and function, leading to an increased risk of falls, fractures, physical disability, and mortality. Few controlled studies have assessed the efficacy of physical activity in treating sarcopenia. This study presents preliminary results from the Grow Your Muscle (GYM) randomized-controlled trial, a 48-week home-based, app-monitored body-weight resistance training program aimed at improving muscle function and mass in older adults with sarcopenia, both in the general population (GP) and in persons with HIV (PWH).

METHODS: Participants were sedentary adults diagnosed with sarcopenia based on low appendicular skeletal muscle mass index (ASMMI) by bioimpedentiometry (BIA) and/or reduced handgrip strength, aged >60 years (GP) and >50 years (PWH). Participants were randomized (1:1) within each group into: (1) an Exercise Group (EG) performing a home-based, app-monitored resistance training program; or (2) a Control Group (CG) receiving no exercise prescription. Assessments at baseline (BL) and week 48 (W48) included muscle function (handgrip strength, chair-stand test, maximal knee extensor strength, Mini-BESTest, 6MWT), body composition (DEXA), cognitive function (TMA, TMB, digit symbol test), and MRI evaluation of Intermuscular Adipose Tissue (IMAT) and muscle Cross-Sectional Area (CSA). Changes between BL and W48 were assessed using the Wilcoxon matched-pairs signed-rank test, while differences in BL values and percent change between groups were analyzed with the Mann–Whitney test.

RESULTS: A total of 196 participants were enrolled (98 GP, 98 PWH), and 87 [EG: n=43, 69% male, age 63 (59-69); CG: n=44, 70% male, 67 (61-73), median (IQR)] completed the 48-week assessment, while 34% (n=45) dropped out. At W48, significant improvements from BL were observed in EG for measures of muscle function (handgrip strength, p=0.017, chair-stand, p<0.0001, maximal knee extensor strength, right: p=0.033, left: p=0.002 and Mini-BESTest, p=0.0001); body composition (leg lean mass, p=0.024); and cognitive function (TMA: p=0.009; TMB: p=0.045; digit symbol: p<0.0001). Significant between-group differences were found in handgrip strength (p=0.013), chair-stand (p=0.0003), left knee extensor strength (p=0.04), and Mini-BESTest (p=0.0001). No significant differences were observed for MRI measurements and the other parameters.

CONCLUSION: These preliminary findings suggest that a 48-week home-based, app-monitored body-weight resistance training program can improve muscle strength, and mass, balance, and cognitive function.

## Oral Presentations

### OP-MH34 Mixed-Exercise Therapy / Pregnancy

**HOW CAN WE HIT PRENATAL NORMOTENSION THROUGH HIIT? ANALYSIS OF EXERCISE-INDUCED CHANGES IN INSULIN, LEPTIN, RESISTIN AND IRISIN IN THE SECOND TRIMESTER OF PREGNANCY - A RANDOMIZED CONTROLLED TRIAL**

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INTRODUCTION: To avoid blood pressure (BP) disorders, pregnant women have been advised to engage in moderate to vigorous physical activity (MVPA). However, there is little data available on the cardiovascular effects of high-intensity interval training (HIIT) in the perinatal period. We aimed to determine how an 8-week HIIT programme affects insulin, leptin, resistin, and irisin levels and their role in BP regulation during pregnancy.

METHODS: The study involved 54 Caucasian participants identifying as women in uncomplicated, singleton pregnancies (age 32 ± 4 years, week of gestation 24 ± 4, mean ± SD). Thirty-four were randomly allocated to the 8-week supervised HIIT programme (HIIT group). The comparative (EDU) group consisted of twenty pregnant women who completed an edu-

cational programme and were encouraged to perform MVPA on their own. Before and after the interventions, maternal blood pressure (BP), serum glucose, carbohydrate and lipid metabolism markers (including insulin, leptin, resistin, and irisin) from blood samples taken in fasting conditions were assessed.

RESULTS: All participants had normal glucose and lipid profile values throughout the study. At baseline, both HIIT and EDU groups presented similar systolic (111.76 ± 9.42 and 115.95 ± 11.77 mmHg) and diastolic BP (73.12 ± 6.63 and 72.95 ± 8.66 mmHg) at rest. Although all participants met the inclusion criteria (normotension, normoglycaemia, and normolipidaemia), further analyses showed statistically significant differences in baseline levels of blood insulin ($p = 0.001$), leptin ($p = 0.001$), and resistin ($p = 0.046$). The baseline irisin concentration did not differ between groups ($p = 0.266$). In the HIIT group, we observed a significant decrease in diastolic BP ($p = 0.031$), and in the EDU group, a significant decrease in systolic BP ($p = 0.005$), but all values were within the normotension range. HIIT training induced a statistically significant increase in insulin ($p = 0.005$) and resistin ($p < 0.001$) levels. Moreover, leptin production tended to increase but did not reach statistical significance ($p = 0.071$). The only significant change observed in the EDU group was the decrease in resistin ($p = 0.037$). Despite these differences between groups, we observed similar associations of selected biomarkers with BP after eight weeks of interventions. In both groups, higher diastolic BP was significantly correlated with higher insulin ($r = 0.51$ and $r = 0.45$; $p < 0.05$) and leptin ($r = 0.39$ and $r = 0.62$; $p < 0.05$). After both interventions, we observed no associations of resistin and irisin with systolic or diastolic BP.

CONCLUSION: Physical activity in pregnancy, regardless of intensity, optimises physiological and biochemical responses, maintaining normotension. HIIT, similarly to the commonly recommended MVPA, due to the interconnection of hormones regulating the cardiovascular and metabolic systems, can help avoid BP disorders without negatively affecting the course of pregnancy or neonatal outcomes.

**POSTPARTUM SPRINT INTERVAL TRAINING IS SAFE AND RAPIDLY INCREASES FITNESS IN TRAINED FEMALES**

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INTRODUCTION: Female athletes, or those in arduous occupations, lack objective guidance on effective and safe rigorous training postpartum. Our investigation examined the effectiveness and safety of sprint interval training (SIT) undertaken soon postpartum (PP) in a cohort of healthy females ranging from recreationally active to international-level athletes.

METHODS: Nine new mothers completed laboratory testing pre-intervention (PPpre) and post-intervention (PPpost). We measured maximal oxygen consumption ($\dot{V}O_2$ max) with a metabolic cart, peak cardiac output ($\dot{Q}$peak) with inert gas rebreathing, and blood volume (BV), plasma volume (PV), and haemoglobin mass (Hbmass) with carbon monoxide rebreathing. Between laboratory visits, participants completed six weeks of home-based SIT at 130% of $\dot{V}O_2$ max peak power output (PPO). Sessions were conducted thrice weekly and progressed from four to eight 30-second sprints. Freely chosen moderate-intensity aerobic exercise was performed on alternate days. The training was supervised remotely by an experienced exercise physiologist.

RESULTS: No adverse events occurred, and collectively, 155/162 sessions were completed. All participants breastfed with no difficulties throughout the study duration. Mean study entry was 8.0±2.5 weeks PP and parity 1.6±0.8 children. Absolute (2.44±0.34 vs 2.79±0.27 L/min $p<0.0001$) and relative $\dot{V}O_2$ max (36.1±4.8 vs 42.0±4.8 mL/kg/min $p<0.0001$) both increased from PPpre to PPpost. Similarly, absolute (236±25 vs 267±21 watts $p<0.0001$) and relative (3.5±4 vs 4.0±0.4 watts/kg $p<0.0001$) PPO also increased from PPpre to PPpost. $\dot{Q}$peak remained stable from PPpre to PPpost (14.7±2.0 vs 14.6±2.1 L/min, 8.3±1.2 vs 8.3±1.1 L/min/m2). Values for Hbmass (617±76 vs 631±84 g, 9.2±1.3 vs 9.6±1.4 g/kg), BV (4737±610 vs 4877±611 mL, 71±11 vs 74.12 mL/kg) and PV (2937±428 vs 3014±391mL, 44±7 vs 46±8 mL/kg) tended to be increased at PPpost, although this did not reach statistical significance.

CONCLUSION: Lack of change in $\dot{Q}$peak despite an increased $\dot{V}O_2$ max could be explained by a greater arterio-venous oxygen difference at PPpost. In addition, variability in study entry time, combined with cardio-haematological transitions, could account for the nonsignificant changes in haematological and $\dot{Q}$peak results. Breastfeeding may have influenced $\dot{Q}$ and PV. In summary, six weeks of SIT rapidly improves cardiovascular fitness, as demonstrated by enhanced PPO, in previously trained women. Ergometer cycling SIT is safe, can be started as soon as five weeks postpartum, and does not impede breastfeeding. Our intervention was effective in recreationally active females to professional sportswomen.

**EFFECT OF EXERCISE TRAINING IN PREGNANCY IN PEOPLE WITH OVERWEIGHT/OBESITY ON ADIPONECTIN AND LEPTIN CONCENTRATIONS IN MATERNAL AND CORD BLOOD**

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INTRODUCTION: High maternal body mass index (BMI) is associated with adverse pregnancy outcomes. The adipokines adiponectin and leptin are involved in metabolic regulation. Exercise training during pregnancy can potentially influence the concentrations of these adipokines, lower the risk of several adverse pregnancy outcomes, and improve the intrauterine environment for the fetus. We aimed to study the effects of exercise training during pregnancy on adiponectin and leptin concentrations in maternal blood and cord blood in individuals with pre-pregnancy overweight/obesity.

METHODS: This is a secondary analysis of the Exercise Training in Pregnancy (ETIP) randomized controlled trial. ETIP was a parallel-group randomized controlled trial in pregnant individuals (N = 91) with a pre-pregnancy BMI ≥ 28 kg/m2. We

offered the intervention group (n = 46) three weekly supervised exercise sessions (35 minutes of moderate-intensity endurance training and 25 minutes of strength training), starting in gestational week (GW) 12-18 and continuing throughout pregnancy. We collected maternal blood samples at baseline, in GW 34-37, and 3 months postpartum, and cord blood at delivery. Adiponectin and leptin concentrations were assessed by enzyme-linked immunosorbent assays (ELISA). We compared changes over time and between groups in maternal blood using linear mixed models and differences between groups in cord blood with t-tests.

RESULTS: Seventeen participants were lost to follow-up in the ETIP trial and 50% of the women in the exercise group adhered to the exercise protocol as prescribed a priori. We measured adiponectin in samples from 58 participants at baseline and in GW 34-37, and from 62 participants postpartum. There was no change in adiponectin concentrations from baseline to GW 34-37 (estimated mean difference [MD], -0.05 µg/mL, p = .91) or from baseline to postpartum (MD, -0.05 µg/mL, p = .90), and no differences between groups at any time-point. We measured leptin from 64 participants at baseline, 59 in GW 34-37, and 56 postpartum. Leptin increased from baseline to GW 34-37 (MD, 8.8 ng/mL, p < .001) and decreased between baseline and postpartum (MD, -16.2 ng/mL, p < .001), with no between-groups differences from baseline to GW 34-37 (MD, -4.0 ng/mL, p = .18) or from baseline to postpartum (MD, -0.8 ng/mL, p = .82). Cord blood adiponectin concentration was 24.4 µg/mL (standard deviation [SD] 5.4) in the exercise group (n = 22) and 24.8 µg/mL (SD 5.4) in the control group (n = 28, p = .77). There was no statistically significant difference in leptin concentrations in cord blood samples: 25.6 ng/mL (SD 22.0) in the exercise group (n = 19) versus 29.6 ng/mL (SD 17.9) in the control group (n = 25, p = 0.54).

CONCLUSION: Offering pregnant women with overweight/obesity supervised exercise training during pregnancy had no statistically significant effect on maternal or cord blood concentrations of adiponectin or leptin. The suboptimal adherence rates to exercise may explain these findings.

**AN INDIVIDUALIZED AND UNLIMITED TRAINING PROTOCOL HAS A POSITIVE EFFECT ON FATIGUE AND PHYSICAL FITNESS IN PATIENTS WITH LONG-COVID: RELATIONSHIP TO RED BLOOD CELL MORPHOLOGY**

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INTRODUCTION: Physical activity may have a positive effect on the rehabilitation of patients with Long-COVID (LC) with mild to moderate disease severity. However, current approaches are often time-limited and may not fully restore daily living skills. Furthermore, the physiological processes that are improved by physical activity in LC are not fully understood. This study examines the effect of an individualized, time-independent exercise intervention on fatigue, physical fitness, degree of functional limitations and duration of the program. Finally, the findings will be related to RBC morphology.

METHODS: Ten LC (3 f, 7 m; age: 45±16 years) completed the TRIBAL program, a multiphasic, multidisciplinary training protocol. Training intensity was progressively increased based on individual performance to avoid post-exertional malaise. Sessions (2-3 times per week, 30 min) included 15 minutes on a whole-body ergometer and 15 minutes of breathing, strength, and stretching exercises. Patient-reported outcomes (Post-COVID functional status (PCFS) scale, FACIT-fatigue score) and objective parameters (repetitions of 1-minute sit-to-stand test (1MSTST), average wattage over 15 minutes with own pacing, blood samples) were analyzed at the beginning (pre) and after each of the five phases (post phase 5 = post). The Post-COVID score (PCS) was determined pre and post. RBC morphology was assessed using Pappenheim-stained blood smears and analyzed using microscopic evaluation. Statistical analyses included tests for normal distribution, t-tests, Wilcoxon tests, and Pearson correlation.

RESULTS: At the end of the protocol, the fatigue score improved by 27.1% ($p<0.001$); towards clinically normal values. The repetitions in the 1MSTST increased by 55% ($p<0.001$) and the wattage by 194% ($z=-2.703$, $p=0.005$). RBC morphological changes decreased by 5.1% ($p<0.05$) and an average of 92.2% RBC then showed normal cell shape. High positive correlation was calculated between wattage and fatigue $r=0.669$, $p=0.001$. Medium correlations were found between 1MSTST and fatigue $r=0.399$, $p=0.041$ and morphology and fatigue $r=-0.403$, $p=0.049$. The PCFS decreased from an average of 2 (minor functional limitations) to 1 (negligible limitations) and the PCS improved from moderate to no/mild LC ($z=-2.703$, $p=0.007$). LC patients completed the program in 37±10 weeks and corresponding 61±18 training sessions.

CONCLUSION: The unique time-unlimited, progressive and individualized TRIBAL protocol significantly improves physical fitness, reduces functional limitations and LC symptoms such as fatigue, which may be related to reductions in RBCs morphological abnormalities. It became apparent that a long period of time is necessary for LC therapy. However, by the end of the program, it was evident that the functional limitations were minimal, and the patients had fully regained their everyday skills, leading to a substantial improvement in their quality of life.

Oral Presentations

OP-MH16 Return to Play

**HOW TO REDUCE INJURY RISK AFTER RETURN-TO-PLAY IN ELITE FOOTBALL? SYNERGIES BETWEEN EXPERIENCE-BASED AND DATA-DRIVEN INSIGHTS**

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INTRODUCTION: In elite football, injury risk is considerable, especially in the weeks after return-to-play (RTP) from a previous injury. Consequently, optimal rehabilitation and well-informed decisions regarding the timepoint of RTP are crucial. Arguably, experiential knowledge as well as data-driven analyses may provide meaningful insights. This work aims to leverage their synergies to identify options for improving the rehab process and reduce injury risk after RTP.

METHODS: Following a mixed-methods approach, semi-structured interviews were conducted with 14 practitioners in elite European football (2 orthopaedic surgeons, 5 physiotherapists, 7 rehab and / or strength-and-conditioning (S&C) coaches). Areas of overlap in the interview data were identified by thematic analysis. Subsequently, media-based injury data from European top leagues were used to investigate novel themes where possible. Specifically, we used methods of causal inference and classifier development to assess the expert opinion that a reduction in injury risk may be expected when RTP is delayed.

RESULTS: 4 themes and 6 subthemes were identified. With the highest consistency and attributed importance, theme 1 posits that injury risk after RTP would be lower with longer rehab. Data analytics confirmed the previously reported negative association between rehab time and injury risk. However, this association is entirely accounted for by higher exposure after early return ("They return early for a reason."). Importantly, the virtual absence of high exposures after long rehab (for the respective diagnosis) impedes on predicting the effect of actively prolonging rehab time.

CONCLUSION: Taken together, our results point to surprisingly clear and simple options for improving rehab outcome in elite football. While data analytics did not provide evidence in favour of reduced injury risk with prolonged rehab, the massive increase in risk with high exposures after early return entails two important messages: (1) If an early return must be attempted exposure should be limited to the strict minimum. (2) If no injury occurred during initial match exposure(-s), luck should not be mistaken for evidence of low injury risk.

**FACTORS FOR A SUCCESSFUL RETURN TO SPORT AFTER ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A 2-YEAR FOLLOW-UP COHORT STUDY ON REHABILITATION VOLUME, PSYCHOLOGICAL READINESS, AND MOTOR FUNCTION**

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INTRODUCTION: Return to sport (RTS) after an anterior cruciate ligament (ACL) rupture and reconstruction is successfully reached when one returns to the pre-injury level of sports participation. A multitude of individual and spatiotemporal factors interact during the rehabilitation and RTS process. Only if these potential factors are known, they can be considered and, where possible, modified to improve the RTS process. The objective of this study was to find contributors to RTS success or time until RTS in patients after an an ACL reconstruction aiming to RTS.

METHODS: We performed a cohort study and secondary analysis of the data of two intervention studies. We included adults <36 years of age with a tendon autograft ACL reconstruction who were active in any type of sport prior to the injury and aiming to RTS. All participants were prospectively monitored for 24 months. At the end of the individual post-surgery rehabilitation and re-injury prevention programs, self-report- and objective functional outcomes were quantified. Main outcome measures were the potential RTS success (return to the same type of sports, frequency, intensity, and quality of performance as pre-injury), secondary injuries, and all rehabilitation and training measures were prospectively monitored. To determine the contributing factors, Cox regressions for traits and baseline factors and a logistic mixed model, which also included prospective time-dependent factors, were calculated.

RESULTS: Overall, 203 participants were included; 104 (51% of the total sample and 68% of the full cases) successfully returned to their sporting activity. The median duration until RTS was 302 days (interquartile range was 114 days). Contributing factors were the type of working (blue- vs. white collar: odds ratio (OR) for RTS = 0.51 [95% CI = 0.29 to 0.90]) and the athletic status (elite vs. non-elite: OR = 2.28 [1.03 to 5.03]). Prospectively, higher rehabilitation volumes until the end of the rehabilitation were predictive for RTS success: the OR per additional hour of rehabilitation was 1.004 [1.001 to 1.006]. Functional abilities such as the normalized knee separation distance during drop jump landing (OR = 0.961 [0.924 to 0.999]) were predictive at a later stage, at the end of the re-injury prevention. Psychological readiness for RTS was predictive at most of the timepoints: those who were confident to RTS were more successful to RTS at the end of the rehabilitation (OR = 1.029 [1.004 to 1.056]) and at the end of the re-injury prevention (OR = 1.038 [1.004 to 1.073]).

CONCLUSION: The most important factors for a successful pre-injury-level return to sport after anterior cruciate ligament reconstruction were the exercise volume, psychological readiness and functional hop/jump abilities. Whilst the impact of

these modifiable factors were robust against multilevel modeling, the impact of athletic and working status vanishes when the prospective factors are included.

**TEMPORAL CHANGES IN TALOFIBULAR DISTANCE DURING ULTRASOUND-GUIDED ANTERIOR DRAWER TEST IN PATIENTS WITH ACUTE GRADE Ⅱ LATERAL ANKLE SPRAINS**

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INTRODUCTION: Lateral ankle sprain (LAS) is the most common sports-related injury, with a re-injury rate exceeding 50% (1). Despite conservative management being the standard approach for grade II injuries (excluding recurrent cases), the timeline for the resolution of anterior displacement remains unclear. This study aimed to quantify temporal changes in talofibular distance using an ultrasound-guided anterior drawer test to determine the critical period for restoring ankle joint stabilization in patients with acute grade II LAS.

METHODS: This prospective observational study included 94 patients with acute grade II LAS who visited a single clinic between April 2021, and December 2023. All patients underwent splint fixation for 1–2 weeks without weight-bearing restrictions, followed by functional ankle brace until 6 weeks. Rehabilitation began at 3 weeks to facilitate functional recovery and return to sports. The ultrasound-guided anterior drawer test was conducted at initial consultation and follow-ups at 1, 3, and 5–6 weeks by a single examiner, assessing changes in talofibular distance (difference between maximum and minimum distances). Statistical analysis was performed using a mixed-model repeated-measures one-way analysis of variance, followed by Tukey's post-hoc test, with significance set at $p < 0.05$.

RESULTS: The mean change in talofibular distance on the affected side was 3.2±1.8 mm at the initial consultation and 3.1±1.7, 1.6±0.9, and 1.6±1.0 mm at 1, 3, and 5–6 weeks, respectively. A significant reduction was observed at 3 weeks ($p < 0.01$), with no further significant changes thereafter. The mean change in talofibular distance on the unaffected side was 1.3±0.8 mm. The mean time to return to sports practice (excluding dropouts) was 41.2±14.3 days from the initial consultation.

CONCLUSION: These findings identified mean change in talofibular distance on the affected side significantly decreased at 3 weeks post-injury and remained unchanged at 5–6 weeks. Previous studies reported that unrestricted activity from the initial consultation failed to restore joint stability, even at 3 and 6 weeks (2). Conversely, our results suggest that restricting activity to walking until 3 weeks facilitated ligament healing, thereby optimizing rehabilitation outcomes and preventing residual joint instability upon return to play at 5–6 weeks .

The critical recovery period for change in talofibular distance occurred between 1 and 3 weeks post-injury. These findings highlight the importance of managed activity limitation in the early phase in promoting ligamentous recovery and reducing re-injury risk in acute grade II LAS.

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**THE LYSHOLM SCORE CAN BE USED AS A SIMPLE METHOD TO EVALUATE THE BOXERS WITH CHRONIC KNEE PAIN: A CORRELATIVE ANALYTICAL STUDY**

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INTRODUCTION: Chronic knee pain (CKP) is defined as knee pain persisting for over three months, with a visual analogue scale (VAS) score of 3 or higher in the past month. Pain has the potential to induce deterioration in motor control capabilities, disrupt neuromuscular coordination and power output, increase athletes anxiety and depression levels, and subsequently impact their sporting form and competitive performance. Currently, the common assessment indicators for CKP encompass both subjective measures (e.g., VAS, Lysholm knee function score, etc.) and objective measures (e.g., muscle strength, range of motion (ROM), muscle circumference, knee stability, etc.). However, the complexity and time-consuming nature of these tests will, to a certain extent, affect the training and rest of athletes. Consequently, this study aims to investigate the correlations between subjective and objective measures to identify a simple and rapid testing method that can assist coaches in quickly monitoring the CKP status of boxers.

METHODS: Thirty-two boxers (22 males: 19.9 ± 2.3 y, 180.2 ± 8.3 cm, 71.0 ± 20.9 kg, trained for 5.3 ± 2.0 y, suffering from CKP for 19.0 ± 13.3 month; 10 females: 21.0 ± 1.0 y, 170.8 ± 6.9 cm, 63.5 ± 8.5 kg, trained for 6.2 ± 3.6 y, suffering from CKP for 20.2 ± 8.1 month) with CKP were recruited from 5 provincial boxing teams. After 5-minute jog and 5-minute dynamic stretching of warm-up, VAS of knee pain, Lysholm knee function score, ROM of knee flexion, maximal voluntary isometric contraction (MVIC) muscle strength of knee extensor and flexor, muscle circumference at 10cm above the upper edge of the patella and single-leg stance with eyes closed were measured. All data were analyzed using the Spearman rank correlation method. Correlation interpretations were as follows: $|rs| = 0.1$ small; $|rs| = 0.3$ medium; $|rs| = 0.5$ large.

RESULTS: The Lysholm score has a strong correlation with VAS (rs = -0.591, p < 0.001), a medium correlation with MVIC muscle strength of knee extensor (rs = 0.309) and flexor (rs = 0.372, p = 0.036), and a small correlation with knee stability (rs = -0.210), and no correlation with ROM (rs = -0.045) and muscle circumference (rs = -0.083). VAS has a small correlation with MVIC muscle strength of knee extensor (rs = -0.108), muscle circumference (rs = 0.143), and knee stability (rs = 0.157), and no correlation with MVIC muscle strength of knee flexor (rs = -0.011) and ROM (rs = 0.035).

CONCLUSION: Lysholm knee function score could be an alternative comprehensive evaluation for objective measures for boxers with CKP.

**EFFECTIVENESS OF NEUROCOGNITIVE TRAINING IN ENHANCING REHABILITATION OUTCOMES AFTER ACL RECONSTRUCTION: A SYSTEMATIC REVIEW**

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INTRODUCTION: Anterior cruciate ligament reconstruction (ACLR) is one of the most common knee surgeries, yet many patients fail to return to their pre-injury performance levels. [1] Emerging evidence suggests that deficits in neurocognitive processing may contribute to suboptimal neuromuscular control and increased re-injury risk. [2] We hypothesized that integrating neurocognitive training—through approaches such as cognitive-behavioral interventions, dual-task neuromuscular exercises, and operant conditioning protocols—can accelerate neuromuscular adaptations and enhance functional recovery in ACLR patients.

METHODS: A systematic review was conducted following PRISMA guidelines. Two databases were searched in January 2025, and studies evaluating neurocognitive training interventions in ACLR patients were included. Out of 400 records identified, 352 studies were screened after duplicates were removed, 8 full-text articles were assessed for eligibility, and 6 studies met the inclusion criteria.

RESULTS: Among the 6 studies included, two randomized controlled trials demonstrated that neurocognitive training facilitated faster load symmetrization, improved gait patterns, greater proprioception efficiency, and enhanced quality of life compared to conventional rehabilitation. Additionally, a pilot study employing a telephone-based cognitive-behavioral intervention showed promising improvements in return-to-sport readiness and psychological adaptation. Further, quasi-experimental and laboratory investigations reported that advanced neuromuscular training improved performance on visuomotor reaction tests and single-leg hop tests, while an operant conditioning protocol induced acute increases in corticospinal excitability. An innovative aquatic proprioceptive training program was also associated with enhanced proprioception.

CONCLUSION: These preliminary findings suggest that neurocognitive training could serve as a feasible adjunct to traditional ACLR rehabilitation. However, due to the limited number of studies, varied study designs, and lack of standardized methodologies, the current evidence is not definitive. A larger, more robust body of research is needed to confirm these benefits and to establish optimal intervention protocols.

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## Oral Presentations

### OP-MH33 Inflammation

**REDUCING INFLAMMATION THROUGH PHYSICAL ACTIVITY IN MIDDLE-AGED AND ELDERLY POPULATIONS: EVIDENCE FROM CHARLS**

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INTRODUCTION: Chronic low-grade inflammation is a pathogenic mechanism underlying many chronic diseases such as type 2 diabetes and cancer [1]. C-reactive protein (CRP) is an important indicator reflecting systemic inflammation levels [2]. Previous studies have shown that Physical Activity(PA) helps reduce CRP levels, but most research has focused on younger adults, with relatively few studies specifically targeting middle-aged and elderly individuals [3]. Moreover, middle-aged and elderly people are more susceptible to chronic inflammation [4]. Therefore, exploring the association between PA and inflammation levels in the middle-aged and elderly population is necessary.

METHODS: We used data from the third wave (2013) of the China Health and Retirement Longitudinal Study (CHARLS) to test our hypotheses. Specifically, a total of 6,279 middle-aged and elderly individuals aged 45 years and above participated in this study, representing a weighted sample of 261,532,239 middle-aged and elderly people in China. According to the

WHO physical activity guidelines, we defined individuals with weekly PA expenditure of <600 MET-minutes as not meeting the standard, and those with ≥600 MET-minutes as meeting the standard. Furthermore, to verify whether inflammation levels continuously decrease with increasing PA levels, we divided physical activity expenditure into quartiles. Multiple linear regression was used to explore the association between PA and CRP levels; all analyses were adjusted for age, gender, education level, marital status, per capita household expenditure(PCE), smoking, alcohol consumption, and sleep duration.

RESULTS: After adjusting for age, gender, education level, marital status, PCE, sleep duration, alcohol consumption, and smoking, compared to individuals not meeting the guidelines, those meeting the guidelines had a significantly lower C-reactive protein level by an average of 0.772 mg/L (β = -0.772, 95% CI: -1.226 to -0.318, p < 0.001). Compared to the first quartile of PA, the CRP concentration in the second quartile decreased by an average of 0.366 mg/L (β = -0.366, 95% CI: -0.843 to 0.112, p = 0.134). In the third quartile, CRP concentration decreased by an average of 0.429 mg/L (β = -0.429, 95% CI: -0.915 to 0.057, p = 0.083). In the fourth quartile, CRP concentration significantly decreased by 0.731 mg/L (β = -0.731, 95% CI: -1.226 to -0.236, p = 0.004). These findings suggest a trend of decreasing CRP levels with increasing PA.

CONCLUSION: Our study results indicate that adequate physical activity can reduce systemic inflammation levels among middle-aged and elderly individuals in China, and as physical activity levels increase, inflammation levels further decrease. In the future, more policies and measures should be implemented to promote physical activity participation among the middle-aged and elderly population to maintain lower inflammation levels.

**BIOMARKERS OF CARDIAC, MUSCULOSKELETAL STRESS AND INFLAMMATION IN EXTREME ENDURANCE ATHLETES: INSIGHTS FROM A MOUNTAIN ULTRAMARATHON**

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INTRODUCTION: Extreme physical exertion, such as ultramarathons, places considerable physiological demands on the cardiovascular and musculoskeletal systems. Biomarkers like high-sensitivity Troponin I (hs-TnI), NT-proBNP, high-sensitivity C-Reactive Protein (hs-CRP), creatine kinase-MB (CKMB), Interleukin-6 (IL-6), and soluble ST2 (sST2) offer insights into myocardial stress, systemic inflammation, and skeletal muscle damage. This study assessed these biomarkers in athletes completing a 330 km mountain ultramarathon with a 24,000 m elevation gain to differentiate physiological adaptation from pathological risks.

METHODS: Blood samples were collected from 48 participants at three time points: pre-, mid- (148 km), and post- (330 km) race. Biomarker levels were measured using MAGLUMI X3 (Snibe®) and Alinity immunoassay systems (Abbott®). Pre-concentrations were compared with mid- and post- to evaluate the impact of extreme exertion.

RESULTS: All biomarkers showed significant increases during the race. hs-TnI levels rose from <5 ng/L at pre- to peaks of 12 ng/L at post-, indicating mild, transient myocardial strain without permanent damage. NT-proBNP increased from 50 pg/mL at pre- to >600 pg/mL at post-, reflecting acute cardiac volume overload. Inflammatory markers showed marked responses: hs-CRP levels increased from <1 mg/L at baseline to 30 mg/L at post-, while IL-6 increased to >200 pg/mL at mid- and remained elevated at post-, indicating early systemic inflammation.

sST2 showed notable elevations, with baseline levels (~30 ng/mL) close to thresholds indicating subclinical cardiac stress, rising to >100 ng/mL at post-, suggesting baseline myocardial stress exacerbated by exercise. CK levels rose to 5,000 U/L at post-, indicating acute severe skeletal muscle damage, while CKMB peaked at 60 U/L, requiring careful contextual analysis.

CONCLUSION: Extreme endurance events cause substantial physiological stress, as reflected in biomarker fluctuations. The alarming baseline and peak levels of sST2 highlight its utility in detecting early cardiac strain. Tailored monitoring and recovery strategies are vital to safeguarding the long-term health of athletes exposed to such challenges. Additionally, the significant rise in IL-6 and hs-CRP underscores the pronounced inflammatory response induced by extreme exertion, which may contribute to prolonged recovery and systemic stress.

**CHRONOTYPE DOES NOT SOLELY EXPLAIN THE DIFFERENCES IN MARKERS OF CHRONIC INFLAMMATION IN HEALTHY, MALE AND FEMALE ADULTS: A CROSS-SECTIONAL STUDY.**

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INTRODUCTION: Chronotype, or diurnal preference, spans from morning (M-type) to evening (E-type). It can be subjectively or objectively measured [1], and can be state- or trait-like [2]. E-types are linked to unhealthy lifestyles, such as irregular meals and lower physical activity (PA) [3], increasing their risk of low-grade inflammatory issues like cardiometabolic diseases [4]. Potential sex differences exist in chronotype and cardiometabolic risks [5]. This study examined differences in moderate-vigorous PA (MVPA), sex, and the chronotype-inflammation relationship in adults.

METHODS: Fifty-one healthy adults [19 male (M), 33 female (F); 18-41 years] wore a triaxial accelerometer for 8 days/nights to assess MVPA and chronotype via sleep midpoint. Fasted blood samples and anthropometric data were collected. Total and differential leukocyte counts were analysed. Monocyte subsets were identified via flow cytometry. Plasma interleukin-6 (IL-6) and LPS-stimulated IL-6 levels were measured using ELISA. T-tests and Mann-Whitney U tests assessed MVPA differences between chronotypes, and sex differences in inflammatory markers. Generalised linear models evaluated

chronotype-inflammatory markers associations, further adjusted for age. Effect sizes were calculated, and data presented as mean±SD or median (IQR). P<.05 indicate significance.

RESULTS: M-types were ~3 years older than E-types [26 (23-33) years vs. 23 (21-26) years; p=.010, ES=.43]. No MVPA-differences were noted between chronotypes (p=.604, ES=.15). LPS-stimulated IL-6 levels were ~6x higher in M than F (p=.032, ES=.39). M-type M had lower classical monocyte counts than E-type M [296.4±81.3 vs. 355.6±130.1 cells/µL; p=.024]. M-types showed lower plasma IL-6 [0.58 (0.42-0.75) vs. 0.89 (0.57-1.38) pg/mL; p=.034], lymphocyte [1.59 (1.40-1.77) vs. 1.87 (1.71-2.04) $\times 10^9$/L; p=.020], and monocyte counts [0.37 (0.32-0.41) vs. 0.45 (0.40-0.50) $\times 10^9$/L; p=.017] compared with E-types, but these differences became nonsignificant after age adjustment.

CONCLUSION: This study found no differences in MVPA between chronotypes. LPS-stimulated IL-6 levels were higher in M compared to F. M-types initially showed a more favourable inflammatory profile than E-types; however, this difference was not observed after adjusting for age, suggesting that age may be a major factor influencing chronic inflammation in young to middle-aged adults.

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**IBUPROFEN INTAKE PRIOR TO INTENSE ENDURANCE EXERCISE MIGHT NOT TRIGGER LPS-MEDIATED SYSTEMIC INFLAMMATION IN HEALTHY MALE ATHLETES: A RANDOMIZED, DOUBLE-BLIND, PLACEBO-CONTROLLED CROSSOVER STUDY**

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INTRODUCTION: Non-steroidal anti-inflammatory drugs (NSAID) are widely used in sports for pain management but can exacerbate gastrointestinal issues during exercise [1]. A previous analysis of this study showed that even low, over-the-counter available doses of NSAIDs affect the intestinal barrier. Increased permeability may allow lipopolysaccharide (LPS) to enter the bloodstream, triggering systemic inflammation [2]. LPS-binding protein (LBP) and soluble CD14 (sCD14) cooperate to recognise and respond to LPS initiating immune activation [3]. This study examines whether NSAID use during acute exercise impacts circulating LPS levels, LPS-associated immune responses and immune cell counts.

METHODS: In a randomized, double-blind, crossover study, eleven male subjects (29.2±5.6 yrs; BMI: 24.4±2.8 kg/m²; $VO_2$max: 52.6±4.8 ml/min/kg) completed two 45-minute runs at 75% $VO_2$max, followed by an all-out run. Participants received either a placebo or 400 mg ibuprofen, with a one-week washout phase. Blood samples (pre, 0, 1, 3, and 24 h post-exercise) were analysed by ELISA for LPS, sCD14 and LBP, and a blood analyser was used to measure leukocyte subpopulations. Data were normalised to the baseline measurements prior to analysis using two-factor repeated measures ANOVA.

RESULTS: Although no significant condition*time interactions were observed for LPS (p=0.177, $\eta^2$p=0.224), LBP (p=0.765, $\eta^2$p=0.044), and sCD14 (p=0.736, $\eta^2$p=0.048), significant time effects were revealed for LPS (p=0.018, $\eta^2$p=0.544), LBP (p=0.015, $\eta^2$p=0.364), and CD14 (p=0.005, $\eta^2$p=0.301) highlighting the impact of exercise rather than ibuprofen on these parameters. Bonferroni-corrected post hoc test showed that LPS peaked immediately post-exercise (0h) and was lowest at 24h, although differences between time points were not significant. LBP decreased by 7.4% at 1h (p=0.050) and 9.0% at 3h (p=0.013) post-exercise, while sCD14 increased by 9.3% at 24h (p=0.024). These changes paralleled well-documented increases in leukocyte counts (time: p<0.001, $\eta^2$p=0.751; condition*time: p=0.502, $\eta^2$p=0.070), particularly granulocytes (time: p<0.001, $\eta^2$p=0.801; condition*time: p=0.795, $\eta^2$p=0.013), and a biphasic lymphocyte response (time: p<0.001, $\eta^2$p=0.634; condition*time: p=0.239, $\eta^2$p=0.132).

CONCLUSION: Intense endurance exercise significantly modulates LPS, LBP, and sCD14 levels, as well as leukocyte subpopulations, demonstrating the exercise-induced impact on immune responses. Notably, these changes occurred independently of ibuprofen intake, suggesting that the low-dose ibuprofen-induced disturbance of the intestinal barrier (as demonstrated in the first study part) does not exacerbate systemic inflammatory processes. It remains to be determined whether this holds true for the higher doses that are frequently used.

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**THE EFFECTS OF EXERCISE THERAPY AND SELF-MANAGEMENT SUPPORT ON SYSTEMIC LOW-GRADE INFLAMMATION, GLYCAEMIC CONTROL, LIPIDS, AND BLOOD PRESSURE IN PEOPLE WITH MULTIMORBIDITY: A PRE-PLANNED SECONDARY ANA**

BRICCA, A., NYBERG, M., LEGAARD, G.E., DIDERIKSEN, M., ZANGER, G., THYGESEN, L.C., SKOU, S.T.
*UNIVERSITY OF SOUTHERN DENMARK*

INTRODUCTION: In this pre-planned secondary analysis of the MOBILIZE trial, we investigated the effect of a 12-week personalised exercise therapy and self-management support programme, in addition to usual care, on systemic low-grade inflammation, glycaemic control, lipids, and blood pressure in people with multimorbidity

METHODS: The statistical analysis plan for this pre-planned secondary analysis of the pragmatic, assessor-blinded, multicenter, parallel-group RCT (1:1 treatment allocation) was made available in OSF before any analyses commenced. We enrolled adult patients aged 18 or older with multimorbidity, defined as having at least two of the following conditions: knee or hip osteoarthritis (OA), chronic obstructive pulmonary disease (COPD), heart disease (heart failure or coronary heart disease), hypertension, type 2 diabetes mellitus (T2DM), and depression. Patients with additional comorbidities were not excluded. Individuals (n=228) were randomised (1:1) to the intervention group or usual care. Biomarkers, assessed at baseline and 4 months, included interleukin-1 receptor antagonist (IL-1ra), high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), hemoglobin A1c (HbA1c), fasting glucose, fasting insulin, high-density lipoprotein (HDL), low-density lipoprotein (LDL), triglycerides, and blood pressure. Between-group comparisons of change from baseline to the 4 months follow-up in continuous outcomes were analysed using repeated measures mixed-effects linear model. ClinicalTrials.gov registration: NCT04645732

RESULTS: Between January 18, 2022, and May 30, 2023, 228 were randomised. Participants were allocated to either the exercise therapy and self-management support intervention group (n = 115) or the usual care group (n = 113). In the total group, the average age was 69.8 years (SD 8.4), with a mean BMI of 30.9 (SD 5.7), 43% were female, and patients had an average of 7 chronic conditions (SD 3, range 2–19). The median session attendance for the exercise therapy and self-management support group was 76%. The intention to treat analysis showed that the intervention group had a statistically and clinically significant reduction in systolic blood pressure compared to usual care (mean difference: -4.7 mmHg, 95%CI: -8.8 to -0.6). No statistically significant differences were observed for other biomarkers, although favouring the intervention group. Per-protocol analyses: i) including only individuals attending 75% or more of the intervention sessions, ii) without individuals in the usual care group that received supervised exercise therapy sessions and individuals that in both groups undergo surgery in the 4-month fw

CONCLUSION: Personalised exercise therapy and self-management support reduced systolic blood pressure, but not other biomarkers, in individuals with multimorbidity. Further trials powered to investigate biomarkers related to ageing and cardiovascular health are needed in individuals with multimorbidity to confirm these findings.

## Oral Presentations

### OP-SH26 Psychology IV - Mixed Session II

**AN EXPLORATION INTO WOMEN'S RELATIONSHIP WITH EXERCISE, BODY IMAGE BELIEFS, AND SOCIOCULTURAL FACTORS: A US/ITALY CROSS-CULTURAL COMPARISON STUDY**

HADFIELD, J., TOSELLI, S., LEONARDI, C.
*LOUISIANA STATE UNIVERSITY*

INTRODUCTION: Today's world assesses the ideal female figure as not only thin, but also muscular, or more colloquially known as fit. Internalizing ideal body standards has been linked to various negative health outcomes. Exploring women's pursuits to achieve idealized body appearance and resultant health outcomes has been a salient and sought-after topic among behavioral health researchers. Considering that sociocultural factors significantly influence health outcomes such as disordered eating and disordered exercise, it is vital to assess the social and cultural determinants influencing behavioral dynamics within women's relationships of idealized aesthetics. Two cultures that share Westernized customs and beliefs yet have distinct value systems are the Italian and US cultures. These two distinct cultures hold varying family, peer, and media value systems inherently influenced by cultural impacts that arguably shape today's exercise culture and aesthetic ideals. This study cross-culturally explores Italian and US adult women's relationships with fit ideal body image beliefs and sociocultural factors.

METHODS: This sub-study is under a larger bilingual (Italian/English) multi-phase explanatory sequential mixed-methods design. This sub-study includes the phase that examines differences between sociocultural influences and body image in Italian and US women. Women (n=153) 18-45 living in Italy (n=105) or the USA (n=53) completed an online survey measuring demographic, body image, and sociocultural attitudes, namely the sociocultural attitudes towards appearance questionnaire and the Multidimensional Body-Self Relations Questionnaire. Sub-scales were compared between U.S. and Italian women using analysis of covariance. The model included age, race, income, and education as covariates to adjust for potential confounders between the two groups.

RESULTS: Italian women reported a higher internalization of general appearance than US women (2.60 vs. 2.47, p=0.031) and higher levels of familial pressures regarding appearance (4.36 vs. 3.64, p=0.005). Italian women reported lower fitness evaluations like feelings of being fit than US women (3.14 vs. 3.70, p=0.001) and fitness orientation, such as personal investment in being fit (2.99 vs. 3.30, p=0.005).

Conclusions

Italian and US women differ in the sociocultural internalized pressures toward appearance and general appearance beliefs. These two cultures also differ in how they evaluate and orient themselves to fitness. Since sociocultural factors inform health beliefs, behaviors, and, subsequently, health outcomes, it is warranted to explore further how these significant sociocultural factors and body image-related beliefs inform fitness/exercise behaviors among these women. Our findings may lead to a better understanding of the phenomenon of sociocultural determinants and their relationship with body image and exercise behaviors for optimal women's health outcomes on an internationalized scale.

**WHAT ROLES DO SELF-CONSCIOUS EMOTIONS PLAY FOR ATHLETES? A SYSTEMATIC REVIEW BASED ON ECOLOGICAL SYSTEM THEORY**

TSAI, C., LEISTERER, S., WINKLER, E., CHO, K., ELBE, A.M.

*LEIPZIG UNIVERSITY*

Objective: Self-conscious emotions, such as guilt, shame, pride, and embarrassment, play a key role in the performance outcomes of athletes in sport and training. This systematic review aimed to examine the interplay of personal and contextual sources influencing self-conscious emotions in athletes.

Methodology: We conducted a comprehensive search across Web of Science, Scopus, PubMed, and PsycINFO, covering the years 2004 to 2023. Using key terms such as "self-conscious emotions," "guilt," "shame," "pride," "embarrassment," "environment," "athlete*," and "sport*," we identified 31 studies that met the inclusion criteria: (a) focusing on self-conscious emotions, (b) written in English, (c) investigating factors influencing these emotions, (d) involving sports-related settings or participants, and (e) using qualitative or quantitative methods. Only studies from A&HCI, SCI, or SSCI-indexed journals were included to ensure quality, while theoretical reviews, non-English papers, and studies with non-athlete participants were excluded. Risk of bias was assessed using the Mixed Methods Appraisal Tool (MMAT).

Result: Based on Bronfenbrenners ecosystem theory, we categorized findings into individual (n = 24; e.g., perfectionism, moral disengagement) and microsystem (n = 8; e.g., coach, teammate) levels. Notably, gaps were identified in the mesosystem (n = 3; e.g., motivational climate), exosystem (n = 1; e.g., management style), and macrosystem and chronosystem levels, which remain unexplored.

Discussion: The study highlights the need for cross-cultural investigations of athletes self-conscious emotions, inclusion of additional stakeholders (e.g., parents, referees), and research on underexplored emotions such as pride and embarrassment. However, this review has limitations, including the exclusive focus on English-language and indexed journals, potentially excluding culturally diverse perspectives and non-indexed studies. Furthermore, the review was limited to studies published before December 2023, suggesting the need for periodic updates to capture emerging research.

Other: This systematic review was registered with PROSPERO (CRD42023494012) and received no external funding.

**ACUTE EFFECT OF EXERCISE INVOLVING COOPERATIVE ACTIVITIES ON EMOTION RECOGNITION IN PREADOLESCENTS: MODERATING EFFECTS OF PSYCHOPATHOLOGY**

BERGER, M., ISHIHARA, T., KAMIJO, K., GERBER, M., LUDYGA, S.

*UNIVERSITY OF BASEL*

INTRODUCTION: Emotion recognition refers to the ability to identify another individuals emotional state [1]. In school settings, better emotion recognition promotes positive peer relationships and academic success, while deficits are linked to problematic behaviors and various mental difficulties [1]. A single exercise session has the potential to temporarily enhance emotion recognition by implementing components of social skills training or by trigger a cascade of physiological effects underlying cognitive enhancements [2]. However, the effects may differ depending on the children's psychopathology due to varying adaptation reserves. We aimed to investigate the acute effect of exercise, with and without the integration of cooperative activities, on emotion recognition in children depending on their psychopathology, indicated by the Strength and Difficulties Questionnaire (SDQ).

METHODS: Using a between-participants-design, 140 children (age = 11.5 years) were randomly allocated (stratum: school class) to groups performing exercise involving cooperative activities (EX+CO, n = 45), exercise without cooperative activities (EX, n = 45), and a control group watching a video (CON, n = 50). The interventions lasted 20 minutes and were completed in a school setting. Prior and after the interventions, participants completed a computerized facial emotion recognition task, in which anger, fear and happiness had to be categorized. In addition, psychopathology was assessed using the SDQ sum score, dividing participants into normal (<16) and abnormal (≥16) behavioral difficulty groups.

RESULTS: A mixed ANCOVA revealed a significant interaction of group and psychopathology for post-test emotion recognition accuracy, while controlling for pre-test scores. Decomposition of the interaction showed that among participants with a normal range of behavioral difficulties, the EX group had a significantly greater accuracy (M = .62, SE = .02) compared to EX+CO (M = .57, SE = .02) and CON (M = .57, SE = .02) at post-test. The analysis of reaction time showed no indication

for a speed-accuracy trade-off. In contrast to participants with behavioral difficulties in the normal range, the exercise groups and the control group did not differ with regard to emotion recognition in those with abnormal scores on the SDQ.

Discussion: A single aerobic exercise session without the integration of cooperative activities temporarily enhances emotion recognition in children without behavioral difficulties. This finding offers initial insight into exercises potential use fostering this ability within school context.

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**THE PARADIGM SHIFTS OF PERSONAL VALUES DUE TO THE LONG-TERM CONFLICTS IN THE PROFESSIONAL BALLET COMPANY**

CHOI, Y.

*CHONNAM NATIONAL UNIVERISTY*

INTRODUCTION: We study on the priorities of personal values that are changed due to the conflicts experienced among members of professional ballet company, in which the physical ability is playing a key role. Conflicts are inevitable phenomenon in the life of more than two persons or organizations [1]. The organization of ballet company are composed of artistic directors, dancers, and administrative staff, in there they form work roles, goals and various relationships. These members have personal or relational conflicts. Values are the principles or standards as like the flag of thinking, judgment, and behavior of individuals, therefore it is not willing to change [2]. The values have two main categories as the instrumentals and the terminals [2]. Nevertheless, by help of these research, the changing of personal values by conflicts can be clarified, which can lead to inconsistency with professional ethics in the organization.

METHODS: This research is deployed by the qualitative-intense interviews of 15 members in the ballet company.

For this study, first, the theoretical background of conflicts and individual values was explored, by help of 3 expert's prereviews, the conflict factors are 163 cases of 5 categories. Also, important personal values are 12-values of total 24 individual values. Second, both conflict experiences and changing values of members were interviewed. The 3-classified periods of employments as like, short, mid and long-terms, are <5yrs, 5-10 yrs, and >10yrs, respectively. Third, the relationship study was conducted on both conflict factors and the changed important personal values.

RESULTS: The main steps of the conflicts in the ballet company are the cause, phenomenon as the process, and results. First, the causes are based on the organizational, social and personal. Second, the members can undergo the conflict process such as less communications, a lack of the emotional understanding. Finally, the conflict has been done as shown leaving, injury, fighting, conform to the trend and work inefficiency, etc. Through the trajectory study on both personal values and conflicts experiences, the personal paradigm shifts, changing of personal values, are featured. The priority of personal values is more permissible to the instrumental values, imposed to the family and personal health, changing from professional ability and organizational goals as the terminal values. The members have experienced the decoupling between personal values and organizational goals.

Discussion: It provides an opportunity to enhance the understanding of conflicts in the professional ballet company as well as the perception of individual values. The personal paradigm shifts by conflicts can be occurred in team sports, such as football teams, cricket teams, etc.

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**COACHES BELIEFS ON THE CORE COMPONENTS OF PARENTAL SUPPORT IN YOUTH HOCKEY**

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*RIGA STRADINS UNIVERSITY*

Introduction

Previous research has shown that young athletes experience stress due to parental expectations, problematic behavior, excessive involvement in training, and financial pressure related to their familys investment in athletic development. Coaches can form professional relationships and collaborate with parents to consciously reduce the pressure on young athletes, so coaches must be familiar with the involvement of parents of children and youth to foster a positive sports experience for children and youth athletes. This research aim is to explore coaches beliefs on the core components of parental support in youth hockey.

METHODS: 105 coaches (n=92 male, n=13 female; work experience – 7.8 ±0.87 years) voluntarily participated in the survey from several children and youth hockey clubs. A custom-designed questionnaire was developed to evaluate coaches' beliefs about the core components of parental support in youth hockey. The responses were given on a scale. The questionnaire survey has a Cronbach's Alpha coefficient of 0.87. The questionnaire was highly reliable because the results of the questionnaire survey are 0.80 – 0.90. Data were processed with SPSS 28; descriptive and inferential mathematical

statistics were used. The mean results are expressed as a percentage score; the coefficient of internal coherence (Cronbachs Alpha); the Kolmogorov-Smirnov test for the determination of the data distribution; the Spearman rank correlation for the examination of the relationship between variables.

RESULTS: Coaches believe that the more hockey plays a central role in the family, the more it becomes a key aspect of the lives of parents and guardians lives (rs = .795; p<.01). If logistic support becomes more important to parents and guardians, financial support increases in importance to them (rs = .428; p<.01). The coaches believe that parents and guardians who analysed their childs performance after practice are also inclined to do so after games (rs =.644; p<.01). The higher the parents need for psychological and emotional support from the club, the higher the demand for general educational support as well (rs= .606; p<.01) and for education support in hockey (rs= .606; p<.01).

Discussion

Coaches recognize that parents who invest time and resources to facilitate their child's participation in hockey become more deeply involved with the sport, both practically and psychologically. When logistical responsibilities (such as transportation, scheduling, and attendance) become increasingly vital, parents and guardians also place greater emphasis on financial contributions. Parental involvement in performance analysis can have both positive and negative effects, while constructive feedback can aid player growth, excessive scrutiny could contribute to excessive pressure and stress. Clubs and coaches can use this knowledge to promote support systems that address logistical, financial, emotional, and educational needs.

## Oral Presentations

### OP-SH27 Physical Activity and Health

**BEYOND THE STEPS: THE ROLE OF HARMONIOUS PASSION AND EMOTIONAL EXPERIENCES IN FEMALE RECREATIONAL DANCERS**

MARINI, S.1, BORTOLI, L.1, ROMANO, G.2, DI LIBORIO, M.3, ROBAZZA, C.1

*1 G. DANNUNZIO UNIVERSITY OF CHIETI-PESCARA; 2 AZIENDA OSPEDALIERA UNIVERSITARIA FEDERICO II DI NAPOLI; 3 ACCADEMIA ITALIANA OSTEOPATIA TRADIZIONALE, PESCARA.*

INTRODUCTION: Dance involves perceptual and motor aspects, requires the memorization of motor sequences, and has an artistic component combined with music, which underlines its socio-cultural dimension. The combination of motor skills, physicality, relationality, artistic and expressive ability makes dance a tool that can give its own particular contribution within the broad scope of motor activities. The purpose of the present study was to investigate the interplay between passion, self-confidence, emotional arousal control, worry, concentration disruption, and functional psychobiosocial experiences among amateur female dancers.

METHODS: A convenience sample of 160 Italian women, aged 16 to 36 years (M = 20.63, SD = 4.93), practicing dance at a nonprofessional level, was recruited from main dance schools in central and south Italy. The recreational dancers had between 1 and 22 years of dance experience (M = 7.52, SD = 3.44) and practiced dance 3 to 5 times a week. Assessment was conducted in small groups before practice sessions. The Passion Scale [1,2] was used to assess two dimensions: Harmonious passion (6 items,) and Obsessive passion (6 items). Performance-related feelings were assessed using the subscales of the emotion higher-order factor of the IPPS-48 [3], which consists of 24 items covering 4 factors: Self-confidence, Emotional arousal control, Worry, and Concentration disruption subscales. The Psychobiosocial Experience Semantic Differential scale in sport [4] was administered to assess psychobiosocial experiences. This instrument is composed of 30 bipolar items representing 10 modalities with 3 items. Statistical analysis was performed using hierarchical regression with a step-wise method. In the first step, Self-confidence and Emotional arousal control were entered, followed by Harmonious Passion and Obsessive Passion in the second step.

RESULTS: Participants reported higher mean scores for Harmonious passion (M = 4.08, SD = .49) than Obsessive passion (M = 3.01, SD = .87; $p < .001$), indicating a predominance of harmonious passion. In the first step of the regression model, Self-confidence and Emotional arousal control together accounted for 28.2% of the variance in psychobiosocial experiences, with Self-confidence being the primary predictor in this step ($\beta = .51$, $p < .001$) explaining 26.0% of the variance. After entering Harmonious passion in the second step ($\beta = .17$, $p < .032$), the overall model explained 30.3% of the variance.

CONCLUSION: In summary, preliminary study findings suggest that, for female recreational dancers, self-confidence and harmonious passion for dance are important contributors to positive psychobiosocial experiences. This could imply that dance, when engaged in with a healthy mindset and accompanied by feelings of competence, can be a valuable physical activity for promoting overall well-being.

REFERENCES: 1. Marsh et al., 2013; 2. Vallerand et al., 2003; 3. Robazza et al., 2009; 4. Robazza et al., 2021

**UNDERSTANDING THE BENEFITS OF PHYSICAL ACTIVITY PROMOTION ON MENTAL HEALTH OF PRESCHOOLERS: A QUALITATIVE STUDY**

LIN, S., AU, W., LEUNG, C., FONG, D., WONG, S., CHAN, D., CAPIO, C., YU, C., WONG, S., CHEN, Y., THOMPSON, W., SIU, P.
*THE UNIVERSITY OF HONG KONG*

Introduction: Physical activity (PA) positively impacts childrens psychological health, especially in reducing depression, anxiety and improving well-being. According to the World Health Organization and United Nations Childrens Fund report, around one in seven children and adolescents are affected by mental health issues. Previous studies suggested that childrens PA might enhance psychosocial functioning and guard against internalizing (e.g., depression and anxiety) and externalizing (e.g., aggression and impulse control) symptoms. Given the current situation of young childrens physical inactivity, increased sedentary time, and accelerating mental health problems, active physical activity promotion at a young age is crucial to prevent deteriorating effects on the psychological development of young children. This study qualitatively explores the feasibility and potential effects of a one school year preschool-based PA intervention on increasing awareness of PA and improving childrens psychological health from childrens and parents perspectives.

Methods: Fifty children were randomly selected from each of the intervention and control groups of the KID-FIT study, which investigated the efficacy of a preschool-based PA intervention on improving physical fitness and health in preschoolers. One hundred children and their parents were interviewed in semi-structured interviews at the end of a preschool year to understand childrens psychological changes over the period. The recorded audio content was transcribed verbatim and analyzed by thematic content analysis using Thematicoder software.

Results: The preliminary analysis included 34 children (INT: 17, CON: 17). Interview results highlighted the increased awareness of the importance of PA, and parents from the intervention group expressed that their children were more willing to try different kinds of sports. Among the children in the intervention group, the childrens emotions were more stable after doing different types of sports and being more willing to share their feelings with parents was shown to have more positive effects than the control group.

Discussion: The findings revealed the importance of promoting PA in children and facilitating positive experiences that contribute to their enjoyment of various sports and psychological development. Parents in the intervention group reported that their children showed an increased willingness to try different sports, influencing their attitudes towards PA and encouraging them to explore new activities they may enjoy. Furthermore, these children were more willing to share their feelings with their parents, emphasizing the potential emotional and communication benefits of regular physical activity and the positive effects of parental involvement in promoting childrens mental health. These findings provide valuable insights for developing effective interventions to promote childrens physical and psychological health.

**FITNESS APPS PROMOTING COLLEGE STUDENTS' FITNESS LEVEL: DIFFERENCES IN THE EFFECTS OF INTERNAL AND EXTERNAL MOTIVATION**

HAN, Y., LI, L.S.
*SHANGHAI INTERNATIONAL STUDIES UNIVERSITY*

INTRODUCTION: Research indicates that the use of fitness apps can promote physical exercise behaviors and enhance fitness level. Based on this, most Chinese universities have adopted mandatory exercise check-in tasks to increase students' physical activity time, aiming to cultivate regular exercise habits among college students. However, some issues persist in the implementation of this mandatory measure. Students exhibit resistance and engage in cheating behaviors, such as proxy running or shaking phones while cycling to falsify exercise data, which make the effectiveness questionable consequently.

METHODS: This study conducted a questionnaire survey among 201 college students in Shanghai and analyzed the results using SPSS 28.0. The questionnaire was based on the Theory of Planned Behavior and Self-Determination Theory, using the Exercise Fitness Scale and the Self-Determination Motivation Scale to measure the factors influencing college students' intention to use fitness apps. The sample included undergraduate students from several well-known universities in Shanghai. The questionnaire has passed reliability and validity tests, with all scale items' Cronbach's alpha coefficient and KMO value being greater than 0.6.

RESULTS: According to the results of descriptive statistics, the average fitness level of 201 college students was 2.82. Among them, the average physical fitness level of students who used fitness apps and those who did not were 2.94 and 2.67, respectively. Additionally, the average fitness level of students who used the apps to complete the school's mandatory exercise check-in tasks was 2.67. According to the results of the correlation analysis, among students who used fitness apps, the Pearson correlation coefficients between attitude, subjective norm, perceived behavioral control, and self-determination motivation and the intention to use fitness apps were 0.534, 0.509, 0.427, and 0.665 ($p < 0.01$).

Discussion: The average fitness level of students who used fitness apps was higher than the overall average fitness level, which indicates that the use of fitness apps can, to a certain extent, improve the fitness level of college students. However, the average fitness level of students who used fitness apps to complete the schools' mandatory exercise check-in tasks was the same as that of students who did not use fitness apps, which suggests that the school's mandatory exercise check-in measures may not be effective in enhancing the fitness level of college students, and the type of motivation for using the app can influence the effect on promoting students' fitness level. Besides, the correlation analysis revealed that self-determination motivation had the highest positive predictive effect on the intention to use fitness apps, further proving that the internal motivation of college students to use fitness apps plays an important role in promoting their fitness level.

**EFFECTIVENESS OF PHYSICAL ACTIVITY FOCUSSED MHEALTH INTERVENTIONS ON MENTAL HEALTH OUTCOMES IN ADOLESCENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS**

BAUMANN, H., SINGH, B., STAIANO, A., GOUGH, C., AHMED, M., FIEDLER, J., TIMM, I., WUNSCH, K., BUTTON, A., YIN, Z., VASILOGLOU, M., SIVAKUMAR, B., PETERSEN, J., DALLINGA, J., HUONG, C., SCHOEPPE, S., KRACHT, C., SPRING, K., MAHER, C., VANDELANOTTE, C.

*GERMAN SPORT UNIVERSITY COLOGNE*

Introduction: Adolescence is a critical period for the onset of mental disorders that adversely affect well-being and academic and social functioning (Polanczyk et al., 2015). Emerging evidence indicates that modifiable lifestyle factors—particularly physical activity—can improve mental health (Kandola et al., 2019). Mobile health (mHealth) interventions offer a scalable approach to promote physical activity and optimize sedentary behaviour, sleep, and nutrition. This review focuses on the effectiveness of mHealth interventions for adolescents (11–21 years) with emotional, behavioural, and eating disorders, with special emphasis on physical activity components.

Methods: A systematic review and meta-analysis were conducted following PRISMA guidelines (PROSPERO ID: CRD42024591285). A comprehensive search of eight databases was performed to identify randomized controlled trials (RCTs) published up to October 2024. Eligible studies involved adolescents with clinically relevant mental health disorders and assessed interventions targeting lifestyle behaviours, including physical activity. Data extraction was completed independently by reviewers, and risk of bias was evaluated using the ROB2 tool.

Results: Nine RCTs with a total of 3,219 participants met the inclusion criteria. Physical activity was incorporated in 55% of the interventions. For emotional disorders, mHealth interventions that combined mindfulness, cognitive-behavioural therapy, and physical activity significantly reduced depressive symptoms (pooled effect size = –0.35, 95% CI: –0.50 to –0.20) and anxiety symptoms (–0.22, 95% CI: –0.37 to –0.07). In interventions targeting behavioural disorders, those integrating physical activity with cognitive tasks yielded a moderate reduction in symptoms (pooled effect size = –0.40, 95% CI: –0.62 to –0.18). In contrast, interventions for eating disorders produced mixed outcomes, indicating a need for more adaptive designs.

Discussion: The findings suggest that mHealth interventions, particularly those incorporating physical activity, hold promise in reducing mental health symptoms among adolescents. The benefits observed in reducing depression, anxiety, and behavioural problems support the integration of exercise components into digital interventions. Future research should refine these approaches, assess long-term sustainability, and explore integrated, multi-component strategies that complement traditional care to enhance mental health outcomes in this vulnerable population.

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## 16:15 - 17:30

# Plenary Session

## PS-PL03 Exercise science and medicine in the era of incretins and exercise mimetics

**THE OZEMPIC OLYMPICS: EXERCISE TRAINING AND CHRONIC DISEASE PREVENTION IN THE INCRETIN ERA**

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The world is embracing an exciting new era of chronic disease prevention and management: the age of Ozempic or Incretin therapies. There has never been a class of drugs that so effectively targets brain and behaviour to induce profound, rapid and life-changing decreases in body weight. Early intervention targeting obesity, a recognised gateway to multiple chronic diseases, can impact fatness, with beneficial pleiotropic impacts on blood pressure, cholesterol, blood glucose, insulin, heart and artery function, and perhaps even cognition. Beyond the glucagon-like peptide-1 receptor agonists (GLP-1ra) which induce rapid and substantial weight loss (liraglutide and semaglutide), newer and perhaps even more effective weight loss therapies are co-targeting glucose-dependent insulinotropic polypeptide (GIP) receptors (tirzepatide - dual agonist), and glucagon receptors (retatrutide - triple agonist). However, these agents cause rapid and significant loss of lean mass, comparable to a decade of ageing. Maintaining muscle mass and function as humans age is crucial to avoiding sarcopenia and frailty, which are strongly linked to morbidity and mortality. This talk will discuss the results of contemporary studies showing that supervised resistance exercise training interventions elicit increases in lean mass and strength in men and women across the lifespan. A compelling rationale will be presented for including strategies that retain lean mass during incretin therapy, to enhance fat loss and blunt body weight (and fat) re-gain on cessation of weight loss pharmacotherapy. De-prescribing is an important but challenging and complex goal for patients who achieve target changes in body composition. This talk will also address the global impact of targeted and personalised

exercise interventions, during and after incretin therapy, in the prevention of chronic disease in humans. Insights derived from the Tirzepatide and Resistance Exercise (T-REX) trial, focussed on the impact of combined exercise and incretin therapy in older overweight and obese adults, will also be shared. Finally, the talk will conclude by considering the opportunity afforded by this once-in-a-generation class of drugs for the development of Clinical Exercise Physiology (CEP) as an allied health profession globally. To this end, a strategic roadmap will be presented based on the Australian and more recent UK experiences of establishing national CEP regulatory frameworks, practitioner registries, proficiency standards, and higher education curricula for the global advancement of this nascent allied health profession, which is so crucial to future cost-effective preventative healthcare delivery worldwide.

**EXERCISE MIMETICS: A "POLYPILL" TO COMBAT THE EROSION OF PHYSICAL ACTIVITY IN THE 21ST CENTURY?**

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Almost two decades ago it was reported that an oral 'exercise mimetic' (GW1516, an AMP-activated protein kinase agonist) administered to sedentary mice for 4 weeks induced a muscle 'endurance gene signature' and enhanced treadmill running capacity by 44%. Since publication of that study there has been growing scientific and commercial interest in the identification of bioactive oral compounds that mimic or potentiate the effects of exercise, so-called exercise pills or exercise mimetics. This pursuit has been driven, in part, by the application of molecular techniques to exercise biology that have provided greater understanding of the complexity of cellular networks involved in exercise responses and increased our knowledge of the mechanisms by which muscle 'communicates' with other organs and mediates the beneficial effects of exercise on health. As such, the first part of this talk considers how this myocentric approach has often failed to consider the wide-ranging effects that exercise exerts in tissues and organs other than skeletal muscle. Indeed, it is both perplexing and frustrating to many exercise scientists that the focus of these 'mimetics' has been exclusively on promoting mitochondrial biogenesis in skeletal muscle, when there is a much larger and more compelling landscape for the benefits of exercise in humans While the idea of taking a pill (or a 'polypill') to acquire the benefits of exercise in the absence of voluntary physical movement and energy expenditure has great appeal for many sedentary individuals who, for a variety of reasons, do not obtain sufficient physical activity to improve their general health, it is also attractive for 'big pharma' who view physical inactivity as an ever-growing market to be medicated for profit. As such, the second part of this talk will examine whether an exercise pill is a bio plausible, realistic or desirable goal. It will be argued that exercise training provokes widespread perturbations in numerous cells, tissues and organs, conferring multiple health-promoting benefits, with the multiplicity (and redundancy) of these responses and adaptations making it highly improbable that any single pharmacological approach could ever mimic such wide-ranging effects. Finally, given that some calls for an 'exercise pill' stem from a response to the perceived failure of the majority of the population to comply with national recommendation for exercise prescription, the last part of this talk will address potential barriers that underpin the global decline in physical inactivity and novel strategies to overcome them.

## PP-UD01

E-poster

Biomechanics

### KINEMATIC ANALYSIS OF CENTRE OF MASS DYNAMICS DURING THE TURNING PHASE OF JUDO UCHIMATA

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INTRODUCTION: Uchimata is a frequently utilised technique in judo competitions, requiring precise balance control as it involves throwing the opponent while using a single leg as a pivot. The turning phase, preceding the execution of the throw, is crucial for Kuzushi (balance breaking) and Tsukuri (preparatory positioning). While previous studies have examined the biomechanics of judo techniques, the role of centre of mass (COM) momentum in differentiating skill levels remains unclear. This study aimed to compare COM dynamics between high- and low-skilled judokas during the turning phase.

METHODS: Twenty male judokas (10 high-skilled, 10 low-skilled) were categorised based on uchimata execution frequency and effectiveness in competition and training. A 14-camera Mac3D motion capture system (250 Hz) recorded three-dimensional movement, with 47 reflective markers tracking both linear and angular motion. The turning phase was defined as the period between the initial lift of the supporting leg and the moment the sweeping leg left the ground. The highest-quality trial was selected for analysis based on the thrower's self-evaluation and assessments by experienced judo coaches using predefined criteria [1]. COM momentum was analysed in the anteroposterior (x-axis), mediolateral (y-axis), and vertical (z-axis) directions, and opponent trunk angular momentum was also assessed. Statistical parametric mapping (SPM) was used to compare time-series data between groups, and Welch's t-tests ($p < 0.05$) with effect sizes (Cohen's d) were applied to evaluate peak differences.

RESULTS: High-skilled judokas showed significantly greater peak COM momentum in all directions: x-axis (0.60 vs. 0.41 m/s, $p = 0.027$, $d = 1.07$), y-axis (0.92 vs. 0.63 m/s, $p = 0.012$, $d = 1.26$), and z-axis (0.79 vs. 0.60 m/s, $p = 0.047$, $d = 1.00$). Opponent trunk angular momentum was also higher when thrown by high-skilled judokas (2.90 vs. 1.75 kg·m²/s, $p = 0.038$, $d = 1.15$). SPM analysis found no significant time-series differences ($p > 0.05$).

CONCLUSION: These findings indicate that high-skilled judokas generate greater COM momentum, contributing to more effective Kuzushi and smoother throw transitions. The increased trunk angular momentum observed in opponents highlights the role of rotational force in balance breaking. Consistent with previous research, our results suggest that high-skilled judokas achieve more effective kuzushi by actively shifting their centre of mass [2]. This implies that controlled COM shifts are fundamental to optimising balance breaking in judo. Coaches should emphasise these aspects in training to enhance judokas performance.

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### THE EFFECTS OF PASSIVE LEG PRESS TRAINING TO MUSCLE FAILURE AT DIFFERENT TRAINING SPEEDS ON THE MUSCLE MASS, ENDURANCE STRENGTH AND KICKING PERFORMANCE FOR TAEKWONDO ATHLETES

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INTRODUCTION: Passive leg press (PLP) training can overcome the problem that general resistance training cannot accurately control the "movement speed" and cannot train at a fast speed when carrying heavy loads. PLP training has been proven to enhance velocity and explosive power in athletes. However, do different training speeds of PLP training to muscular failure enhance skeletal muscle mass, muscular endurance and kicking performance? Not confirmed by research. The aim of the present study was to identify which of three training speeds of PLP training leads to the best training effects on skeletal muscle mass, endurance strength and kicking performance in Taekwondo athletes.

METHODS: thirty taekwondo athletes were recruited and divided into high training speed group (HTSG, n=10), normal training speed group (NTSG, n=10), low training speed group (LTSG, n=10). All subjects complete 12 weeks,3 times a week training program which consisted of 60% MVIC load but three different training speed and perform to muscle failure. Before and after training, muscle mass, dynamic endurance (average height of continuous countermovement jumps), static endurance (duration time of >80% MVIC), specific continuous kicking ability (speed and average peak force of con-

tinuous kicking) were collected for statistical analysis. The Paired Samples t-Test was used to compare the difference between pre-test and post-test. Percentage of training effects among groups were analyzed with Analysis of Variance, ANOVA and Bonferroni post hos test. The level of significance was set at $\alpha = .05$.

RESULTS: Muscle mass did not significantly improve in LTSG ($P>.05$), but all other dependent variables were significantly enhanced ($P<.05$). All dependent variables were significantly enhanced in both of NTSG and HTSG ($P<.05$). Besides, the percentage of training effect of kicking speed in HTSG were significantly greater than in the LTSG.

CONCLUSION: The training methods of passive leg press training to muscle failure at different training speeds could improve dynamic endurance, static endurance, and specific continuous kicking ability. Training speed during resistance training is a key factor that affects improvement of muscle mass. Low speed training cannot significantly improve muscle mass. The speed during resistance training is also a factor that affects the improvement of specific kicking speed. High speed training is the optimal training intensity when the coach wants to transfer the effects of resistance training to specific kicking abilities.

**EEG ANALYSIS OF NEUROPLASTICITY IN TRANSTIBIAL PROSTHESIS USERS DURING OVERGROUND WALKING**

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INTRODUCTION: Lower-limb amputees often rely on prostheses for daily activities and environmental adaptation, while transtibial prosthesis (TTP) users experience greater motor control challenges and cognitive impairments than able-bodied individuals (1). Thus, this work aims to investigate neuroplasticity in TTP users through the analysis of electroencephalogram (EEG) signals recorded during overground walking in order to understand neural mechanisms of adaptation, which are capable of informing advanced rehabilitation strategies.

METHODS: Herein, firstly, we recorded the 32-channel EEG and inertial measurement unit (IMU) data derived from five TTP users and five able-bodied participants during 2 minutes of overground walking. Secondly, this dataset was used to identify the stride cycle from thigh angle peaks (Segment Thigh RT-orientation-y from IMU). Then, EEG data defined by these peaks were extracted and structured into a 30×100 matrix (30 electrode placements, 100 time points representing the percentage of gait cycle). Finally, the EEG signals were analyzed across delta, theta, alpha, and beta frequency bands. Two-sample t-tests using statistical non-parametric mapping (SnPM) were performed to identify differences in continuous EEG data across the gait cycle between TTP users and able-bodied participants.

RESULTS: Experimental results indicated the EEG theta frequency band during the walking gait cycle revealed a significant difference at the Pz electrode position ($p = 0.032$) during the mid-swing sub-phase of the gait cycle. Additionally, a significant difference in the alpha frequency band was identified at the CP2 electrode position ($p = 0.044$) during the loading response sub-phase. The average stride cycle across participants was 57.

CONCLUSION: Activity at the Pz position aligns with its established role in proprioception and the integration of sensory information from the body and external environment (2). Similarly, activity at the CP2 position highlights its involvement in processing proprioceptive feedback, particularly related to motor control and sensory input from the lower limbs (3). The findings reveal adaptive neuroplasticity in TTP users, with distinct cortical activity patterns during gait cycle, reflecting increased reliance on cortical regions for motor control and sensory integration. These results highlight the need for rehabilitation strategies to enhance gait efficiency and cortical activities.

**MUSCLE ACTIVITY AND KINEMATICS OF FIN SWIMMING IN PROFESSIONAL DIVERS**

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INTRODUCTION: Scuba diving is an activity that is increasingly practiced, whether in a sport, professional, or military context. Among the well-known criteria that influence diver performance, body kinematics and muscle activity are particularly important. These two parameters are directly related to the energy cost of the diver, which is an important factor in performance. Understanding the biomechanics of this atypical sport in ecological conditions allows for correcting improper posture, thereby improving performance. However, the literature on the subject is still limited. Recent advances, such as the development of new waterproof sensors, promise significant progress in the field of kinematic and muscle activity analysis. The purpose of this study is to describe the kinematics and muscle activation patterns of fin swimming in professional divers.

METHODS: Eight professional military divers participated in the study. Participants swam underwater for 30 min in a counter-current pool at a pace of 4 min per 100 meters. Divers performed swimming trials using diving fins while wearing waterproof sensors to record both kinematic and muscle activity data. Kinematics were measured using seven inertial measurement units (IMUs) placed on both feet, both shins, both thighs, and on the pelvis. Muscle activity was recorded using surface electromyography (EMG) on the rectus femoris (RF), vastus lateralis (VL), biceps femoris (BF), semitendinosus (ST), gastrocnemius medialis (GM), soleus (Sol), tibialis anterior (TA), and the gluteus maximus (Glut). EMG data were normalized to the maximum activation obtained during a maximal voluntary contraction (MVC). Cardio-respiratory data, including heart rate (HR) and oxygen consumption (VO2), were also monitored.

RESULTS: The kicking cycle was divided into two phases: the downward phase (0-50 %) and the upward phase (50-100 %). The joint amplitudes for ankle, knee, and hip were 25 ± 10 °, 85 ± 12 °, and 10 ± 4 °, respectively. The maximum angle for

the knee was reached at the start of the stroke cycle. The maximum angles for the ankle and hip were reached at 15 % and 18 % of the stroke cycle, respectively. The minimum angles for the knee, ankle, and hip were reached at 50 %, 78 %, and 70 % of the stroke cycle. The average peak EMG activation occurred during the downward phase for the RF (33 ± 14 %MVC), VL (17 ± 6 %MVC), and TA (15 ± 8 %MVC) muscles, and during the upward phase for the GM (32 ± 11 %MVC), Sol (29 ± 10 %MVC), BF (47 ± 19 %MVC), ST (21 ± 4 %MVC), and Glut (4 ± 3 %MVC) muscles. After 5 minutes, the HR and VO2 stabilized, averaging 105 ± 10 bpm and 18.1 ± 2.0 mL·min-1·kg-1, respectively.

CONCLUSION: This study provides a detailed analysis of both kinematics and muscle activity during scuba diving kicking. This knowledge is essential for teaching proper technique and providing appropriate training protocols to enhance the performance of sport, professional, or military divers.

**RELATIONSHIP BETWEEN REBOUND JUMP PERFORMANCE AND SPRINT PERFORMANCE IN JUNIOR SPRINTERS**

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INTRODUCTION: In sprinting, minimizing the decline in speed during the latter stages of the race is crucial for achieving high performance, in addition to maximizing peak speed. Even elite sprinters experience a reduction in speed before reaching the finish line (1). Because this decline directly affects overall sprint performance, identifying its underlying causes is essential for developing effective training methods. Rebound jump (RJ) performance, which involves repeated jumps with minimal ground contact time (typically around 160 ms) (2), may be relevant in this context. The contact time per step in a 100 m sprint is comparable to that in RJ tasks (3), suggesting that the ability to generate high force in a short period may be common to both tasks. Thus, inferior RJ performance may be associated with longer contact times during the latter phase of sprinting, thereby contributing to speed decline. This study examined the relationship between RJ ability and the maintenance of sprint speed in junior sprinters.

METHODS: Participants were 22 elementary school sprinters undergoing regular training. Each participant performed a 100 m sprint at maximum effort, during which total time and 20 m split times were recorded using a photoelectric timing system. RJ performance was assessed using a mat switch during five consecutive jumps, with participants instructed to jump as high as possible while minimizing ground contact time. The RJ index was calculated as the ratio of jump height to contact time. Pearson's product-moment correlation coefficients were computed, and statistical significance was set at $P < 0.05$.

RESULTS: The RJ index was significantly negatively correlated with the 100 m sprint time ($r = -0.594$). Additionally, when the 80–100 m split time was normalized to the total 100 m time, a significant negative correlation with the RJ index was observed ($r = -0.464$).

CONCLUSION: Superior RJ performance is associated with better 100 m sprint performance and a reduced decline in speed during the latter stages of the sprint in junior sprinters.

**NEUROMUSCULAR RECRUITMENT STRATEGIES OF THE LOWER LIMB BETWEEN SPRINTERS AND DISTANCE RUNNERS DURING MAXIMAL SPRINT RUNNING**

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INTRODUCTION: A previous study found that thigh muscle activation timing is associated with sprint performances. However, no research has investigated the individual differences in the multiple muscle activation patterns in sprint running. Therefore, the purpose of this study was to investigate the difference in strategy in the neuromuscular activation patterns of the lower limb muscles between sprinters and distance runners during maximal sprint running.

METHODS: Twenty well-trained male athletes (ten sprinters and ten distance runners) ran 50 m with maximal effort. The spatiotemporal variables (e.g., running speed, step frequency, and step length) were measured over a distance from 42 m to 50 m using a high-speed camera (250 Hz) and timing gate systems. Electromyography (EMG) signals were obtained using wireless EMG sensors (2000 Hz) from eight lower limb muscles (rectus femoris: RF, biceps femoris: BF, semitendinosus: ST, gluteus maximus: Gmax, vastus lateralis: VL, tibial anterior: TA, gastrocnemius: GAS, and soleus: SOL). The running cycle was divided into four phases from foot-strike and foot-off timings from both feet that consisted of contact, early-swing, mid-swing, and late-swing phases. Root mean squares (RMSs) were calculated every four phases. The RMSs were normalized maximal voluntary contraction value (%MVC).

RESULTS: Sprinters showed significant greater spatiotemporal variables than distance runners. RMS of hip extensors (Gmax and BF) during mid- to late swing phases, hip flexor (RF) early to mid-swing phases, and ankle dorsiflexor (TA) during early-swing phase in sprinters were significantly greater than distance runners ($P < 0.05$). However, the RMS of ankle plantar flexors (SOL and GAS) and knee extensor (VL) were found to be similar between both groups of runners.

CONCLUSION: A previous study demonstrated that sprinters showed greater thigh movements than recreational athletes. In this study, it was also observed that sprinters showed greater both hip extensor and flexor activation than distance runners. However, there was no significant group differences in knee extensor and ankle plantar flexors. These results suggest that sprinters generated rapid and greater leg movements by recruiting more hip muscles. Furthermore, sprinters showed higher ankle dorsiflexor activation during early-swing phase. This suggests that sprinters would have a specific technique that keeps ankle joint more dorsiflexed position to reduce the moment of inertia of the legs during early-swing

phase. The results concluded that sprinters have specific neuromuscular adaptations of both hip extensor and flexor, and ankle dorsiflexor to distance runners.

**EFFECTS OF MOUTHGUARD USE ON SHOULDER ISOKINETIC STRENGTH: AN ELECTROMYOGRAPHIC ANALYSIS**

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INTRODUCTION: Para-powerlifting, a bench press competition for individuals with disabilities, requires smooth and stable movements to lift maximum weights. In competitive sports, mouthguard (MG) use is recommended to protect oral structures and improve occlusion. Moreover, the use of MGs has been reported to potentially enhance muscle strength. This study aimed to explore the effects of MG use on shoulder isokinetic strength using electromyographic (EMG) analysis.

METHODS: This study included 11 male university rugby players. Shoulder isokinetic strength was measured using a Biodex system at angular velocities of 60°/s, 120°/s, and 180°/s, with participants performing five consecutive concentric arm-raising and -lowering movements. The following four conditions were tested: (1) right arm without an MG, (2) left arm without an MG, (3) right arm with an MG, and (4) left arm with an MG. Surface EMG was performed on the masseter, deltoid, and pectoralis major muscles using bipolar electrodes. Muscle strength, range of motion (ROM), and integrated EMG values were analyzed. Two-way ANOVA was conducted with MG use and velocity as factors for isokinetic strength evaluation. Additionally, Tukey's post-hoc tests were used. Paired t-tests were used to compare the integrated EMG values between the use and non-use of MG.

RESULTS: No significant differences in muscle mass or ROM were observed between the dominant and non-dominant sides. However, shoulder isokinetic strength showed significant improvements with MG use, as the non-dominant/dominant ratio of peak torque approached 100%, and peak torque per body weight and rise torque were significantly higher. Time to peak torque was significantly shortened, indicating that MG use may enhance initial strength generation and improve muscle balance between the dominant and non-dominant sides.

A significant increase in masseter activity was observed with MG use, as indicated by integrated EMG values. This suggests that clenching may enhance spinal excitability and, consequently, increase muscle activity, potentially influencing the shoulder-related muscle groups. However, no significant changes were noted in the average integrated EMG values of the deltoid and pectoralis major during five consecutive contractions. Given their antagonistic functions, the time-averaging method used in this study may have limited applicability. Future research should focus on analyzing specific movement phases for more detailed insights.

CONCLUSION: While the primary role of MG use is to protect oral structures, the findings of this study suggest that MG use may also enhance the initial strength output of muscles and improve muscle balance in shoulder isokinetic strength.

**ACCURACY VERIFICATION OF MARKERLESS MOTION CAPTURE DURING KENDO EQUIPMENT WEAR**

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INTRODUCTION: In recent years, studies utilizing markerless motion capture have become increasingly common. Traditional optical motion capture provides high measurement accuracy but requires the attachment of reflective markers to the entire body. This makes it difficult to conduct kendo research in a practical setting, as practitioners must wear Dogi (traditional training attire), Hakama (pleated skirt-like trousers), and Bogu (protective armor consisting of a helmet, gloves, chest protector, and waist protector).

Markerless motion capture eliminates the need for reflective markers, reducing restrictions related to measurement time and environmental conditions. Previous studies have reported that markerless motion capture can measure three-dimensional movement, such as throwing, jumping, and walking, with an accuracy of approximately 30 mm compared to optical motion capture (Nakano et al. 2021). However, the effect of wearing kendo-specific attire and protective gear on measurement accuracy remains unclear.

Therefore, this study aims to examine the accuracy of markerless motion capture in kendo by analyzing Men strikes (a frontal strike to the head) under different clothing and equipment conditions.

METHODS: One male kendo practitioner participated in this study. The subject performed Men strikes while facing a striking target positioned 1.9 m away from his right foot. The experiment was conducted under four conditions:

1. Wearing only spats (baseline condition)

2. Wearing spats along with Men (helmet), Kote (protective gloves), and Do (chest protector)

3. Wearing spats with Men, Kote, Do, and Tare (waist protector)

4. Wearing a full kendo outfit: Dogi, Hakama, Men, Kote, Do, and Tare

The subject performed 15 trials per condition. Motion data were captured using the markerless motion capture system (Miqus, 250 Hz). The analysis focused on the 200 frames preceding the moment of impact (when the Shinai [bamboo sword] reached the target). Coordinate values were calculated using Visual3D software, and the mean and standard deviation of the differences between condition (1) and the other three conditions were analyzed.

RESULTS: The mean and standard deviations of the maximum differences between condition (1) and conditions (2), (3), and (4) were as follows:

- Condition (2): 5.3 ± 2.3 cm
- Condition (3): 5.7 ± 4.2 cm
- Condition (4): 21.5 ± 17.19 cm

CONCLUSION: When using condition (1) as a baseline, measurement accuracy remained relatively high under conditions (2) and (3). However, in condition (4), the presence of Dogi and Hakama significantly affected measurement accuracy, likely due to fabric movement interfering with body tracking.

These findings suggest that while markerless motion capture can be useful in kendo research, the accuracy is affected by protective gear and traditional attire. By limiting equipment usage or restricting analysis to specific body segments, motion capture in more practical kendo settings may become feasible.

**BIOMECHANICAL RESEARCH PROGRESS IN TRAMPOLINE SPORTS: MECHANISMS, METHODS, AND CHALLENGES**

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INTRODUCTION: Trampoline is an important sport in both competitive athletics and mass fitness. Since its inclusion as an official Olympic event in 2000, trampoline has been characterized by its high technical difficulty and inherent risks (1). Biomechanical research in trampoline is crucial for enhancing athletic performance (2), optimizing technical movements (3), and preventing sports injuries (4). The increasing complexity of competitive movements, such as triple twists and quadruple tucks, has created an urgent need for biomechanical analysis. This article systematically reviews the current state of biomechanical research in trampoline, focusing on the kinetic characteristics of the takeoff-flight-landing phases, mechanisms of human posture control, injury risk factors, and technical assessment methods. It also explores future research directions. Studies indicate that the integration of multimodal sensors and computer modeling techniques is becoming a key breakthrough in this field.

METHODS: This study conducted a literature search using authoritative databases such as Web of Science, Scopus, CNKI, and PubMed, with keywords including "trampoline," "technical analysis," and "kinematics." The search included all literature on trampoline biomechanics up to 2025.

RESULTS: Key Findings on Movement Execution Mechanisms:

Takeoff Phase:Elite athletes achieve vertical ground reaction forces up to 8-10 times their body weight.Force curve displays a "double peak": first from net deformation energy storage, second from lower limb explosive extension.Coordination between knee extension and net rebound velocity is crucial; a >50ms delay increases energy loss by 15%.

Flight Phase:Athletes control angular momentum via head positioning and asymmetric arm movements.A 5°head deviation increases somersault axis deviation by 1.2 rad/s.Tuck position reduces moment of inertia by 60-70%, but premature tightening can disrupt timing.

Landing Phase:Forefoot bears >65% of impact force; incorrect posture increases ankle dorsiflexion moments by 37%, raising sprain risk.A 10% increase in net tension boosts peak knee compression force by 22%.

CONCLUSION: Movement Optimization Theory:Takeoff Phase: Precise control of "energy storage-release" timing is crucial, with knee extension velocity synchronized to net rebound velocity (error window <30ms).Flight Phase: Fine adjustments in head positioning and dynamic regulation of limb moment of inertia enhance stability during multiple somersaults.

Innovations in Technical Diagnosis:The "sensing-modeling-feedback" system enables real-time movement assessment, but signal drift in high-speed rotations remains a challenge.Deep learning algorithms show promise for action recognition but need expanded sample libraries of high-difficulty movements to improve generalization.

**GAIT INITIATION CONTROL AND COGNITIVE PERFORMANCE IN MULTITASKING SITUATIONS FOR MILD COGNITIVE IMPAIRMENT ELDERLY**

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INTRODUCTION: With an aging population, the prevalence of neurodegenerative diseases, including dementia, has increased. Older adults with mild cognitive impairment (MCI) are at higher risk for both dementia and falls. This study investigates biomechanical differences in gait initiation between older adults with MCI and cognitively healthy individuals, aiming to provide insights for diagnosing, preventing, and managing MCI and fall risks.

METHODS: This study employs three experimental conditions: spontaneous, cue-induced, and dual-task gait initiation. In the first two conditions, we analyze how MCI status and gait initiation speed (comfortable vs. maximum) affect gait performance. In the dual-task condition, we assess the impact of cognitive tasks (countdown, subtraction, and semantic fluency) on gait initiation. Thirty elderly participants (11 with MCI, 19 cognitively healthy) were recruited for this cross-sectional observational study. Gait initiation performance was measured using infrared motion capture and force plates to assess movement time, center of pressure (COP) displacement and velocity, center of mass (COM) displacement, balance stability, and overall gait. Repeated two-way ANOVA was used for statistical analysis.

RESULTS: Under spontaneous gait initiation, no significant differences were observed between the MCI and control groups. However, during cue-induced and dual-task conditions, participants with MCI showed shorter gait initiation times,

longer COP displacement, and faster COP velocities. Gait initiation speed influenced biomechanical parameters in all conditions, while the semantic fluency task had the most significant effect during dual-task conditions.

CONCLUSION: These results suggest that individuals with MCI may experience altered gait initiation under specific conditions, particularly when cognitive load is involved. This highlights the need for clinical interventions that incorporate dual-task training and faster gait initiation requirements to improve gait performance. Additionally, fall prevention strategies should focus on reducing cognitive load and time pressure during gait tasks. Future studies should explore the effects of dual-task conditions and gait initiation across different MCI subtypes and environmental contexts, incorporating physiological indicators like EEG and EMG. This research underscores the importance of addressing cognitive and motor challenges in older adults with MCI to reduce fall risk and improve quality of life.

**EFFECTS OF 6-WEEK PLYOMETRIC TRAINING ON ANKLE KINEMATICS IN THE FIRST FIVE STEPS OF SPRINT START IN SPRINTERS**

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INTRODUCTION: In accordance with Valamatos et al. (2022), plyometric training is widely recognized for enhancing athletic performance by optimizing the stretch-shortening cycle (SSC), improving neuromuscular coordination, and increasing explosive power. Previous research (e.g. Eraslan et al.2021) has demonstrated its benefits in sprint acceleration, particularly in enhancing lower-limb power output. Since ankle motion plays a crucial role in propulsion and step length regulation, understanding its adaptations to plyometric training could provide valuable insights for sprint performance optimization. Therefore, the aim of this study was to investigate how a 6-week plyometric training influence ankle kinematics in the first five steps of a sprint start.

METHODS: Six male Chinese elite sprinters (Age: 19 ± 0 years, Height: 1.78 ± 0.03 m, Weight: 67.7 ± 6.5 kg, 100 m PB: 10.94 ± 0.15 s, Training Experience: 3.25 ± 1.94 years) who were coached by the same trainer participated in this study. All participants underwent a six-week training program (3 times/week) incorporating hurdle jumps, drop jumps, and bounding exercises. 14-camera Qualisys system (Qualisys, Gothenburg, Sweden) were used to collect the trajectories of the passive reflective markers of the first five steps of the sprint start at 200Hz. Kinematic parameters of the ankle joint were calculated by using Visual 3D 4.0 (C-motion, Maryland, USA). Sprinters' velocity at the fifth step before (Vpre) and after (Vpost) the training program were used to represent the sprint performance.

RESULTS: Sprinters had a better performance after the training program (Vpre = 6.53 ± 0.39 m/s, Vpost = 6.70 ± 0.38 m/s, $p = 0.004$). The first flight time (PRE: 0.09 ± 0.02 s vs. POST: 0.07 ± 0.02 s, $p = 0.033$), first step time (PRE: 0.09 ± 0.02 s vs. POST: 0.07 ± 0.02 s, $p = 0.033$), and second step time (PRE: 0.26 ± 0.02 s vs. POST: 0.25 ± 0.02 s, $p = 0.038$) significantly decreased after training. The reduction in first flight time and step times suggests improved ground contact efficiency, which is a hallmark of enhanced SSC function. The third step length (PRE: 1.20 ± 0.15 m vs. POST: 1.23 ± 0.14 m, $p = 0.009$), angular velocity at toe-off of the first step (PRE: -863.65 ± 141.71°/s vs. POST: -1085.44 ± 117.54°/s, $p = 0.014$), and mean extension angular velocity during the first step (PRE: -329.58 ± 80.61°/s vs. POST: -453.04 ± 120.43°/s, $p = 0.004$) significantly increased after the training program indicated that training enhanced ankle joint propulsion ability, which may further improve sprint start efficiency.

CONCLUSION: This study confirmed that six weeks of plyometric training improved the ankle joint kinematics during the sprint start, characterized by faster take-off angular velocity, shorter ground contact time, and longer step length.These findings suggest that incorporating plyometric training into sprint programs can enhance propulsion efficiency and optimize early acceleration performance.

**HIP EXTENSION RANGE OF MOTION IS ASSOCIATED WITH IMPULSE DURING THE LATE CONCENTRIC PHASE OF VERTICAL JUMPING**

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INTRODUCTION: Previous studies have reported a relationship between lower limb flexibility and vertical jump (VJ) height; however, few studies have focused on the differences in kinematics and kinetics during VJ in athletes with varying levels of lower limb flexibility. The present study aimed to categorize participants into flexible and non-flexible groups based on their lower limb flexibility and examine differences in force output characteristics during VJ.

METHODS: Thirty-two male american football players participated in this study. Each participant performed three range of motion (ROM) tests (hip flexion, hip extension, and ankle dorsiflexion ROM). Participants performed two types of VJ, countermovement jump (CMJ) and squat jump (SJ), on a force plate while being filmed with a high-speed camera. Pearson's correlation analysis was conducted to examine the relationship between jump height and each ROM test. Participants were divided into two groups (flexible vs. non-flexible) based on the median values of ROM tests showing a significant moderate or higher correlation ($r > 0.3$), and kinetic and kinematic variables were compared using an independent t-test. Effect size (Cohens d) was also calculated, with a significance level set at 5%.

RESULTS: A significant moderate correlation was observed between both CMJ and SJ height and hip extension ROM ($r = 0.37 - 0.49$, $p < 0.05$). No significant correlation was found between jump height and ankle dorsiflexion ROM or hip flexion ROM. Between-group comparisons of hip extension ROM revealed that the flexible group showed significantly greater impulse in the late half of the propulsion phase during CMJ and SJ compared to the non-flexible group ($d = 0.80 - 1.14$, $p <$

0.05). The joint angles of the lower limbs at the second peak of the force-time curve in CMJ were significantly larger in the flexible group (d = 0.83 – 1.21, p < 0.05), indicating that they generated force at more extended joint angles.

CONCLUSION: This study clarified the relationship between hip extension ROM and power output characteristics during VJ. Previous research has shown that limited hip extension ROM results in reduced gluteus maximus activation (1). Similarly, participants with restricted hip extension ROM in this study may have had difficulty generating torque with the gluteus maximus in the late half of the propulsion phase. Previous studies have demonstrated that plyometric training enhances power output during the early phase of the concentric contraction; however, strategies for improving power output during the latter phase remain insufficiently explored (2). The results observed in this study, when further investigated in future research, may lead to the establishment of a comprehensive approach that includes improvements in force output during the latter phase of the concentric contraction.

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**EFFECT OF LOWER LIMB MUSCLE STRENGTH AND ACTIVITY ON POSTURAL STABILIZATION DURING LANDING IN FEMALE ARTISTIC GYMNASTS**

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INTRODUCTION: Performance in artistic gymnastics requires a significant level of physical fitness (1), including high lower limb muscle strength (2). Gymnasts have to meet numerous requirements when performing the landing, including aesthetic execution and the ability to absorb large reaction forces to ensure safety (3). Optimal muscle activity plays an important role in influencing the execution of the landing (4). Therefore, the aim of the study was to assess the relationship between lower limb muscle strength and activity and postural stabilisation during the landing in female artistic gymnasts.

METHODS: Thirty-one female gymnasts were included in the study. An inertial sensor placed on the lower back was used to determine postural stabilisation by using dynamic stability index (DSI) and time to stabilization (TTS) in the sagittal plane for one and three second intervals from contact with the mat. Surface electromyography was used to assess muscle activity of the m. vastus medialis, m. rectus femoris, and m. biceps femoris. Gymnasts performed three valid drop landings, forward somersaults, backward somersaults, and acrobatic series on the floor. To assess eccentric isokinetic muscle strength, the IsoMed 2000 (D. & R. Ferstl GmbH, Hemau, Germany) for the hip and knee joints at a speed of 180 deg. s-1, and a leg-press module with a test speed of 400 mm.s-1 were used. Statistical analysis was performed using Spearmans correlation coefficients.

RESULTS: For the drop landing, significant correlations were found between the three-second interval TTS and m. biceps femoris activity before landing (r = -0.40), as well as after landing (r = -0.46, r = -0.54, for one and three second intervals respectively).

For the forward somersault, significant correlations were found for TTS and hip work (both r = 0.52) and one-second interval TTS and hip peak torque (r = 0.46). For the backward somersault, a significant correlation was found for the three-second interval TTS and hip peak torque (r = -0.55).

Significant correlations were found for the acrobatic series between DSI and m. biceps femoris activity before landing (r = 0.54, r = 0.44, for one and three second intervals respectively) and DSI and legpress work (r = -0.49, r = -0.48).

CONCLUSION: The results show that in simple movement tasks such as drop landing, higher muscle activity of the m. biceps femoris before and after the landing positively influences postural stabilization. On the contrary, in the acrobatic series, a complex involvement of the whole lower limbs is required during the deceleration phase. Achieving high values of peak torque when performing the eccentric movement at the hip joint seems to be important for stabilisation after the backward somersault, probably because of the lower heights achieved.

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**ANTHROPOMETRIC DETERMINANTS OF SKATING SPRINT KINEMATICS IN BANDY**

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INTRODUCTION: Sprint skating is a crucial bandy skill for effectively performing game-specific tasks [1,2]. Previous studies showed the step frequency (SF) during the acceleration (ACC) and maximum sprint (MAX) phases, and the glide length (GL) obtained during the MAX phase were the most important spatiotemporal (ST) metrics in predicting the maximal skating velocity [3]. However, no studies have examined the correlation between anthropometrics and ST parameters for skating sprints in bandy. Thus, this study investigated the correlation between ST parameters and anthropometrics in bandy players during skating sprints.

METHODS: Thirty-two well-trained male bandy players [age: 17.8 ± 1.2 years; height: 1.80±0.06 m; body mass (BM): 75.7±1.2 kg; BMI: 23.3±2.2 kg/m2; leg length (LL): 100.6±5.2 cm] completed two 80m skating sprints. 9 timing gates and two skate-mounted IMUs were synchronised to calculate velocities and obtain glide-by-glide kinematics. The skating ST kinematics at each step included SF, GL, glide time (GT), double support time (DST), double support length (DSL) and step length (SL). All ST variables were analysed separately in the ACC and MAX phases (i.e., over the first and last six steps). Partial correlation (r) with an alpha level (p) of 0.05 was used to investigate the strength and direction of correlation between LL, BMI, and ST in the ACC and MAX phases.

RESULTS: When controlling for BMI, LL showed a positive and moderate correlation with GT, GL, and SL ($r = 0.40$-$0.49$, $p<0.05$) while exhibiting a negative correlation with SF in both phases ($r = -0.47$, $p<0.05$). When accounting for LL, BMI correlated positively only with the max velocity attained in the ACC phase ($r = 0.40$, $p<0.05$).

CONCLUSION: Given that a higher SF during the ACC and MAX phases and a longer GL during the MAX phase determine maximal skating velocity [3], it is logical to conclude that LL may affect skating speed by negatively impacting SF while positively influencing GL, GT, and ST. Therefore, the results suggest that a longer LL might be a disadvantage in the ACC phase but an asset in the MAX sprint phase, where the GL is a crucial determinant. Players with a higher BMI demonstrated better acceleration ability, which may be attributed to their greater muscle mass and enhanced ability to exert force and power. Such a conclusion is supported by the understanding that a higher BMI in the athletic population signifies a greater proportion of muscle relative to fat mass [4]. The increased muscle mass enables players to overcome body inertia more effectively and, thus, accelerate more rapidly [1-3]. The current study indicates that a higher BMI may indicate a greater muscle mass in a homogenous group of well-trained bandy players. Coaches should consider players' anthropometrics when optimising skating technique, where an individualised ratio between SF and GL is adapted to maximise skating speed in the ACC and MAX phases.

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**CONTRIBUTION OF BODY-SEGMENT ROTATION TO MECHANICAL ENERGY IN POLE VAULTING USING EMBEDDED INERTIAL MEASUREMENT UNITS**

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INTRODUCTION: Performance in pole vaulting is highly related to energetic parameters during both the run-up and the jump phases [1,2]. Most studies used a mass-point model to describe the motion of the athlete's center of mass. This does not allow to quantify the fraction of mechanical energy associated with body-segment rotations [3]. The aim of this study is thus to investigate the influence of the segmental rotations on the mechanical energy of the pole vaulter using a 3D multibody biomechanical model based on inertial motion capture.

METHODS: Data were collected from a female pole vaulter (1.77m, 61 kg). 7 trials were performed using a 4.15m pole with a bending index of 59 and a crossbar set at a height of 3.50m. Kinematic data were collected using the Xsens MVN Awinda® system (Xsens Technologies B.V, The Netherlands) composed of 17 body-worn IMUs sampled at 60 Hz. Kinetic (KE), Potential (PE) and mechanical (ME) energies were studied at take-off (TO), maximal pole bend (MPB) and bar clearance (BC) and were computed using a full-body biomechanical model [4].

RESULTS: The results indicated that the energy associated with the rotation of the body-segments accounts for (14%±0.92) of the total kinetic energy at TO, (27%±4.02) at MPB and (39%±4.39) at BC. Considering the ratio of rotational energy relative to the total mechanical energy, it represents (9.5%±0.62) at TO, (8.5%±0.70) at MPB and (4.3%±0.61) at BC. The decreasing trend in the proportion of segment rotational energy to total mechanical energy is associated with the progressive increase in potential energy across the different phases (32% at TO, 68% at MPB, and 89% at BC). Focusing on BC, 4.3% of the total mechanical energy calculated using the multibody model corresponds to approximately 97J. Given the athletes characteristics and the height at which the bar was cleared, this would correspond to an additional centre of mass height of 16cm. Furthermore, the increase in the standard deviation of kinetic energy from TO to BC suggests greater variability in technique up to bar clearance, which may be associated with precise segmental adjustments (quantified by body segment rotational kinetic energy).

CONCLUSION: Our results suggest that considering body segment rotations is essential when analysing the energy content of movement. This study suggests the importance of the pole vaulters body segment adjustments in interaction with the pole, particularly during bar clearance.

**REFERENCE DATA OF DOUBLE AND SINGLE-LEG POSTURAL STABILITY MEASURED WITH AN INERTIAL SENSOR: PRELIMINARY RESULTS.**

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INTRODUCTION: Postural stability is a global health key factor in the maintenance of upright standing balance. The most used instruments for measuring double and single-leg stability are usually platforms. In the last ten years, inertial sensors are growing up as stability measuring tool. The different technology of the inertial sensor in measuring stability requires

reference data in order to use them to classify stable and unstable individuals. This study aims to show the preliminary results of a larger study for assessing reference data of stability measured through inertial sensors.

METHODS: One hundred thirty-seven healthy volunteers (55 male and 82 female, height 165.4 ± 11.1 cm; weight 62.1 ± 15.4 kg; age 27.7 ± 14.4 yo) were recruited and tested for double and single leg stability. All subjects were right leg dominant. An inertial sensor (Beyond Inertial, Motustech, Italy) was applied on the lumbo-sacral region to assess stability, measuring sway path length (PL) and oscillation ellipse area (EA), both in open and closed eyes conditions (OE, CE respectively). Double and single leg stability tests lasted 30" and 10", respectively. For single leg stability dominant (DL) and not-dominant (NDL) leg was tested. Preliminary data analysis involved a descriptive statistic approach with percentiles and a Student T-test for a paired and independent sample to measure significant differences. The significance level was set at $P < 0.05$.

RESULTS: For the whole sample, in double legs test OE-AE was 4.2 ± 7.5 cm2 (percentiles 25th 1.3; 50th 2.2; 75th 4.1) and CE-AE was 3.6 ± 4.1 cm2 (percentiles 25th 1.2; 50th 2.2; 75th 3.9); OE-PL was 51.0 ± 30.3 cm (percentiles 25th 35.6; 50th 44.3; 75th 59.4) and CE-PL was 55.1 ± 22.2 cm (percentiles 25th 41.4; 50th 51.1; 75th 61.7). CE-PL was significantly greater respect OE-PL (p 0.017). In single leg test DL-AE was 37.9 ± 62.8 cm2 (percentiles 25th 9.2; 50th 17.4; 75th 34.1) and NDL-AE was 22.2 ± 35.6 cm2 (percentiles 25th 7.2; 50th 11.1; 75th 23.8); DL-PL was 37.2 ± 22.7 cm (percentiles 25th 24.2; 50th 31.3; 75th 41.5) and NDL-PL was 32.9 ± 17.0 cm (percentiles 25th 22.6; 50th 28.3; 75th 37.8). Both DL-AE and DL-PL were significantly greater respect NDL-AE and NDL-PL (p 0.000 and 0.001, respectively). Male showed higher values respect female for DL-PL and NDL-PL (41.9 ± 24.3 and 34.0 ± 21.0 cm p 0.044; 37.1 ± 17.6 and 30.2 ± 16.0 cm and 0.019, respectively).

CONCLUSION: The preliminary results of this ongoing study, allow concluding that the need for reference data is high due to the significant differences between conditions and gender. The study will allow professionals and researchers to use inertial sensors to test double and single-leg stability in all that contexts where the use of stabilometric platforms is limited.

**DIFFERENCES IN STRENGTH UTILIZATION OF LOWER LIMBS IN DIFFERENT LEVEL PÉTANQUE PLAYERS AT VARIOUS SHOOTING DISTANCESCES**

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INTRODUCTION: The original meaning of French Pétanque is "throwing the ball with both feet on the ground", so the lower limbs play an important part in the entire throwing process. Lower extremity strength is the primary source of power in most throwing sports (1). However, when tossing the ball in pétanque training or competition, some players may not properly apply lower extremity force, and more upper arm strength is required. This may lead to either insufficient throwing force or frequent directional deviations even easy to injury. The purpose of this study is to compare the body segment coordination, lower limb kinematics characteristics, center of pressure transfer, and muscle activation between elite players and amateurs while throwing various distances.

METHODS: 10 elite players and 10 amateurs were recruited for this study. Insole foot pressure, markerless motion analysis system, and surface electromyography were applied for data collection while players executed formal throws at six to nine-meter distances. Two-way ANOVA was applied to test the differences in joint kinematics, foot pressure distribution, center of pressure displacement, and maximum muscle activation between the two groups at different distances during different throwing phases.

RESULTS: Both groups throwing patterns were similar, increasing their backswing angle, release angle, and trunk horizontal displacement with distance increasing. However, the amateurs have significantly larger releasing angles than elite players. During backing, the contact area and foot pressure in the forefoot and midfoot of the non-throwing side in amateurs were larger than in elite players. The elite players put more pressure on the hindfoot on the throwing side. When releasing the ball, the contact area, contact pressure, and peak contact pressure in the forefoot of the throwing side in elite players were larger than in amateurs. The elite players were with less medial-lateral displacement of the center of pressure in the throwing side during throwing. Regarding muscle activations during throwing, higher wrist extensors were found in amateurs, however, higher rectus femoris and vastus medialis were found in elite players.

CONCLUSION: Better foot pressure distribution and center of pressure transfer patterns enable better performance in throwing. To increase stability during the throwing, skill training should follow the motion patterns identified in this study, and strength training may focus on core muscle groups to improve trunk and pelvic stability to have better performance.

**A PILOT STUDY ON KNEE AND ANKLE MUSCLE CO-CONTRACTION PATTERNS DURING SINGLE LEG DROP JUMP AFTER PEOPLE FOLLOWING ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION.**

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INTRODUCTION: Single leg drop jump (SLDJ) is widely used in the assessment of post-anterior cruciate ligament reconstruction (ACLR) performance . The Co-contraction Index (CCI) is a valuable metric that evaluates the degree of simultaneous contraction between agonist and antagonist muscles using electromyography (EMG) signals. In general, a high CCI indicates excessive co-contraction of the antagonist muscle, which contributes to joint stability but may decrease energy efficiency. Conversely, a low CCI suggests reduced antagonist muscle involvement, improving movement efficiency but

potentially compromising joint stability. This study aims to investigate the differences in knee and ankle muscle co-contraction patterns between the reconstructed limbs (RL) and non-reconstructed limbs (NRL)during SLDJ in ACLR patients.

METHODS: Three males patients following ACLR (mean age: 18.7 years, mean height: 176.7 cm, mean weight: 74 kg) performed SLDJ five times both RL and NRL. EMGs were recorded from six lower limb muscles: vastus lateralis (VL), vastus medialis (VM), biceps femoris (BF), semitendinosus (ST), soleus (SOL), and tibialis anterior (TA) using wireless surface EMG system (Ultium, Noraxon) with 2000 Hz. Foot strike (FS) and foot-off timing were identified using a force plate (AMTI). We divided into five distinct phases: Pre-activation phase (50 ms before foot strike to FS), landing phase 1 (FS to foot-off), first-half of flight phase (foot-off to mid-swing), second-half of flight phase (mid-swing to the second FS), and the landing phase 2 (second FS to 100 ms after second FS). CCI was calculated using the ratio of agonist muscle activity to antagonist muscle activity multiplied by 100%. The CCI values for each phase were compared between RL and NRL to analyze differences in neuromuscular control.

RESULTS: The results revealed that in the lateral knee muscle group (LM/BF), CCI in the reconstructed limb was lower during the landing phase 1(FS to foot-off) compared to the non-reconstructed limb (NRL: 403% vs. RL: 87.1%). However, no differences were observed in the other phases. In contrast, no differences were found between the RL and NRL in the medial knee muscle group (VM/ST). In the ankle muscle group (SOL/TA), RL exhibited higher CCI during the landing phase 1. (215.8% vs. 128.9%), indicating excessive co-contraction.

CONCLUSION: The reduced CCI in the lateral knee muscle group of the RL during the landing phase may indicate decreased knee joint stability post-ACLR. This lower co-contraction would lead to inadequate shock absorption upon landing. The excessive co-contraction observed in the ankle joint of the RL during the landing phase suggests a compensatory mechanism, where the ankle attempts to counterbalance knee instability.

Based on these results, rehabilitation strategies for ACLR patients should prioritize improving knee muscle activation during landing to enhance stability while simultaneously addressing excessive ankle co-contraction to encourage proper neuromuscular control.

**EVALUATION OF MUSCLE ACTIVITY AND RECOVERY PROCESS BEFORE AND AFTER MUSCLE FATIGUE TASK BY MC SENSOR METHOD**

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INTRODUCTION: The muscle contraction sensor (MC sensor) method has been used to evaluate the mechanical activity of muscles during muscle contraction. In previous studies, it has been shown that muscle tension in the biceps brachii muscle and knee extensor muscles measured by the MC sensor method are an indicator that can estimate the elbow flexion and knee extension muscle force levels (1, 2, 3). However, muscle fatigue and its recovery process have not been clarified. Therefore, the purpose of this study was to investigate the muscle activity and its recovery process before and after the muscle fatigue task by eccentric contraction by the MC sensor method.

METHODS: Eight males without disabilities to knee joint were participated in this study. The isometric knee extension torque at the knee joint angle of 80 degrees in before, after the fatigue task and four days after were measured by a dynamometer (Biodex co.). At the same time, the muscle tension as an index of muscle activity at rectus femoris (RF), vastus lateralis (VL), vastus medialis oblique (VMO) were measured by Muscle Contraction Sensor (TMG-BMC) method. The subjects were performed fatigue task with knee extension exercises consisting of 5 sets of 20 maximal effort eccentric contractions with 90 seconds of rest.

RESULTS: The knee extension torque decreased significantly after the fatigue task, with a decrease of approximately 23.4%. In four days after the fatigue task, the knee extension torque had recovered to the same value as before the fatigue task. The maximum muscle tension measured by the MC sensor method decreased by about 30% in all muscles after the fatigue task. 4 days after the fatigue task, maximum muscle tension in RF and VL had recovered to the same value as before the fatigue task. However, maximal muscle tension of VMO had not yet recovered.

CONCLUSION: The knee extensor torque was reduced due to the high intensity fatigue task caused by eccentric contraction. The muscle tension in the RF, VL and VMO muscle were also reduced in a similar value. In previous studies, it has shown that muscle tension measured by the MC sensor method estimates the muscle force levels (1, 2, 3). In this study, knee extensor torque and muscle tension also showed similar decreases before and after the fatigue task. On the other hand, it was observed that muscle recovery from fatigue differed by each muscle. These results suggest that differences in the contribution of the muscles participating in the knee extension may affect the recovery from fatigue.

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**COMPARISON OF KINEMATIC CHARACTERISTICS ON HITTING MOTION TO THE FAST AND SLOW BALL VELOCITIES IN SOFTBALL PLAYERS**

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INTRODUCTION: Baseball and softball hitters must respond to a various pitches and velocities thrown by the pitcher. It has been there are several reports to examine the focus on timing of the baseball hitting motion (1, 2, 3). In hitting motion, the step is an important movement for timing. Therefore, differences in step length are thought to affect lower limb and trunk motion. The purpose of this study was to examine that the step and kinematic characteristics of torso movement on hitting motion to the fast and slow ball velocities in soft ball players.

METHODS: The subjects were 14 male university softball players. Batters hit fastballs (FB:26.6±2.3m/s) and slow balls (SB:20.4±0.9m/s) thrown randomly by the pitcher. Bat swing speed was measured with a swing speed measurement system (BLAST Mizuno). Hitting motions were captured using 3D motion capture system (Xsens MVN, Movella co.) and two high-speed cameras (Degimo co.). The analysis phase was from the batters take back (TBM) to impact (IMP), and the release (RLS), toe ground contact (TC), and heel contact (HC) times were extracted. The analysis trials were hits in the center direction both FB and SB. The analysis items were stride length, upper and lower torso rotation angles, center of gravity displacement in the direction of the pitcher.

RESULTS: Stride length from TBM to IMP for FB and SB was significantly greater for SB than FB in TBM-TC phase and HC-IMP phase. The angles of rotation of the upper and lower torso in FB were significantly greater than that of SB in both RLS-TC phase. The distance on center of gravity toward the pitcher direction was greater SB than FB in from TBM to IMP phase, and the difference was especially significant from HC to IMP phase.

CONCLUSION: In this study, the kinematic characteristics of hitting motion to the fast and slow ball velocities in softball players. The response was to change the stride length and delay the timing of the upper and lower torso rotations at the time of SB hitting compared to the time of FB hitting. Also, compared to FB hitting, SB hitting may respond with a center of gravity displacement toward the direction of the pitcher during the HC-IMP phase.

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**EFFECTS OF RESISTANCE TRAINING TO STRENGTH AND SPRINT TIME IN COLLEGE RUGBY PLAYERS**

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INTRODUCTION: In contact sports such as rugby and american football, intense contact play with tackles, scrums, and mauls are repeatedly performed during a game (1). And also, rugby players need to be able to sprint ability for move quickly to take their positions in attack and defense (2). Therefore, training programs aimed at improving strength and sprint ability are important in rugby players (3). The purpose of this study was to investigate the effects of resistance training (RT) on muscle strength and sprint ability in rugby players.

METHODS: The subjects were 16 university rugby players (Age:20.8±0.4 yrs, Hight:174.1±6.3cm, BW:81.4±10.0kg, LBW:64.6±7.7kg). RT was performed 4 times per week for 12 weeks. RT was programmed conceit of 5-weeks for hypertrophy period (middle load and high repetitions), 4-weeks for strength period (middle load and middle repetitions), and 3-week for strength and power period (low load and high repetitions). The maximal strength of lower body was tested at Squat (SQ) 1RM and Deadlift (DL) 1RM restrictively. The maximal strength of Upper body was tested by Bench Press (BP) 1RM and Pullup (PU) 1RM in all subjects. In addition, Sprint time was tested at 30 m time and 10m lap times. These parameters were tested before (Pre) and 12 weeks after (Post) the RT. Moreover, the change ratios were calculated in all subjects.

RESULTS: As a result, SQ and DL1RM in Post were showed significant higher values compered to Pre. And BP and PU showed for Post to Pre. These change ratios ranged from 104.8 to 107.3%. On the other hands, 30m sprint time and 10m lap times were not observed significant deferens between Pre and Post.

CONCLUSION: SQ, DL, BP, and PU are important physical fitness components, especially for Rugby, which involves repetitive heavy collisions and sprinting. The planned training program in this study was effective in improving the strength of SQ, DL, BP, and PU. On the other hand, the RT in this study did not improve sprint ability. Therefore, it is suggested that training at the field level is necessary to improve sprint ability in rugby players.

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**SELF-ORGANISATION AND MUSCLE SYNERGIES IN PARACANOE PERFORMANCE**

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INTRODUCTION: Paddling technique is fundamental to kayaking performance and varies with body coordination adaptation (1). Athletes dynamically adapt through self-organisation, forming synergies to optimise movement. They exploit degeneration, the ability to use different structures for the same output (2). In the ecological-dynamic approach, muscle synergies emerge as self-organising mechanisms, simplifying motor control and reducing degrees of freedom (3). Studying synergies helps understand neuromuscular control. This study aims to investigate paddling muscles synergies in paracanoe athletes, an unexplored area, to clarify how they optimise performance through degeneration, ensuring flexibility and adaptability.

METHODS: Three paracanoe athletes (KL3: 2, KL1: 1; two men, one woman; 31 ± 10.5 years) performed two 30-second maximal sprints on a paddle ergometer. The electromyographic activity (sEMG) of six ipsilateral muscles, biceps brachii (BB), triceps brachii (TB), pectoralis (PECT), middle deltoid (MD), upper trapezius (UT) and latissimus dorsi (LD), was recorded with wireless electrodes (BTS S.p.A., Italy). sEMG data were filtered, rectified, and normalised to the paddling cycle, defined by two successive paddle inputs into the water, identified using an optoelectronic system (BTS S.p.A., Italy). Non-Negative Matrix Factorization (NMF) extracted muscle synergy modules, identifying contributions and temporal activation. k-means analysis grouped the modules by similarity. Cosine similarity (CS) assessed the similarity in contributions and activation across athletes.

RESULTS: Three modules for athlete were extracted and classified into three clusters, indicating that the central nervous system facilitates paddling through three modular structures. Clusters of muscle contributions and temporal activation were similar among athletes (CS > 0.80). Cluster 1 involved the UP, MD (bilateral) and right BB, active between 10-30% of the cycle (pulling phase). The UT and MD stabilise the scapula, while the BB balance the TB in Cluster 3. Cluster 2 involved the left LD, left BB, right PECT and left TB, active between 40-60% of the cycle (input phase and traction of the opposite limb). Cluster 3 involved the right LD, right TB and left PECT, active at 0-20% and 90-100% of the cycle (water entry phase). The TB reduced elbow flexion, while the LD was the primary motor for shoulder extension and internal rotation.

CONCLUSION: The muscle synergies identified confirm common strategies to optimise paddling, simplifying motor control recurring modules ensuring stability and adaptability. The similarity in activation patterns suggests shared biomechanical principles despite individual differences. This evidence provides a basis for analysing variations in the motor skills of paracanoe athletes and offers insights for training optimisation.

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**MUSCLE SYNERGIES IN SQUATTING: AN ECOLOGICAL-DYNAMICS PERSPECTIVE ON NEURAL CONTROL AND TASK CONSTRAINTS**

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INTRODUCTION: The front squat and back squat are widely used strength training exercises across various sports (1). Different barbell placements result in variations in movement biomechanics (2). However, the extent to which these variations influence motor control remains unclear.

The complexity of motor control, due to the abundance of degrees of freedom, is managed through synergies, as proposed by Bernstein. Within the ecological-dynamics framework, muscle synergies represent the self-organization of the movement system as a result of the continuous interaction between the organism, task, and environmental constraints, facilitating movement toward specific goals (3).

This study aimed to investigate whether different barbell placements in squats act as constraints that influence the emergence of distinct muscle synergies.

METHODS: Four healthy male participants performed three sets of five repetitions at their 10RM load for back and front squats.

Eight sEMG sensors were placed on the following muscles: gluteus maximus (GM), biceps femoris (BF), semitendinosus (ST), gastrocnemius lateralis (GL), rectus femoris (RF), vastus lateralis (VL), vastus medialis (VM), and tibialis anterior (TA). An inertial sensor was used to define squat cycles. Raw sEMG signals were band-pass filtered, rectified, and their envelopes were extracted. Muscle synergies were extracted using non-negative matrix factorization (NMF) and clustered using k-means analysis. Cosine similarity (CS) analysis was performed to assess the similarity of muscle synergies among subjects and squat variation.

RESULTS: Two motor modules were extracted for both squat variations in all subjects, grouping into two clusters. No subject exhibited individual-specific clusters. Cluster 1 primarily included GM, BF, ST, and GL muscles, peaking at 80% of the squat cycle. Cluster 2, comprised RF, VL, VM, and TA muscles, with peak activation between 30% and 75% of the squat

cycle. Muscle synergies remained highly similar across subjects and squat variations, with median CS values exceeding 0.85, indicating that squat variations did not alter the underlying synergy structure.

CONCLUSION: The findings could advise that motor control in squatting emerges as a self-organized process, where the central nervous system simplifies movement execution through two robust muscle synergies, independent of barbell placement.

Furthermore, the absence of significant differences in muscle contribution or temporal activation patterns between variations suggests that barbell position could not impose sufficient task constraints to induce distinct synergy structures.

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**MUSCULAR SYNERGIES AND SELF-ORGANIZATION IN RHYTHMIC GYMNASTICS TRAINING: AN ECOLOGICAL-DYNAMIC ANALYSIS**

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INTRODUCTION: In the ecological-dynamic approach, muscle synergies are referred to as self-organization, that is the organization of the different degrees of freedom of the body in relation to a goal (1). Studying the synergies in rhythmic gymnastics (RG) jumps, performed free body and with overloads, is useful for improving performance, as jumps require considerable inter and intramuscular coordination (2). Ankle weights are commonly used in RG jump training, but there is no scientific research on this topic. The aim of this study is to investigate, through the analysis of muscle synergies, the effectiveness of using ankle weights in the split leap training to identify conditions of specificity and transfer with the competitive context.

METHODS: Six competitive gymnasts (16.5±2.7 years) performed five trials of the free body split leap and five trials of the same jump with 0.5 kg ankle weights. The BTS Bioengineering S.p.A. integrated multifactorial optoelectronic system was used, consisting of seven force platforms and six surface EMG sensors applied on the rectus femoris (RF), biceps femoris (BF) and gastrocnemius lateralis (GL) muscles. After identifying two events, the foot contact with the platforms and the take-off, synergy modules were extracted using non-negative matrix factorization (NMF). Average values of temporal activations and muscle contributions of the clusters identified through cluster analysis were highlighted. To compare the trials with and without ankle weights, the Pearson correlation was made.

RESULTS: Two synergic modules associated with two clusters were identified for each condition. Cluster 1 of the split leap with ankle weights and cluster 2 of the split leap without ankle weights show high levels of correlation in both muscle contributions ($|r|=1$) and temporal activations ($|r|=0.98$). The synergic muscles are the right RF, the right and left BF and the right GL. The greatest muscle activation occurs around 50% of the cycle. Cluster 1 of the split leap without ankle weights and cluster 2 of the split leap with ankle weights also show a strong correlation in both muscle contributions ($|r|=0.99$) and temporal activations ($|r|=1$). The synergic muscles are the left RF and the left GL. The peak of muscle activation occurs around 15% of the cycle. From the results of Pearson correlation, very strong correlation relationship ($|r|=0.99$) (3) between the two conditions emerged.

CONCLUSION: The results show that, despite the small size of the sample, the 0.5 kg ankle weights don't seem to alter self-organization and muscle coordination in the split leap. From an ecological-dynamic perspective, it is hypothesized that they represent a useful overload to support specificity and transfer between training and competition contexts in RG. Ankle weights, therefore, could be used for improving the performance of the split leap.

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**CHARACTERISTICS AND COMPARISON OF POSTURE ESTIMATION AI MODELS FOR EVALUATING CHILDRENS RUNNING MOTION**

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INTRODUCTION: The authors have developed an observational evaluation method for assessing childrens running motion. In this evaluation, we hypothesize that combining qualitative assessments based on motion observation with AI-driven motion recognition can enable the development of a machine learning and deep learning-based AI capable of highly accurate motion analysis. However, current AI technology has not yet achieved sufficient accuracy in extracting key motion features from continuous movements or conducting precise evaluations. As a preliminary step in evaluating running motion, this study aims to examine the characteristics and accuracy of multiple posture estimation AI models by analyzing identical image datasets.

METHODS: In this study, we visually compared the accuracy of four posture estimation AI models available in Python: HRNet, MediaPipe, YOLO11, and MMPose. The evaluation was conducted by using these models to estimate skeletal structures and key body parts in images of two runners running simultaneously. The images were captured from a lateral perspective at 60 FPS in high-definition resolution.

RESULTS: HRNet and YOLO11 estimated a total of 17 key body points, including the nose, eyes, ears, shoulders, elbows, wrists, hips, knees, and ankles. MMPose was capable of estimating the feet in addition to these, while MediaPipe could estimate both hands and feet, making it the most comprehensive in terms of detected body parts.

Regarding estimation accuracy, YOLO11 exhibited low reliability, correctly estimating knees and ankles in only 20–30% of frames, rendering it unsuitable for large-scale motion analysis such as running evaluation. MediaPipe failed to estimate posture in approximately 10% of frames, despite detecting the runners with Norfair. Among the estimated frames, knees were accurately estimated in 80% of cases and feet in 60%.

HRNet and MMPose demonstrated superior accuracy, correctly estimating 13 body points (excluding feet and legs) in over 97% of frames. Additionally, they achieved 95% accuracy for knee and ankle estimation. MMPose further excelled in foot estimation, achieving 85% accuracy. However, occasional misclassification of left and right body parts was observed.

CONCLUSION: HRNet and MMPose appear to be the most effective AI models for posture estimation, with MMPose being particularly advantageous when foot movement data is required. However, the current results remain insufficient for precise running. Further refinement is necessary, including correcting left-right misclassifications, filtering out inaccurate estimations, and supplementing missing data. In conclusion, while HRNet and MMPose exhibit high accuracy in skeletal estimation, their precision remains inadequate for detailed running motion analysis.

**ESTIMATION OF GROUND REACTION FORCE FEATURES USING INERTIAL SENSORS DATA IN RUNNING: ACCURACY ASSESSMENT AND SENSITIVITY ANALYSIS WITH RESPECT TO GAIT EVENT IDENTIFICATION OF 12 ALGORITHMS**

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INTRODUCTION: Running is a widely practiced activity with significant health benefits but also a high risk of lower limb injuries. The study of Ground Reaction Force (GRF) is essential for performance optimization and injury prevention. Traditional GRF measurement instruments ensure high estimation accuracy, but are restricted to laboratory settings, while wearable alternatives like force insoles represent a more practical tool but face durability and foot-shoe interaction issues. Inertial Measurement Units (IMUs) provide a portable solution for in real-world applications, yet their accuracy and robustness in relation to gait event identification relying exclusively on IMU data has not been investigated. This study evaluates the performance of 12 IMU-based algorithms for GRF estimation using Loadsol® insoles as gold standard, aiming to refine estimation techniques for a portable and fully independent alternative to traditional measurement tools.

METHODS: Eleven amateur runners (9M2F, age: 26±4 years) performed sprints at 15, 20 and 25 km/h. Two IMUs (OPAL, ±200g, ±2000deg/s, 800Hz) were attached on the participant's right shank and lower back (L5) and secured with adhesive tape and a belt for the lower back sensor. Loadsol® insoles (Novel, 200Hz) served as gold standard. A total of 1177 steps were analysed separately for each speed. The GRF features examined were the first and second peak, loading rate, average load, impulse, and GRF time series. Algorithms were classified based on sensor placement (shank: 4, sacrum: 8) and methodology (Neural Networks (NN: 2, traditional approaches: 10) A linear mixed-effects model was used for statistical comparison. Additionally, sensitivity analysis was performed by varying initial contact (IC), final contact (FC) timings and stance window, with starting time points identified by selected IMU-based algorithm, assessing their impact on estimation errors.

RESULTS: While no single algorithm consistently outperformed the others across all metrics, NN-based methods generally showed better performance, with lower bias and dispersion (e.g. -0.3kN/s bias and limits of agreement 48.9kN/s for the loading rate metric with Kim method at 20km/h). The sensitivity analysis highlighted that estimation errors depended on both the analyzed GRF metric and the specific algorithm. NN-based approaches were more affected by FC misidentifications, while traditional methods showed higher sensitivity to IC and stance window variations. An overall worsening of algorithms' performances was observed at increasing speeds.

CONCLUSION: NN-based algorithms demonstrated the highest accuracy in GRF estimation. Traditional methods proved to be less reliable, particularly for peak force and loading rate measurements. The study highlights the importance of accounting for test speed and ensuring accurate gait event detection, as variations in IC and FC timing significantly affected GRF estimates.

**ENERGY COST AND EFFICIENCY OF SEMI-TETHERED SWIMMING WITH A PARACHUTE**

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INTRODUCTION: Swimming parachutes are commonly used for resisted swim training. Their effects on the hydrodynamic resistance encountered by the swimmer (1) as well as on his/her technique have been investigated and reported (2,3). Their use can be expected to affect also swimming economy (C) and efficiency ($\eta$), but this has not been investigated yet. The aim of this study was to determine C and $\eta$ during swimming with and without a parachute (at comparable effort).

METHODS: Fifteen swimmers (14M/1F, 565.4 ± 118.4 of World Aquatic Points) completed two series of incremental pace trials: semi-tethered swimming while towing a squared-shape parachute of 900 cm² (para) and free-swimming (free); each trial lasted 4 min and was swam at constant speed (v). In the free condition, v was set at 60, 65, 70, 75 and 80% of the swimmer's best 400 m front-crawl performance and the corresponding Fd values were calculated as kfree · vfree² by knowing the speed-specific drag in active condition (kfree), that was estimated through the residual thrust method (4). To maintain an equal effort (Fd) when towing the parachute, the values of v were recalculated based on values of k measured when towing the parachute, as reported by (1) (vpara= √(Fd/kpara)). The aerobic contribution (Eaer) to total energy expenditure (Etot), was determined by measuring oxygen uptake, while the anaerobic lactic contribution (EanL) was estimated based on the net increase in blood lactate concentration assessed at the end of the trial. The energy cost of swimming (C) was calculated as the ratio between metabolic power (E'tot = Etot /trial duration) and v, while drag efficiency was calculated as the ratio between drag power (Pd = Fd · v) and metabolic power ($\eta$ = Pd /E'tot). Stroke rate (SR) was assessed using inertial measurement units placed on the swimmers wrists, as an indicator of swimming technique.

RESULTS: To maintain the same effort (Fd: p=0.336) the participants swam at reduced speeds when towing the parachute (p<0.001; vpara=0.93-1.24 m/s; vfree=0.65-0.86 m/s). No differences in total energy expenditure were observed (Etot: p=0.475; para=149-275 kJ; free=143-279 kJ), and this confirms that the participants were swimming at equal effort in the two conditions. Yet C (the energy expended per unit distance) was found to increase significantly (p<0.001; para = 0.95-1.32 kJ/m; free=0.64-0.91 kJ/m) and drag efficiency to decrease (p<0.001; para = 4-5%; free =5-8%) in resisted swimming.

CONCLUSION: Towing a parachute slows down a swimmer, but the decrease in speed is associated with an increase (rather than a decrease) in the energy cost of locomotion. In addition, even if the swimming technique can be assumed to be unchanged (no differences in SR: p=0.272), a reduction in drag efficiency is observed: the capability to transform metabolic power into useful mechanical power is thus impaired during resisted swimming.

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**ANGULAR VELOCITY AND ANGULAR ACCELERATION OF PELVIC ROTATION AND KNEE ROM OF THE KICKING LEG DURING DIFFERENT ROUNDHOUSE KICKS IN JU-JITSU ATHLETES**

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INTRODUCTION: In ju-jitsu fights, athletes compete using various technical gestures including kicks to the head and abdomen of the opponent and the points obtained depend on the part of the body hit (i.e., three points for a kick to the head and one point for a kick to the abdomen). This technical gesture requires a rapid axial rotation of the pelvis and kicking leg to attack. This study aimed to analyse the angular velocity and angular acceleration of of the pelvic rotation and the knee ROM of the kicking leg during the roundhouse kick to 3 different heights and from 3 different distances in ju-jitsu athletes.

METHODS: Firstly, the length of the dominant leg (trochanter-malleolus distance in cm) in 16 black belt ju-jitsu athletes were recorded. Then, using a system of inertial sensors applied to specific anatomical points (pelvis, thigh, tibia, metatarsus) each participant performed 9 roundhouse kicks (i.e., 3 kicks to each height from all 3 distances) in a random order. The 3 heights of the target (i.e., head, abdomen, and knee) were calculated based on the height of each participant and the 3 distances from the target (i.e., short, medium, and long) were calculated based on the length of the dominant leg of each participant (i.e., medium distance: equal to the trochanter-malleolus distance; short distance: trochanter-malleolus distance minus 1/3; long distance: trochanter-malleolus distance plus 1/3).

RESULTS: For the pelvic rotation, we found a significant increase in the maximum angular velocity between the roundhouse kicks performed from short distance and those from long distance (p<0.01). No significant differences were found in the maximum angular acceleration of the pelvic rotation among the differents roundhouse kick. For the knee joint of the kicking leg, we found a significant increase in the maximum angular velocity of the knee flexion and extension between the roundhouse kicks performed to the head and to the knee (p<0.05), and between the roundhouse kicks performed to the abdomen and to the knee (p<0.05). Moreover, we detected a significant increase in the maximum angular acceleration of the knee flexion and extension between the roundhouse kicks performed to the abdomen and the roundhouse kicks performed to the knee (p=0.01).

CONCLUSION: These results indicate that, during the execution of the roundhouse kick, both the kicking height and the kicking distance can influence the kinematics of the pelvis and kicking leg. Knowing the biomechanics of kicking could help to better plan the fight, taking into account the score of the match, the time remaining until the end of the fight, and the characteristics of the athlete.

**KINEMATIC EFFECTS OF LEG CONSTRAINT IN FRONT-CRAWL SWIMMING WITH A PULL BUOY**

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INTRODUCTION: The upper limbs are the main contributors to propulsion in swimming [1]. To enhance their arm stroke technique, swimmers perform specific training sessions that exclude leg propulsion by using a pull buoy, sometimes paired with an ankle band to inhibit flutter kicking. This specific training technique reduces both velocity and energy cost of locomotion [2] while preserving hand kinematics and enhancing hand propulsion [3, 4]. Additionally, it is demonstrated that the pull buoy aids buoyancy, sinking the swimmers legs and reducing drag [5]. However, the effect of keeping the legs still with an ankle band on total body kinematics has not yet been analyzed. Therefore, this study aims to analyze kinematic differences in front-crawl swimming with a pull buoy or a pull buoy and ankle band using an underwater motion-capture system.

METHODS: After a routine warm-up, six male national swimmers performed a 25 m front-crawl under three conditions of tools: arm stroke with a pull buoy (P), arm stroke with a pull buoy and ankle band (PB) and arm stroke without a pull buoy and ankle band (C). The swimming speed was set at 80% of the maximum velocity for each condition and controlled using a pacing light (Indico Tech, Italy). The protocol was repeated twice. Their movements were captured using 9 synchronized underwater cameras (Qualisys, Sweden) collecting at a frame rate of 100 Hz. The calibrated volume was 7 × 2.5 × 1.3 m, capturing at least one full stroke cycle per trial, defined from entry to re-entry of the third finger marker. Thirty-five reflective markers were attached to the swimmer's body to enable a complete 3D reconstruction. Hand position in the pool reference frame, hand velocity, shoulder roll, hip roll and knee angle were included in the analysis for each trial. The comparison between intensity conditions was examined using correlation analysis and RMSD.

RESULTS: Knee angle changes in both P e PB compared to C (r = 0.44 and 0.07; RMSD 7.45 and 10.45 deg for C vs P and C vs PB, respectively). In contrast, shoulder and hip roll remain steady (r medio = 0.90; RMSD max 15.1 deg). Similarly, hand displacement and hand velocity were consistently highly correlated across tools conditions (r medio = 0.87 and 0.70, respectively; RMSD max 0.22 m and 0.72 m/s).

CONCLUSION: The use of a pull buoy between the legs does not affect upper limb technique or body roll compared to swimming without a pull buoy, but it decreases leg movement by reducing the knee angle. Adding an ankle band further limits leg movement, but does not affect the kinematics of the upper limbs or trunk. The coach can use the pull buoy and the ankle band without concerns about adjustments in swimming technique.

**THE EFFECT OF STUD DESIGN ON GROUND REACTION FORCE AND SUBJECTIVE PERCEPTION IN FOOTBALL-SPECIFIC MOVEMENTS**

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INTRODUCTION: Anterior cruciate ligament (ACL) injuries are a common concern in football. They often require surgery, lead to lengthy recovery, can cause long-term knee instability, and prevent from returning to the same playing standard. Current research has suggested that football boot studs may play a role in determining lower limb loading and therefore affecting ACL injury factors (1), but evidence upon the effects of stud design on biomechanical factors related to injury is limited. We assessed the effect of stud mechanical features on lower limb loading and subjective perception during lab-based football-specific movements.

METHODS: We measured the effects of three different stud types on 3D ground reaction forces (GRF) and subjective perception of comfort, stability, grip and overall appreciation. Seven male recreational football players (29.7±6.0 y.o.; height 1.81±7,4 m; weight 77.4±6.6 kg) performed 90° and 180° cutting manoeuvres (2), in 3 different stud conditions, presented in random order: STD, standard; FLX, flexible; and VFL, very flexible studs. SASpik (saspik.it) provided FLX and VFL. All participants wore standard 8-stud boots (Mizuno Morelia Neo IV β Elite), sprinted from ~5 m and landed with their dominant foot on a force plate (Kistler 9287CA, 2000 Hz), covered in artificial turf. Repeated measure non-parametric ANOVA (Friedman test) and statistical parametric mapping (www.spm1d.org) were used to compare scalar quantities (subjective feedback via Visual Analog Scales - VAS, GRF loading rates) and timeseries (the first 40 ms of the GRF curves) across conditions (α=0.05).

RESULTS: Subjective evaluations of overall appreciation showed higher scores for FLX (+32.5%, P=0.028) than STD. Comfort (STD= 6.3±2.3; FLX= 8.4±1.1; VFL= 7.7±2.7), Stability (STD=5.8 ±2.3; FLX=7.9±1.2; VFL=6.7±2.4), and Grip (STD=6.7±1.9; FLX=7.2±2.2; VFL=7.2±2.7) did not show statistical differences from the sample tested.

The vertical loading rate was higher in STD (226.03±134.36 BW/s) compared to FLX (127.88±81.45 BW/s; -43.4%) during the 90° cut (p=0.022). No significant differences were found in any of the three GRF components for any movement through SPM timeseries analysis.

CONCLUSION: These preliminary findings suggest that football boots equipped with flexible studs are overall better perceived by users. Adding in-built flexibility to the 8 studs in the boot reduced the vertical force loading rate in 90° cutting, and did not appear to influence other features of the GRF during the initial contact phase of cutting and pivoting tasks. However, the small sample size analysed and variability of the outcomes observed warrant further research of the interplay between stud design and mechanical loading.

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**FORCE AND PRESSURE DISTRIBUTION IN SNOWPLOUGH TURNS: A CASE STUDY COMPARING SKI SLOPE AND SKI TRACK SIMULATOR**

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INTRODUCTION: From the perspective of recreational skiers, alpine skiing is a seasonal sport typically practiced during the winter months. Due to the lack of suitable climatic conditions, skiers often travel to distant locations for their skiing experiences. Along with costs for travel, accommodation, and equipment, novice skiers also invest in ski schools. However, many choose to skip formal instruction and attempt to master skiing techniques independently, which increases the risk of falls and injuries. The snowplough turn, a fundamental technique for recreational skiers, is essential for speed control and stability. A key factor contributing to injuries is the poor physical preparation, as skiing involves specific movements that are unfamiliar to novices. To maximize the ski learning process, a certain level of physical preparedness is essential, and the ski simulator aids in learning the basics of alpine skiing technique. While a novice skier may not fully be able to conquer the ski slope, they will perform specific movements biomechanically resembling those on the skiing terrain and become acquainted with the equipment. In this process, understanding pressure distribution and forces under the feet becomes essential, as these factors play a key role in analyzing weight shifting during different phases of the snowplough turn execution. This study aims to compare differences in foot pressure forces and distribution during different phases of the snowplough turn on a ski simulator and ski slope.

METHODS: Turns were performed by one alpine ski ISIA-level instructor who had previous experience with ski simulators. To measure the kinetic variables, insoles designed for pressure detection (Novel) were used. Mixed model ANOVA was used to detect differences in kinetic parameters between three phases of the turn executed on the simulator and on the slope.

RESULTS: The results indicate a statistically significant difference in the overall force exerted by the outside and inside foot when comparing snowplough turns performed on a ski slope and a ski track simulator ($p<0.05$). However, the analysis of pressure distribution shows a similar pattern across both conditions in all regions (medial, lateral, and heel). These findings suggest that although the overall force differs between the ski slope and the simulator, the pressure distribution pattern remains consistent, indicating potential biomechanical adaptations to different skiing conditions.

CONCLUSION: Based on the results of this study, it can be concluded that it is possible to use the simulator for learning the basics of weight shifting necessary to perform a snowplough turn. Additionally, a simulator can serve excellently for specific conditioning preparation. However, one must be aware of the limitations in imitating the conditions of a ski slope, particularly in terms of friction and the fact that the skier remains stationary while the treadmill moves, unlike on a ski slope where the skier moves on a stationary surface.

**IMU-BASED CHARACTERIZATION OF LOCOMOTOR DEVELOPMENT IN VERY PRETERM TODDLERS**

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INTRODUCTION: Preterm children have a high risk of motor impairment, with very-preterm (VPT, i.e., gestational-age <32weeks) being at higher risk of motor delay [1]. Sensor-based gait analysis resulted effective in distinguishing gait performance between 24-month-old preterm and full-term (FT) toddlers, and among preterm at varying risks of motor delay [2]. However, to implement effective longitudinal monitoring of motor development and identify deviations from typical path, it is essential to understand how motor differences evolve during the early years. Using the approach described in [2], this study aimed to compare VPT and FT children at 18 and 24 months (18m and 24m), considering both their corrected age and walking experience (WE).

METHODS: Fifty-two VPTs and nineteen (12 18-month-old and 7 24-month-old) FTs participated in the study. VPT data were collected longitudinally resulting in fifty-two tests at 18m and thirty-one at 24m. Children walked along a corridor while wearing 3 inertial sensors (MMR, mBient, USA) on the lower back and on the ankles [1]. Gait temporal parameters, their variability, and nonlinear metrics of trunk kinematics (i.e. harmonic ratio, recurrence quantification analysis, multiscale entropy) were extracted. Children were divided based on corrected age (18m and 24m) and on WE (0-2months, 3-5months, >5months). As the relatively low sample size did not allow multi-factorial analysis, results were compared among age/WE groups separately (Wilcoxon-rank-sum test, 0.05). RESULTS: No difference was found in normalized stride-time among groups. VPT exhibited longer double-support and stance than FT at 18m, 24m, and with a WE > 5 months. VPT also showed higher variability in temporal parameters across all comparisons, including at WE < 5 months. At 24m, VPT showed lower medio-lateral (ML) harmonic-ratio, while no difference was found at 18m or when analyzed with respect to WE. VPT showed lower multiscale entropy values in ML direction across all comparisons, with no difference observed in antero-posterior and vertical one. Regardless of age and WE, VPT recurrence parameters were lower in the sagittal plane, and the recurrence-rate higher in ML direction.

CONCLUSION: VPT children exhibited less mature motor performance during gait, characterized by lower stability (i.e., longer support phases) and higher variability. However, this variability did not indicate a structured exploration of more complex movements, as evidenced by lower recurrence in the sagittal plane and lower entropy in ML. The ongoing longi-

tudinal data collection for both VPT and FT participants will increase the sample size and provide an effective means to monitor early locomotor development to support possible early rehabilitative intervention.

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**IS GLENOHUMERAL INTERNAL ROTATION DEFICIT HAZARDOUS FOR ELBOW JOINT LOADING IN BASEBALL PITCHERS?**

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INTRODUCTION: Epidemiologic studies reported overhead athletes with Gleno-Humeral Internal Rotation Deficit (GIRD) have higher risk of shoulder and elbow injuries. However, there is very little information on the effect of GIRD on elbow joint loading of the throwing arm in overhead athletes. The purpose of this study is to investigate the influence of GIRD on elbow joint loading in baseball pitchers.

METHODS: Twenty elite baseball pitchers from high school and university were divided into two groups of ten pitchers: 1) GIRD group (loss of internal rotation (IR) of the throwing shoulder of 20 degrees or more as compared with the non-throwing shoulder); 2) Normal group. After regular warm up routine, each pitcher was asked to throw 15 maximum-effort fastball pitches on the outdoor throwing mound at a distance of 18.4 m. Eight CCD cameras (Motion Analysis Inc., Santa Rosa, CA, U.S.A.) were used to capture the throwing motion at a sampling rate of 300Hz. Kinetic data between the two different groups of pitchers were calculated for comparison. A repeated-measure analysis of variance was used for statistical analysis.

RESULTS: In the late cocking phase, elbow medial force (236.75±22.51N), and maximum elbow varus torque (51.21±8.18N-m) of the GIRD group were significantly greater than that of the Normal group (185.58±17.44N), (43.27±7.66N-m) ($p<0.05$), respectively.

In the acceleration phase, elbow varus torque (32.0±6.89N-m) of the GIRD group was significantly greater than that of the Normal group (20.82±5.87N-m) ($p=0.046$). Although not significant, the elbow medial force (144.08±23.09N) of the GIRD group was greater than that of the Normal group (96.26±20.29N) ($p=0.097$).

CONCLUSION: Literature showed that excessive torque on the medial elbow is a significant contributing factor to elbow injuries among overhead athletes. In this study, baseball pitchers with GIRD have higher elbow joint loading during throwing motion. This increase in elbow joint loading will generate more stress on the flexor/pronator and ulnar collateral ligament of the elbow, and further increase the chance of injury. Therefore, specific training program should be designed for pitchers with GIRD to improve their throwing techniques, and decrease the risk of upper extremity injuries

**KINEMATIC ANALYSIS OF KNEE MOTION ACROSS SINGLE-LEG SQUAT TESTS USING INERTIAL SENSORS**

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INTRODUCTION: The single-leg squat is a closed kinetic chain movement used for strength training and as a diagnostic tool to assess joint alignment and bilateral differences in various attributes, such as muscle strength. It can be performed in different ways, with the position of the non-supporting leg playing a key role in the loads exerted on the knee of the supporting limb. Inertial sensors have been utilized to assess lower limb kinematics; however, related data on single-leg squat variations remain scarce. This study aimed to investigate knee kinematics during three commonly used single-leg squat tests using inertial sensors.

METHODS: Twenty-two uninjured college students (10 males and 12 females), with a mean ± SD age of 23.2±3.4 years, body mass of 67.2±11.8 kg, height of 1.7±0.1 m and BMI of 22.7±2.4 kg/m required to perform (i) a freely performed single-leg squat (SLSQT) while maintaining the thigh as vertical as possible, (ii) a single-leg squat performed during the anterior excursion in the Star Excursion Balance Test (ASEBT), and (iii) a forward single-leg step-down squat (SLFSD). Knee kinematics were assessed by calculating yaw (for knee flexion), pitch (for knee abd/adduction), and roll (for knee rotation) using two inertial sensors positioned on the lateral side of the thigh (reference) and leg, respectively, at one-third of the distance from the knee to the lateral malleolus. A web camera, synchronized with inertial sensors unit, was placed on the side of the participant enabling detection of the maximum knee flexion achieved by participants. Statistical analysis was performed based on the average of three attempts completed by each individual in different testing conditions. One-way ANOVA for repeated measures and Pearsons r correlation coefficients were used to identify differences and relationships, respectively between the three testing conditions.

RESULTS: Statistical analysis revealed significant differences between tests only for yaw on the right knee (SLSQT: 66.7°±15.3° vs. ASEBT: 71.3°±15.6° vs. SLFSD: 73.3°±14.1°, $p<0.05$). Non-significant were the differences between tests for yaw on the left knee (SLSQT: 66.5°±13.0° vs. ASEBT: 68.9°±14.7° vs. SLFSD: 71.4°±15.9°), absolute pitch for the right (SLSQT: 12.4°±10.2° vs. ASEBT: 12.2°±11.6° vs. SLFSD: 13.5°±11.7°), and left knee (SLSQT: 13.9°±11.6° vs. ASEBT: 14.4°±11.3° vs. SLFSD: 12.9°±10.9°), as well as roll for right (SLSQT: 13.9°±9.8° vs. ASEBT: 12.0°±8.5° vs. SLFSD: 15.0°±8.9°) and left knee (SLSQT: 13.8°±8.8° vs. ASEBT: 12.9°±8.5° vs. SLFSD: 12.9°±9.6°). Statistically significant correlations were found between tests ($p < 0.01$), with Pearson's r ranging from 0.74 to 0.90 for yaw, 0.93 to 0.98 for pitch, and 0.73 to 0.88 for roll in both limbs.

CONCLUSION: Our findings suggest that although small differences are expected in knee flexion (yaw) for the right limb, the single-leg squat test variations used in the present study can be used interchangeably in the assessment of knee kinematics using inertial sensors.

**EFFECTS OF FOOTWEAR ON KINETICS DURING MAXIMUM-SPEED SPRINT RUNNING**

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INTRODUCTION: Footwear influences sprint running performance and injury risk by affecting critical kinetic variables such as ground reaction forces (GRF) and impulse, particularly during maximum-speed sprinting. While prior studies have mainly focused on the effects of footwear during acceleration at a single step, limited research has examined footwear effects on kinetics across multiple steps at maximum speed. The objective of this study was to investigate how footwear conditions affect GRF and impulse during maximum-speed sprinting.

METHODS: Seventeen male competitive sprinters (age: 19.5±1.4 years, body height: 1.73±0.06 m, body mass: 66.8±4.5 kg, 100-m personal best: 11.2±0.4 s) implemented standardized warm-ups before completing three 60-m sprints under different conditions (i.e., barefoot, regular running shoes, spiked sprint shoes) in a randomized order. Fifty force platforms (1000 Hz) embedded in a tartan track obtained body mass-normalized horizontal (braking and propulsive) and vertical mean GRF and impulse for each step across 50 m. Additionally, inter-step variability was assessed via standard deviations across steps. Maximum-speed phase was identified based on instantaneous speed (calculated as distance between contacts divided by time). Repeated-measures one-way ANOVA examined footwear effects on GRF, impulse, and their inter-step variability.

RESULTS: Participants reached maximum speed within 40 m, with 4.8±1.9 steps captured at maximum speed. Spiked shoes resulted in higher speeds (9.49±0.34 m/s) compared to barefoot (9.38±0.31 m/s) and running shoes (9.26±0.35 m/s) ($p<.001$, $p\eta^2=.60$). Spiked shoes exhibited greater propulsive GRF ($p<.01$, $p\eta^2=.30$), propulsive impulse ($p<.01$, $p\eta^2=.37$), braking GRF ($p<.01$, $p\eta^2=.35$), and braking impulse ($p<.01$, $p\eta^2=.37$) than running shoes. Vertical GRF did not differ among conditions ($p=.24$, $p\eta^2=.08$), but spiked and running shoes produced greater vertical impulse than barefoot ($p<.001$, $p\eta^2=0.51$). Spike shoes had the highest inter-step variability in vertical GRF, while barefoot had the lowest ($p<.001$, $p\eta^2=.77$). Braking GRF variability was higher in running shoes than barefoot ($p<.05$, $p\eta^2=.19$). Variability of other kinetics did not differ among conditions ($p\geq.11$, $p\eta^2<.13$).

CONCLUSION: Spiked shoes enhanced sprint performance by generating the largest GRF and impulse, which may be associated with increased mechanical stress on joints and tissues. In contrast, cushioned running shoes absorbed horizontal GRF and impulse, reducing performance. Barefoot sprinting produced the smallest vertical impulse (a major contributor to mechanical load), while achieving moderate performance. The findings support the use of spiked shoes for competition and suggest barefoot training as a potential strategy to reduce mechanical overload on the ankle and knee joints. Future studies examining maximum-speed kinetics should consider the revealed effects of footwear on inter-step variability.

## Coaching

**DIFFERENCES BETWEEN HOW BASKETBALL REFEREES DESCRIBED VIEWING GAME FILMED USING FIXED CAMERA IMAGES AND USING VR IMAGES**

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INTRODUCTION: The purpose of this study was for basketball referees to describe a game they viewed using fixed camera images and VR images (recorded with a 360-degree omnidirectional camera) and to identify differences in how these types of images are viewed based on the differences in how the game was described.

METHODS: The study involved two certified referees from the Japan Basketball Association. A college basketball practice game was recorded using a fixed video camera (equipped with a wide-angle lens covering all players) and a 360-degree omnidirectional camera. These cameras were positioned at three locations: on the bench side (Point A), on the side opposite the bench (Point B), and under the goal (Point C).

Two subjects (Mr. H and Mr. L) gave descriptions while watching images recorded using a fixed video camera ("the fixed camera images") and images recorded using a 360-degree omnidirectional camera ("the VR images"). Mr. H watched the fixed camera images first, in order of Location A, Location B, and Location C. Mr. L watched the VR images first, in the order of Location C, Location B, and Location A. The subjects freely talked about what they thought of the recorded images of the games.

RESULTS: The descriptions were categorized into six groups: "situation description," "prediction," "retrospect," "foul judgment," "question," and "delegation (delegating to another referee's judgment). Perhaps this was to be expected for Mr. H and Mr. L, who are experienced referees, but the pair recorded high percentages for descriptions matches on "foul judgments" (over 90%) in both the fixed camera images and the VR images in all three locations. For "situation description," the fixed camera images tended to have more descriptions matches than the VR images at Locations A and B. This is likely because the participants were viewing the phenomenon as bystanders rather than as referees. On the other hand, for

"prediction," the VR images tended to have more descriptions matches than the fixed camera images, and this was especially noticeable at Location C. This is likely because Location C was positioned under the goal, where fouls are more likely to occur, resulting in a greater number of predictions. For "delegation," the VR images at Locations A and B tended to have more descriptions matches than the fixed camera images. A game is usually judged by three referees, and the position and range of each referee's views are generally fixed. The fact that a lot of "delegation" were described suggests that the judges were making judgments as referees.

CONCLUSION: - While watching fixed videos, viewers tend to perceive events objectively, adopting the perspective of bystanders rather than that of referees.

- While watching VR videos, viewers tend to make decisions as referees in situations resembling those in actual games.

**COMPARISON BETWEEN UNILATERAL AND BILATERAL PLYOMETRIC TRAINING IN PREADOLESCENT MALE HANDBALL PLAYERS**

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INTRODUCTION: Plyometric training can play an important role in the development of young handball players. It can also be safe and effective in improving speed, power, and change-in-direction ability in children, provided that age-appropriate instructions are followed [1]. The purpose of the study was to investigate and compare 8 weeks of unilateral, bilateral plyometric training on selected motor characteristics of handball players of developmental age.

METHODS: A total of 57 preadolescent male handball players (age: 12.9 ± 0.5 years, maturity offset: –1.80 ± 0.7 years) voluntarily participated in this study. The sample was randomly divided into the intervention group performing unilateral plyometric training (UG, n = 18), the intervention group performing bilateral plyometric training (BG, n = 21) and the control group (CG, n = 18) performing general handball training. The parameters of linear speed of 5, 10 and 20 meters and Modified Agility T-test were evaluated for all 3 groups. A two-factor analysis of variance with repeated measures (repeated ANOVA 3x2) was used.

RESULTS: From the comparison of the performances at linear speeds of 5, 20 and 30 meters between the three groups, no statistically significant differences were observed. Although the differences are not significant in the parameters examined, a greater improvement is observed in the performance of the unilateral plyometric training group, followed by the bilateral plyometric training group. In the Modified Agility T-test, a significant difference was found only between UG and CG (p=0.005, d=1.224).

CONCLUSION: After 8 weeks of training, results showed that the unilateral plyometric training group recorded better performance. Therefore, it appears that using unilateral plyometric training in preadolescent handball players can improve handball performance.

**CLARIFYING THE FUNCTIONAL DIFFERENCES BETWEEN TSURI-TE AND HIKI-TE IN JUDO KUMITE**

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INTRODUCTION: Judo, originating in Japan, is a martial art where the objective is to defeat the opponent, often through throwing techniques (Nage-waza). The importance of breaking the opponents balance (Kuzushi) before executing a throw is emphasized. Throwing techniques involve controlling the opponents judogi with the arms, and several studies have focused on the role of the arms during throws. However, two-thirds of a judo match is spent fighting for grips (Kumite), and recent rule changes have placed greater emphasis on Kumite. Although there are studies on grip dynamics in combat sports like wrestling, there has been little research specifically on the role of the arms in judo kumite. Furthermore, factors such as weight class, competition level, and gender could influence arm usage. This study aims to clarify the role of each arm in Kumite to enhance judo performance.

METHODS: A questionnaire survey was conducted with 239 Japanese collegiate judokas using Google Forms. The survey asked participants about the most important movements in Kumite and how they use their Hiki-te (pulling hand) and Tsuri-te (lifting hand) during Kumite. Competition levels and weight classes were recorded, and participants were divided into high-performance and other groups based on competition experience. Statistical analysis was performed using chi-square tests, with a p-value of $<0.05$ considered significant.

RESULTS: Participants were divided by competition level, gender and weight class. The chi-square tests showed no significant difference in arm use based on competition level, gender, or weight class. However, there was a significant difference in the most important movements for the Hiki-te and Tsuri-te ($\chi^2(4)= 38.014$, $p < 0.001$), with the Tsuri-te focusing more on "lift" and "relax" and the Hiki-te focusing on "pull."

CONCLUSION: The results indicated that while the role of each arm did not vary based on competition level, gender, or weight class, the primary function of the Tsuri-te and Hiki-te differed. The Tsuri-te is crucial for lifting and relaxing the opponent, while the Hiki-te is mainly used for pulling the opponent. This aligns with the fundamental judo technique of Kuzushi, where pulling with the Hiki-te helps destabilize the opponent. The relaxation of the Tsuri-te was highlighted, as it contributes to smoother execution of throws. This aspect is consistent with research in other sports, where muscle relaxation is key for efficient movement. Understanding these roles is vital for judokas and coaches to refine their Kumite practice and improve performance.

This study suggests that judokas use the Tsuri-te for lifting and relaxing, while the Hiki-te is used for pulling. The role of each arm did not differ significantly by competition level, gender, or weight class, indicating that these movements are fundamental techniques. Understanding these roles is vital for judokas and coaches to refine their Kumite practice and improve performance.

**DETERMINANTS OF SUBJECTIVE TOTAL ATHLETIC ABILITY**

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INTRODUCTION: The awareness of subjective athletic ability significantly influences participation in sports and physical activities, which provide health and academic benefits. Athletic ability, often vaguely defined, generally refers to physical strength, skill, and performance across various sports. Research in physical education and sports psychology highlights "motor competence"—confidence in physical activity—as a key factor tied to self-efficacy theory, where prior successes and social support foster skill development. Studies suggest that motor competence and athletic ability are shaped by lifestyle, family environment, and sports experience. Personality traits such as grit, resilience, and a growth mindset also play essential roles in persistence and skill improvement. This study focused on college students, exploring how personality, family factors, and prior sports participation influence subjective athletic ability.

METHODS: This study surveyed 406 participants (mean age: 19.31 years) from Nanzan University to investigate subjective athletic ability. Participants provided consent, and ethical approval was obtained. The questionnaire collected demographic data, sibling composition, family income, sports experience, and personality traits (grit, resilience, growth mindset). Subjective athletic ability was assessed using an 11-point scale, along with questions on participants awareness of their athletic ability and feedback from others. Data analysis included correlation and regression models to identify factors influencing subjective athletic ability, such as personality, leisure activities, sports experience, and family background.

RESULTS: The study analyzed factors influencing subjective athletic ability using nine linear models. Subjective general athletic ability was strongly correlated with proficiency in soccer, volleyball, basketball, and short-distance racing. Grit, resilience, and a growth mindset positively influenced subjective athletic ability. In contrast, leisure activities such as gaming and studying showed a negative correlation with athletic ability. Being the youngest sibling and having prior sports experience positively impacted subjective ability. Additionally, the number of sports learned, athletic performance, and household income were significant factors. Furthermore, parental athletic ability, frequent praise, and faster skill acquisition were associated with higher subjective athletic ability. Diagnostic tests confirmed the validity of the models, with no major violations of statistical assumptions.

CONCLUSION: Grit, resilience, sports experience, and diverse activities positively influenced athletic ability, while sedentary activities had a negative impact. Parental athletic ability, household income, and feedback from others also played a role. Limitations include reliance on self-reported data and a cross-sectional design. Future research should incorporate longitudinal studies and objective measures.

**ANALYSIS OF THE DISTANCE COVERED AT THE START OF THE IN-SEASON BY A TEAM OF SEMI-PROFESSIONAL SOCCER PLAYERS**

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INTRODUCTION: Distance covered (m) by soccer players during a match can provide useful information about their performance [1]. Additionally, there is a relationship between the level of physical fitness and the distance covered during a match [3]. Team formation also influences the distance covered during a match [3]. Players' position roles and their range of velocities can be used to evaluate the performance during in-season [4]. The aim of the current study was to evaluate the distance covered by soccer players based on their positional roles, identifying who covers more distance in both halves to assess intensity and performance.

METHODS: In the present study, semi-professional football players from a team in the Greek third national division league participated and were examined over the first 12 games of in-season, which lasted 3 months. They were allocated into five positional groups: full-backs (FB, n=23), central defenders (CD, n=23), midfielders (M, n=34), wingers (W, n=22), and forwards (F, n=12). The total distance covered in meters (m), distance per minute (m/min), and distance covered in 4 velocity zones (zone 3: 13.0–15.9 km/h, zone 4: 16.0–19.9 km/h, zone 5: 20.0–25.5 km/h, zone 6: ≥25.6 km/h) were recorded using GPS during both halves. A repeated measures ANOVA was used to detect changes between the positional roles of players in both halves. Significant main effects were followed up with Unequal N HSD post-hoc. Significance level was set at $p<0.05$.

RESULTS: Significant differences were found between the 1st and 2nd halves, regardless of the position played. Distance covered ($p<0.001$) and distance per minute ($p<0.001$) were higher in the 1st compared to the 2nd half. Additionally, distances in zones 3 to 6 ($p<0.001$) were higher in the 1st half. Significant differences were found between positional roles at full time. Specifically, distance covered was higher ($p<0.05$) for FB and M compared to others. Also, distance per minute for M was higher ($p<0.05$) than others. At high intensity running in zone 3 FB, CD and M covered more distance than W ($p<0.001$) and F ($p<0.01$) and zone 4, M was higher ($p<0.05$) than other positional roles. At very high intensity running in zone 5, CD covered less distance ($p<0.001$) than others. Finally, in zone 6 (sprints), only W covered more distance than CD ($p<0.05$).

CONCLUSION: These findings provide insight into the teams playing style and approach during matches. Full-backs and midfielders covered more distance than other positional roles. Wingers covered more distance in sprint compared to central defenders. In the second half, all variables significantly decreased. It appears the team in second half played a more defensive style or needed to improve their fitness levels. To draw more accurate conclusions, the half-time score should also be taken into account.

1. Barros et al. (2007). 2. Modric et al. (2021). 3. Carling (2011). 4. Dellal et al. (2010).

**THE EFFECTS OF VIDEO MODELLING ON STRADDLE JUMP LEARNING IN YOUTH GYMNASTS**

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INTRODUCTION: Effective motor learning, particularly for young athletes, depends on appropriate feedback. In aerobic gymnastics, the acquisition of high-level skills relies heavily on coach-provided feedback. Coaches often utilize video, which allows learners to review their performances (self-modelling) or observe expert athletes (expert-modelling). This study investigates the effects of video modelling on straddle jump learning in youth gymnasts.

METHODS: Eight gymnasts competing in the national development category (age 9 ± 1.5 years; sports age 4 ± 1.5 years) underwent a 24-day intervention program, focused on self-modelling followed by verbal feedback for the straddle jump. The intervention sessions, each lasting 30 minutes, were integrated into the gymnasts regular 90-minute training schedules, occurring three times per week. Before and after the intervention program, the straddle jump (the same element used in the intervention) was performed. A Samsung Galaxy s7 tablet and the Coach's Eye app were used to provide video feedback. The gymnasts reviewed the recordings of their performances on the tablet. Each video was presented only once at normal speed and once in slow motion, immediately after the gymnast performed. Gymnasts performed six trials, of which the three best, based on specific criteria (e.g., height, form, landing, etc.), were chosen for expert technical analysis. Four international FIG-certified aerobic gymnastics judges evaluated the execution of the elements, divided into five subphases. In each subphase, they assigned deductions according to given instructions, based on the current Code of Points. The final score for each gymnast was calculated by averaging the scores from their three selected trials for pre- and post-tests.

RESULTS: A significant improvement ($p \leq 0.05$) between the pre- and post-test measurements was observed in the overall execution score (8.30 pts.) of the element. Notably, the approach and culmination subphases showed significant technical improvements ($p \leq 0.05$), with the culmination subphase (+0.40 pts.) being critical for perfect form. Cohens d, calculated for the overall execution score, indicated a large effect (d = 0.74). A large effect size was observed in the approach (d= 0.80) and culmination subphases (d = 0.83).

CONCLUSION: Self-modelling, followed by verbal feedback, significantly improves the execution of the straddle jump in young aerobic gymnasts. This specific technique is essential for coaches when teaching new skills. Our findings have important practical implications for athletes and coaches, highlighting the value of incorporating specific feedback methods to enhance athletic performance. Acknowledgments: This work was supported by the Scientific Grant Agency of the Ministry of Education, Research, Development and Youth of the Slovak Republic and the Slovak Academy of Sciences (Nos. 1/0725/23 and 1/0712/24).

**WHAT DIFFERENTIATES WIN FROM LOSS IN EUROPEAN MEN'S HANDBALL TOURNAMENT**

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INTRODUCTION: Analysis of sports performance utilizing game data is an important parameter in modern sports that provides knowledge of the structure and development of team sports. Seeking patterns of play that lead to success is what is required at the top level.

The aim of the present study was to highlight the features that differentiate winners from losers in high-level men's handball.

METHODS: Out of 130 games from the 2022 and 2024 Men's Euro Handball, 120 that had winners were analyzed. This included all efficacy parameters for both the goalkeepers and court players as well as defensive and offensive technical variables All variables were checked for differences between the winning and losing teams using the Independent Samples t Test. The level of significance was set at 0.05. Also reported are Cohen's d effect sizes.

RESULTS: Overall, winning teams scored 31.3±4.2 goals while losing teams scored 26.0±3.9 goals. The winning teams' goalkeepers had significantly higher efficacy than those of the losing teams in wing shots (34.7±20.4 vs. 24.7±19.2, p<0.001, Cohen's d=0.501), nine-meter shots (44.1±19.3 vs. 36.7±18.5, p=0.003, Cohen's d=0.395), seven-meter shots (23.2±26.5 vs. 15.2±23.0, p=0.015, Cohen's d=0.322) and six-meter shots (26.9±15.2 vs. 23.0±15.4, p=0.05, Cohen's d=0.255). Likewise, court players of the winning teams had significantly higher efficacy than those of the losing teams in wing shots (69.1±20.3 vs. 58.4±21.1, p<0.001, Cohen's d=0.516), nine-meter shots (49.5±18.2 vs. 40.3±14.8, p<0.001, Cohen's d=0.551), seven-meter shots (79.9±25.1 vs. 71.5±28.3, p=0.017, Cohen's d=0.317) and six-meter shots (71.6±16.2 vs. 67.3±17.0, p=0.047, Cohen's d=0.259). Winning teams had significantly more assists (16.1±4.8 vs. 13.0±4.0, p<0.001, Cohen's d=0.707), steals (3.6±2.3 vs. 2.2±1.7, p<0.001, Cohen's d=0.693) and blocks (1.9±1.4 vs. 1.4±1.3, p=0.002, Cohen's d=0.406) and at the same time significantly less turnovers (4.8±1.9 vs. 7.0±3.1, p<0.001, Cohen's d=0.864).

CONCLUSION: There seems to be a logical consistency between court players and goalkeeper efficacy with regards to wing, nine-meter, seven-meter and six-meter shots. Nonetheless, judging from the effect sizes, turnovers, assists and steals also appear to have an important impact on the outcome of high-level handball games. Further analysis is warranted to clarify which parameters are more consequential in games where the goal differences are minimal.

**ANALYSIS OF GAZE PATTERNS DURING FENCING FIGHTING : A COMPARISON BETWEEN OFFENSIVE AND DEFENSIVE SCORING SITUATIONS**

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INTRODUCTION: In our previous research, we have conducted eye movement analyses across the three fencing disciplines (i.e., foil, épée, and sabre) when points were scored. As an interpersonal combat sport, fencing generally favors the offensive side in all three disciplines. However, by analyzing eye movement dynamics when responding to an opponent's attack, we may be able to develop more advantageous fighting strategies in the future. Furthermore, understanding individual eye movement characteristics could potentially allow fencers to apply their strengths across different disciplines.

METHODS: A total of 22 university fencing club members (10 sabre fencers and 6 fencers from each of the other two disciplines) participated in the study. They wore an eye-tracking device (Tobii Pro Glasses 3, Tobii Technology) while engaging in a five-point bout against an opponent. Each fencer fought the same opponent twice, once while wearing the eye-tracking device and once without it. The time taken to score each point was measured using Wondershare FilmoraX (Wondershare Inc.). Eye fixation locations were classified into four categories: mask and neck, chest and shoulders, arms and hands, and others. Eye fixation durations were measured in seconds using a frame-by-frame analysis (1/60 seconds per frame). All data were expressed as mean ± SD, and significance difference tests between disciplines and between retention sites were analyzed using one-way ANOVA in SPSS, with Tukeys HSD used for multiple comparisons.

RESULTS: The analysis revealed that for the sabre, there was almost no difference in eye fixation areas between scoring and conceding points. In contrast, for the foil, the most frequent fixation area during scoring was the chest and shoulders (45.3%), while for the épée, the arms and shoulders (40.1%) had the highest fixation rate. However, during point concessions, the fixation rate in these areas significantly decreased to 26.3% in épée and 32.8% in foil (a reduction of approximately 10%). Given that the valid target area in foil is the torso, and in épée the entire body, the results suggest a tendency for eye gaze to shift downward when conceding points in both disciplines.Regarding the time taken to score points for the sabre, among the 66 analyzed scoring instances, 19 points (29%) were scored in offensive situations, with an average duration of 5.9 ± 3.2 seconds. Sixteen points (24%) were scored in defensive situations, averaging 6.7 ± 2.5 seconds. Thirty-one points (47%) were scored immediately after the start signal ("Allez"), with a significantly shorter average duration of 2.1 ± 1.1 seconds.

CONCLUSION: There was no significant difference in scoring time between offensive and defensive situations, but the points scored immediately after the start signal were significantly quicker. Although sabre showed no noticeable changes in eye fixation areas between scoring and conceding points, in foil and épée, the findings indicate a shift in gaze direction upward when conceding points.

**THE POTENTIAL BENEFITS OF RECOVERY WEAR FOR IMPROVING SLEEP IN COMPETITIVE SWIMMERS**

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INTRODUCTION: Sleep disturbances and disrupted circadian rhythms have become increasingly recognized as significant health concerns. In the general population, insufficient sleep and sleep debt can impair daytime productivity and increase the risk of accidents. Competitive swimmers, due to the physical demands of intensive training—often conducted early in the morning or late at night—are particularly vulnerable to compromised sleep quality and recovery. Poor sleep may negatively impact both training effectiveness and performance. This study aimed to investigate whether wearing recovery wear made of PHT (Platinum Harmonized Technology) fabric (manufactured by Venex) enhances sleep quality in competitive swimmers experiencing insufficient sleep.

METHODS: Eight healthy male collegiate competitive swimmers participated in the study (age: 20.0 ± 2.0 years, height: 173.0 ± 7.0 cm, weight: 66.0 ± 8.0 kg). Sleep was assessed under two conditions: three consecutive nights with and without wearing recovery wear. Sleep monitoring was conducted using an activity-based sleep monitor (MTN-221, Acos Co.), worn on the waist except during training and bathing. Sleep parameters were analyzed using SleepSignAct2 software (Kissei Comtec Co.). Body water content and composition were measured using the bioelectrical impedance method (InBody770). Body temperature was recorded before sleep and upon waking using a smartwatch (Inspire 3, Fitbit Co.). Statistical analyses were performed using t-tests.

RESULTS: Wearing recovery wear significantly improved sleep quality. Sleep onset latency was significantly shorter when wearing recovery wear (18.7 ± 6.6 min) compared to the non-wear condition (33.8 ± 10.8 min). Wake after sleep onset (WASO) was also significantly reduced (31.7 ± 10.4 min vs. 61.2 ± 17.0 min). Additionally, the number of nighttime awakenings was significantly lower (2.6 ± 1.6 vs. 7.3 ± 2.7). Sleep efficiency was significantly higher with recovery wear (86.4 ± 2.2%) than without (70.9 ± 3.7%). No significant differences were observed in body temperature changes between conditions (pre-sleep: 36.6–37.0°C, post-sleep: 36.1–36.2°C). While body water content exhibited a slight decreasing trend with recovery wear, the difference was not statistically significant.

CONCLUSION: These findings suggest that wearing PHT-based recovery wear (Venex) may enhance recovery efficiency by improving sleep quality in competitive swimmers. Further research is necessary to elucidate the underlying mechanisms responsible for these effects.

**THE INFLUENCE OF MATURITY OFFSET ON COACHES' RATINGS AND SELECTION IN U15 SOCCER: AN ECOLOGICAL DYNAMICS PERSPECTIVE**

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INTRODUCTION: The ecological dynamics framework and the Constraints-Led Approach (CLA) emphasize that motor performance and learning emerge from the interaction of organismic, task, and environmental constraints [1-2]. In youth sports, coaches act as "learning environment designers" [3], yet they often rely on chronological age rather than biological maturation, which may not accurately reflect an athlete's developmental status. Biological maturity can be estimated through peak height velocity (PHV) and maturity offset [4].

This study examined whether maturity offset influences coaches' performance ratings across technical, tactical, physical, and creative domains and whether it affects player selection (starters vs. non-starters) in Under 15 (U15) soccer players at national and regional levels.

METHODS: A cross-sectional study was conducted on 46 male U15 outfield players (national: n= 23, age = 13.8 ±0.7 years; regional: n = 23, age = 14.3 ±0.5 years). Anthropometric measures (height, seated height, body mass) were recorded to calculate maturity offset [4]. Both teams were coached by UEFA B-licensed trainers, who underwent training on a validated 5-point Likert scale questionnaire [5]. Inter-rater reliability was tested (ICC[2,1] =0.77) on 20 external subjects. Coaches rated players across four performance domains and designated starters. Spearman's correlation assessed relationships between maturity offset and performance ratings, while Mann-Whitney U tests examined differences in maturity offset between starters and non-starters.

RESULTS: In the regional group, maturity offset positively correlated with tactical (rho = 0.58; p< 0.01), technical (rho = 0.71; p < 0.001), physical (rho = 0.79; p < 0.001), and creative (rho = 0.76; p < 0.001) abilities. Starters (median = 0.25) had significantly higher maturity offset than non-starters (median = -0.70) (U = 112.5; p < 0.01).

In the national group, only physical ability showed a significant correlation with maturity offset (rho = 0.84; p < 0.001), while tactical (rho = 0.21; p = 0.33), technical (rho = -0.02; p = 0.92), and creative (rho = 0.18; p = 0.40) abilities had no significant relationships. No significant difference was found in maturity offset between starters (median = 0.70) and non-starters (median = 0.30) (U = 83.5; p = 0.26).

CONCLUSION: The results suggest that biological maturation status acts as an organismic constraint, potentially favoring more mature players, particularly at the regional level. In line with existing literature [6-8], these findings highlight the importance of considering biological age in player selection and training load planning to ensure fair evaluation and development. Strategies such as bio-banding and individualized training could support a more equitable and effective youth development system.

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**A NEW THEORETICAL FRAMEWORK FOR TRAINING AUTO-REGULATION**

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INTRODUCTION: The goal of this framework is to develop a new theoretical model for training auto-regulation.

METHODS: A systematic review of literature that highlights different auto-regulated training constructs and their relationship guided by a new theoretical framework.

RESULTS: Our theoretical framework conceptualizes the model as comprising an input channel, an output channel, and a "black box" processing system. The input channel consists of subjects' states, traits, and training behavior variables, whose fluctuations—driven by auto-regulation—lead to variations in the output variables related to training behavior. States refer to conditions or characteristics of the subject that persist and may change within a one-week period, whereas traits are more stable and evolve in more than a week. Both states and traits are classified as subjective, objective, or psychophysical. Subjective states and traits are self-reported measures based on personal perceptions and sensations (e.g., rate of perceived exertion, self-assessed recovery, personality, motivation, etc.). Objective states and traits encom-

pass quantifiable variables independent of self-perception (e.g., performance metrics, body composition, training experience, etc.). Psychophysical variables link subjective and objective measures or subjective measures and training behavior. Training behavior inputs include all variables associated with training (e.g., intensity, volume, duration, etc.). The output channel reflects modifications in training behavior as a result of the subjects' performance during training governed by auto-regulation rules and algorithms. The "black box" represents a system of rules and algorithms that processes input variables to generate outputs (e.g., "Increase the number of repetitions by one in the next set if the subject reaches eight repetitions"). Additionally, all variables are recorded both at the time of their measurement and upon any changes in time. (e.g., pre-training, intra-session, weekly, etc.).

CONCLUSION: This theoretical framework will guide future literature in the training auto-regulation area.

**WINNER FOR LIFE: AN INNOVATIVE PROGRAMME TO PROMOTE LIFE SKILLS DEVELOPMENT AND TRANSFER**

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INTRODUCTION: According to School Sport Canada, over 750,000 student-athletes attend schools where they can practice their sport in a sport-study programme. Their mission is to promote positive development and life skills in student-athletes. Despite this noble aim and the benefits associated with sport practice, there may be undesirable outcomes, such as performance anxiety and injuries. Therefore, life skills programs should be based on scientific advances and respond to stakeholders' expressed needs.

METHODS: In this perspective, our research team launched the Winner For Life programme. The aim was to introduce improvements over a previously implemented programme and to take into consideration a need assessment evaluation in 10 high schools offering sport-study programmes in Québec, Canada. The objective of the improved programme is to equip school sport stakeholders and parents to teach student-athletes four general life skills: (a) optimal mental skills, (b) healthy eating habits, (c) safety behaviours, and (d) physical and mental recovery skills. Stakeholders and parents are invited to collaborate to impart the life skills across different settings (e.g., classroom, training, family). A hybrid format was chosen: distance (Internet platform) and face-to-face components combined with individual intervention and follow-up to make the program accessible and adaptable to the realities of school sport stakeholders and parents. The programme's educational activities and tools are designed following Trudel et al.'s constructivist learning model. Accordingly, for each life skill, the program included: (a) practical workshops, videos, and tools (mediated learning situations), (b) online forums for stakeholders and parents to exchange ideas (unmediated learning situations), and (c) reflective cards to help stakeholders and parents reflect on how they could facilitate life skills development and transfer (internal learning situations). Based on the complementarity of the three learning situations, innovative interventions are created.

RESULTS: The programme design will be presented along with specific examples of the tools and strategies used to help student-athletes apply life skills in school sports and other life settings.

CONCLUSION: This innovative, interdisciplinary program is designed to enable school and sports stakeholders, as well as parents, to work together to teach life skills to student-athletes and ensure their use in different contexts such as sport, school and home.



**UTILIZING MHEALTH TO PROMOTE HEALTHY LIFESTYLES AMONG ADOLESCENTS WITH INTELLECTUAL DISABILITIES**

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INTRODUCTION: Despite the critical role of physical activity and nutrition in improving public health, individuals with intellectual and developmental disabilities (IDD) exhibit alarmingly low engagement levels in these domains. Addressing these disparities, the IDHEApp project developed a gamified mobile intervention tailored to the unique needs of this population, aiming to enhance physical activity and dietary habits through personalized, engaging challenges.

METHODS: Our intervention leverages gamification principles to foster adherence and behavior change. Intensity levels were calibrated using a systematic review of sedentary and physical activity guidelines and iterative feedback from stakeholders, including adolescents with IDD, caregivers, and educators. Pilot studies validated the app's usability, while a living-lab randomized controlled trial (RCT) across multiple EU countries tested its effectiveness. Personalized challenges were designed based on baseline data and focused on step counts, sedentary interruptions, and dietary balance, incorporating competitive and cooperative elements to motivate participation.

RESULTS: Preliminary findings from pilot tests indicated high engagement, with participants demonstrating a 20% increase in daily step counts and a 15% reduction in sedentary time within four weeks. Dietary challenges led to improved intake of fruits and vegetables by 12%, with adherence to recommendations verified via app-reported data. Feedback revealed that personalized and team-based challenges were key drivers of sustained participation.

CONCLUSION: The gamified approach proved effective in tailoring interventions to individual capabilities and fostering sustained healthy behaviors among adolescents with IDD. Collaborative and competitive elements, combined with progressive intensity adjustments, were instrumental in achieving outcomes. These insights underscore the potential of gami-

fication as a scalable solution for promoting health equity in underserved populations. Future directions include broader application of the intervention and refinement of engagement metrics to further optimize results.

**THE ASSOCIATION BETWEEN THE PHYSICAL FITNESS AND MOTOR COORDINATION IN THE DIFFERENTIATION OF THE METABOLOME FINGER PRINT IN INDIVIDUALS WITH DOWN SYNDROME**

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INTRODUCTION: Down syndrome (DS) is characterized by intellectual disability and endocrinological and metabolic comorbidities leading to alterations in clinical markers compared to peers without DS. However, the most important metabolic pathways associated with these differences are still unclear. Thus, the objective of the study is to characterize the plasma metabolomic profile and its correlation with physical fitness and functional capacity in adults with DS.

METHODS: Twenty-two individuals with DS (11 men; age 24 ± 4,37 years) and 15 without DS (8 men; age 24 ± 4,08 years) underwent electrical bioimpedance, anthropometrics assessments, Vo2max, handgrip, KTK for motor coordination test, timed-up-and-go (TUG), sit to stand (STS). Blood samples were analyzed by nuclear magnetic resonance at 600 MHz. All participants underwent a medical evaluation prior to the study. Data acquired were checked for normality, homoscedasticity, and sphericity with the Komolgorov-Smirnov, Levene and Mauchly test. The data were transformed with Box-Cox and z-score. Then a partial least squares discriminant analysis (PLS-DA) was applied and metabolites with Vip Score >1 in both components were retained for pathway enrichment analysis. The Kruskal-Wallis test with Dunn's post hoc test and Eta square ($\eta 2$) was utilized to compare the main metabolites between groups and all other variables were compared utilizing ANOVA and a Tukey post-hoc. Afterwards, a persons correlation was realized.

RESULTS: Individuals with DS had significantly lower body mass, stature, and leg circumference ($\eta 2 > 0.189$, $p < 0.05$), and a worse motor coordination, VO2max, TUG, STS, and hand grip scores ($\eta 2 > 0.417$, $p < 0.05$) than individuals without DS. 62 metabolites were acquired and 8 were retained after the PLS-DA and enrichment pathway analysis: 1,3-diaminopropane, ascorbate, asparagine, glutamate, glutamine, lysine, methionine, and phenylalanine. The most enriched pathways were ammonia recycling, aspartate metabolism, carnitine synthesis, phenylalanine and tyrosine metabolism, urea cycle, lysine degradation, amino sugar metabolism, beta-alanine metabolism, nicotinate and nicotinamide metabolism, biotin metabolism. The retained metabolites were significantly different ($p < 0.05$) between individuals with and without DS, with moderate effect sizes ($\eta 2 > 0.068$), except for glutamate which had a large effect size ($\eta 2 = 2.971$). Ascorbate was significantly associated with TUG ($r = 0.32$, $p = 0.047$).

CONCLUSION: The alterations found in the DS group indicate associations with synapse function and formation, intellectual disability, especially glutamate and phenylalanine. Additionally, lower ascorbate levels, may be associated with higher oxidative stress levels in DS, which is associated with lower muscle development, leading to a lower performance in TUG. Therefore, interventions targeting these metabolic pathways, such as regular exercise and pharmacological treatments, may mitigate the effects of DS.

**ASSOCIATION BETWEEN PHYSICAL ACTIVITY, PSYCHOLOGICAL WELL-BEING AND SLEEP QUALITY IN ATHLETES PRACTICING ADAPTED SPORTS**

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INTRODUCTION: Physical activity is widely recognized as a key factor for health and well-being, particularly for individuals with disabilities. The development of adapted sports (AS) has increased opportunities for this population to engage in regular physical activity. Despite the growing popularity of AS, the impact of sports participation on quality of life and related factors remains poorly investigated. The study aimed to investigate the relationship between physical activity levels (PAL), sedentary behaviours (SB), psychological well-being (PWB) and sleep quality (SQ) in athletes practicing AS.

METHODS: Seventy-four questionnaires were completed by athletes (36.1±9.42 years; females=24; males=50) with physical or sensory disabilities (PSD) who regularly engage in AS, and were analysed. The survey included questions related to PAL and SB using the short form of the International Physical Activity Questionnaire (IPAQ-sf); weekly training volume (VOL_ALL); PWB using the World Health Organization-Five Well-Being Index (WHO-5); SQ using the Pittsburgh Sleep Quality Index (PSQI); enjoyment of physical activity (EPA) using the Physical Activity Enjoyment Scale (PACES). The distribution of the data was checked using the Shapiro-Wilk test. The partial association between variables was estimated by Spearmans Rho correlation coefficient (r) accounting for the effects of age, gender and disability type. The level of significance was set at $p<0.05$. The statistical analysis was conducted using the Jamovi software (v.2.6.17).

RESULTS: A negative and statistically significant association ($r=-0.428$, $p<.001$) was found between WHO-5 and PSQI. In contrast, a positive and statistically significant association ($r=0.267$, $p=0.03$) was found between WHO-5 and IPAQ-sf. A positive and statistically significant association ($r=0.268$, $p=0.032$) was observed between PACES and IPAQ-sf, as well as PACES and VOL_ALL ($r=0.299$, $p=0.017$). PACES also showed a positive and statistically significant association with WHO-5 ($r=0.266$, $p=0.034$). PSQI was negatively associated with VOL_ALL, IPAQ-sf and PACES; however, these associations were not statistically significant ($r=-0.082$, $p=0.511$; $r=-0.098$, $p=0.435$; $r=-0.026$, $p=0.838$, respectively). SB showed a negative and statistically significant associations with VOL_ALL ($r=-0.268$, $p=0.032$), WHO-5 ($r=-0.266$, $p=0.034$) and IPAQ-sf ($r=-0.253$, $p=0.044$).

CONCLUSION: Higher PWB is associated with better SQ and PAL. Greater EPA is associated with higher PWB, higher training volume, higher PAL. SQ, although it impacts the quality of life, does not directly affect PAL or EPA. Higher SB are linked to lower PAL and poorer PWB. These findings underscore the importance of participation in AS for individuals with PSD. Coaches and strength and conditioning specialists should focus on developing inclusive, enjoyable and tailored training programs that enhance PWB and athletic performance. Customized interventions to improve SQ and reduce SB could enhance athletes performance and overall well-being.

## Health and Fitness

### ASSCOCIATIONS BETWEEN SCHOOL-BASED ENVIRONMENTAL FACTORS AND PHYSICAL ACTIVITY IN ADOLESCENTS: A SYSTEMATIC REVIEW AND META-ANALYSIS

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INTRODUCTION: This study aimed to explore the effectiveness of different school environmental factors on improving adolescents' PA levels.

METHODS: A comprehensive search of five databases (PubMed, Embase, Web of Science, EBSCO, and Cochrane Library) was conducted from the earliest available records to September 2023. When two or more studies explored the same school environmental factor, a meta-analysis was performed. The involved school environmental factors encompassed seven school social environmental factors and six school physical environmental factors.

RESULTS: Eighteen studies with a total of 340,749 participants were included in the meta-analysis. The result revealed a significant positive correlation between the school environment and adolescents' PA (OR = 1.09; 95% CI = 1.06 to 1.12; P < 0.001; I2 = 85.9%). Specifically, the school social environment was significantly positive-associated with adolescents' PA level (OR = 1.18; 95% CI = 1.04 to 1.33; P = 0.011; I2 = 83.5%). Among the school social environmental factors, the school-offered daily PE (OR = 1.20; 95% CI = 1.04 to 1.38; P = 0.012; I2 = 89.5%), school-organized extracurricular PA (OR = 1.16; 95% CI = 1.05 to 1.28; P = 0.003; I2 = 87.6%), the encouragement of using sport equipment or facilities (OR = 3.25; 95% CI = 1.87 to 5.64; P < 0.001; I2 = 64.1%), and outdoor obstacle course (OR = 1.58; 95% CI = 1.25 to 1.98; P < 0.001; I2 = 36.2%) were significantly positive-correlated with adolescents' PA level, respectively. Additionally, the school physical environment did not show a significant association with adolescents' PA. However, among the school physical environmental factors, the number of school PA facilities (OR = 1.07; 95% CI = 1.03 to 1.11; P = 0.001; I2 = 78.1%) was significantly positive-associated with of adolescents' PA level.

CONCLUSION: This meta-analysis demonstrates that the school environment is helpful for increasing adolescents' PA level. Among the various school social environmental factors, the school-offered daily PE, school-organized extracurricular PA, the encouragement of using sport equipment or facilities, and outdoor obstacle courses are found to be particularly beneficial for promoting adolescents PA. Furthermore, regarding the school physical environment, the number of school PA facilities is found to be a key factor in enhancing PA among adolescents.

### TIME ABOVE VENTILATORY THRESHOLD AS A DETERMINANT OF POST-EXERCISE HYPOTENSION: SEX-SPECIFIC FINDINGS FROM HIKING

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INTRODUCTION: The temporary reduction in blood pressure (BP), particularly in systolic BP (sBP), following exercise is known as Post-Exercise Hypotension (PEH). Although PEH is influenced by several internal (i.e., age) and external (i.e., caffeine) factors, no studies have yet specifically investigated the influence of the time spent above the ventilatory threshold (MIN≥VT) on sBP reduction. Therefore, this study aimed to investigate the sex-specific PEH responses following hiking and their relationship with the MIN≥VT.

METHODS: 7 females (F) (age: 24.7±0.7 years; BMI: 23.8±2.7 kg/m2) and 7 males (M) (age: 24.1±0.8 years; BMI: 20.2±1.5 kg/m2) participated in a laboratory treadmill walking incremental test and an outdoor hiking session (~3800m length). Participants self-selected a comfortable walking speed for the initial 2-min stage at 0% grade during the incremental test. The grade then increased by 2% every 2 minutes stage until volitional exhaustion. VT was determined using the deflection point method. After 24 hours of rest, participants completed the hiking session. sBP was measured 15 minutes before (PRE) and 30 minutes after (POST) the hike. PEH was calculated as the difference between sBP at PRE and POST. T-tests were used to compare the hike time of completion, MIN≥VT and PEH between sexes. A linear regression analysis was performed with PEH as dependent variable, while MIN≥VT, sex and their interaction were included as independent variables. Statistical significance was set at $p<0.05$.

RESULTS: The hike was completed in 41.4±3.7min and 42.4±3.5min by M and F, respectively, and no significant differences were found. Significant differences between sexes were found for MIN≥VT (F=8.0±2.6min; M=1.7±2.3min; p=0.0005) and PEH (F=12.3±7.8mmHg; M=4.0±5.5mmHg; p=0.04). The regression model explained 74% of the variance in PEH ($R^2$=0.74, p=0.003). In F, increasing MIN≥VT was associated with a significant reduction in PEH (p=0.011). M had significantly lower PEH than F at MIN≥VT @0-min (p=0.001), indicating a weaker PEH response with intensities ≤VT. The

significant positive interaction term (p=0.002) indicates that the effect of MIN≥VT on PEH differs by sex. In M, PEH varied widely at lower MIN≥VT but increased to 15mmHg at 6 min, suggesting that longer MIN≥VT is required for a stronger PEH. In contrast, F exhibited a more stable PEH response with consistently positive values above 9-min.

CONCLUSION: Despite sex-related variations in sBP levels, PEH was observed in both sexes. The findings highlight a sex-specific difference in PEH regulation, potentially influenced by autonomic and vascular adaptations. While F experience a PEH reduction with increasing MIN≥VT, M exhibit an opposite trend, where more MIN≥VT was associated with a rise in PEH. This suggests that M require prolonged high-intensity exercise MIN≥VT for significant PEH, while F benefit from a more immediate response (<3-min). These results emphasize the importance of adapting higher-intensity training to maximize PEH.

**THE IMPACT OF TAEKWONDO TRAINING ON FUNCTIONAL FITNESS IN THE ELDERLY: A 12-WEEK INTERVENTION STUDY**

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INTRODUCTION: Aging is generally associated with osteopenia (loss of bone mass), sarcopenia (loss of muscle mass), and structural and functional brain declines. Regular physical activity positively impacts older adults by enhancing functional autonomy, quality of life, and the ability to perform activities of daily living. Among combat sports, Taekwondo (TKD) offers a diverse range of movements varying in frequency, intensity, duration, and application, which may benefit fitness components in older individuals. This study aimed to evaluate the effects of a 12-week TKD program on functional fitness assessment in older individuals, considering sex-related differences.

METHODS: 16 older subjects (5 male (M), 11 female (F); age: 73.8±5.9 year) were administered the American Alliance for Health, Physical Education, Recreation & Dance (AAHPERD) functional fitness tests before (PRE) and after (POST) the TKD program. According to the AAHPERD protocol (1), subjects performed Chair Sit and Reach test (CSRT) to assess flexibility, Arm Curl test (ACT) for strength, 2 Minute Step test (2MST) for endurance, Agility Dynamic Balance test (ADBT) for agility/dynamic balance, and Coordination "Soda Pop" test (SPT) for coordination. The reached distance (cm) from the toes in CSRT, the total number (AU) of fully-ranged repetitions in ACT, the total number (AU) of correct steps in 2MST, and the best score in ADBT and SPT (s) were recorded and used for the analysis. Repeated Measure ANOVA was used to examine the effects (p<0.05) of TKD program on the functional fitness assessments, in relation to sex.

RESULTS: No sex differences emerged for all tests in PRE vs POST evaluations. There were no differences in CSRT (F = PRE: 3.7±6.8 cm, POST: 4.1±7.2 cm; M = PRE: 8.8±10.2 cm, POST: 8.0±10.2 cm) and ADBT (F = PRE: 44.2±8.7 s, POST: 45.5±11.5 s; M = PRE: 39.8±5.3 s, POST: 39.5±7.2 s). ACT performance decreased in both sexes, with statistically significant decrease only in F (PRE: 11.9±2.6 reps, POST: 9.1±4.9 reps, p=0.044). The 2MST performance significantly improved in both M (PRE: 52.6±21.7 steps; POST: 74.6±12.6 AU, p=0.011) and F (PRE: 51.4±13.9 AU; POST: 64.0±16.2 AU, p=0.034). The SPT performance significantly (p<0.001) improved in both M (PRE: 21.2±3.9 s, POST: 11.4±1.3 s) and F (PRE: 22.3±6.8 s, POST: 12.6±2.4 s).

CONCLUSION: Findings suggest the 12-week TKD program significantly improved endurance and coordination, while flexibility and agility/dynamic balance remained unchanged. The practice of regular TKD can be an efficient intervention strategy to minimize the deleterious effects of aging, contributing to improved well-being in the elderly. As a good alternative to conventional interventions, TKD could be integrated into public health programs for older individuals, as it is a safe, accessible intervention with good adherence.

**THE RELATIONSHIP BETWEEN PHYSICAL ACTIVITY AND LUMBOPELVIC PAIN DURING PREGNANCY: A LONGITUDINAL STUDY OF HOUSEWORK, OCCUPATIONAL ACTIVITIES, AND SPORTS AND EXERCISE**

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INTRODUCTION: Over half of pregnant women experience daily lumbopelvic pain (LPP), including pubic symphysis pain (PSP), low back pain (LBP), and sacroiliac joint pain (SIJP). Physical activity (PA) is thought to influence the severity of LPP, but the effects of different categories of PA, such as housework, childcare, occupational activities, and leisure-time sports/exercise, remain unclear. This study investigates the relationship between the amount and type of PA (housework/childcare, occupational activities, and sports/exercise) and LPP during pregnancy and postpartum.

METHODS: In total, 23 Japanese pregnant women who visited obstetric and gynecological hospitals were included. The severity of LPP was assessed using the Numerical Rating Scale (NRS), and PA was classified using the Pregnancy Physical Activity Questionnaire. A longitudinal study was conducted to assess PA at 12, 20, 30, and 36 weeks of pregnancy, and its association with pain at these time points, as well as one month postpartum. Statistical analysis was performed using t-tests and Spearman's rank correlation coefficient.

RESULTS: At 12 weeks, women without pain exhibited significantly higher occupational PA than those with pain (p = 0.01). At 36 weeks, women with pain showed significantly higher housework/caregiving activity levels at both 20 weeks (p = 0.05) and 36 weeks (p = 0.03). One month postpartum, women without pain showed higher levels of occupational activity at 12 weeks (p = 0.03) and sports/exercise activity at 20 weeks (p = 0.02). Regarding specific pain types, PSP was negatively correlated with housework/caregiving activity at 12 and 20 weeks (12 weeks: ρ = -0.43, p = 0.04; 20 weeks: ρ = -0.43, p = 0.04), and with sports/exercise activity at 20 and 30 weeks (20 weeks: ρ = -0.44, p = 0.04; 30 weeks: ρ = -0.47, p = 0.03). At 30 weeks, PSP was also negatively correlated with sports/exercise activity at 20 weeks (ρ = -0.44, p = 0.04).

At 36 weeks, PSP was positively correlated with housework/caregiving activity at 20 weeks (ρ = 0.43, p = 0.04). LBP showed a negative correlation with occupational PA at 12 and 20 weeks (12 weeks: ρ = -0.55, p = 0.01; 20 weeks: ρ = -0.44, p = 0.04). At 36 weeks, LBP was negatively correlated with occupational PA at 36 weeks (ρ = -0.47, p = 0.03). No significant correlations were observed between SIJP and PA.

CONCLUSION: This study suggests that occupational PA during early pregnancy may be associated with LBP, while housework/caregiving PA in late pregnancy is related to pelvic pain, including PSP. Furthermore, sports and exercise activities, particularly during mid-pregnancy, may help alleviate postpartum pain and may be associated with specific pelvic pain conditions, such as PSP. Therefore, adjusting PA in different categories during pregnancy may help reduce LPP and support postpartum recovery. Further research is needed to clarify the mechanisms by which PA alleviates LPP and to examine the role of sports and exercise interventions.

**EVIDENCE FOR PEDIATRIC DYNAPENIA AND POTENTIAL EFFECTS OF THE COVID-19 PANDEMIC**

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INTRODUCTION: Muscular strength in children and adolescents has progressively declined over recent decades (1, 2), and this decline of muscle strength is referred to as "pediatric dynapenia" (3). Despite "dynapenia" being fundamentally defined as loss of muscle strength, pediatric dynapenia assessment has largely relied on physical fitness tests such as standing long and vertical jumps, pull-ups and sit-ups, rather than muscle strength measurements. Moreover, pediatric dynapenia has not been systematically tracked over time, nor has the potential impact of the COVID-19 pandemic been examined. This study examined changes in knee extension strength of adolescents between 2010 and 2021, and investigated the potential effect of the COVID-19 pandemic on the changes.

METHODS: Maximal voluntary isometric contraction (MVIC) torque of the knee extensors (KE) relative to body mass (BM) in 226 male adolescents aged between 13–15 years with the same maturity status and body mass was examined in this retrospective analyses. Data were collected from studies conducted between 2010 and 2021, including the post-COVID-19 period, across two laboratories in Brazil (UFRGS) and France (UCA).

RESULTS: Analyses revealed a significant decline (~31%) in KE MVIC torque relative to body mass over 12 years ($P<0.01$) and a significant ($P <0.01$) effect of the COVID-19 pandemic on the strength, reducing from before (~4 Nm/kgBM) to after the pandemic (2.7 Nm/kgBM).

CONCLUSION: Adolescent force-generating capacity has declined over the last decade, with the COVID-19 pandemic exacerbating this trend. These findings suggest that modern lifestyles characterized by increased sedentary behaviour reduced the muscular strength in adolescents. While no formal cut-off criterion exists for "pediatric dynapenia," the observed declines indicate a potential rise in its prevalence over the past decade, with the pandemic accelerating this trend. More efforts focusing on interventions to mitigate this decline and increase muscular strength in youth are necessary.

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**AEROBIC EXERCISE PRECONDITIONING SUPPRESSES SUBCUTANEOUS TUMOR GROWTH AND GLYCOLYSIS VIA PI3K/AKT PATHWAY IN TUMOR-BEARING MICE**

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INTRODUCTION: Aerobic glycolysis is a typical metabolic characteristic of tumor, and exercise may regulate the metabolism of tumor cells and thus affect tumor growth. A large amount of epidemiological evidence shows the anticancer effect of exercise, but whether exercise preconditioning can inhibit tumor growth remains unclear. The aim of this study was to investigate the effect of aerobic exercise preconditioning on subcutaneous tumor in tumor-bearing mice and its mechanism.

METHODS: 6 weeks of age male C57BL/6 mice were selected and subjected to 12 weeks of treadmill pre-aerobic exercise intervention. Then, Hepa1-6 tumor-bearing mice were established and divided into a sedentary group and an exercise intervention group. After the intervention and the formation of tumors, the tumors were sampled and weighed. The glycolytic function of the tumors in the mice was observed by detecting the glucose content, the activity of PKM2 enzyme (pyruvate kinase 2), LA (lactic acid), and the content of ROS. RNA-Seq analysis and functional enrichment were carried out to explore the impact of pre-aerobic exercise on the glycolytic capacity of tumor tissues. The phosphorylation level of proteins in the PI3K/AKT signaling pathway was verified by Western Blot. Combining the public database of single-cell tumors TISCH2 and the results of RNA-Seq analysis in this study, the association between glycolysis and immune cell infiltration was explored, and macrophage infiltration was detected by immunofluorescence.

RESULTS: Compared with the control group, we found that aerobic preconditioning inhibited hepa1-6 tumor growth and down-regulated PKM2, GLUT1, LDHA and HK2 expression in tumor tissue. RNA-Seq showed that differentiated gene expression in aerobic exercise group was enriched in PI3K/AKT signaling pathway. Further western blot detection showed that P-PI3K and P-AKT proteins were significantly down-regulated in the tumor tissue of the exercise group. Meanwhile,

RNA-Seq showed that exercise down-regulated the expression of genes related to glucose metabolism. TISCH2 database single cell population gene cluster map (macrophage population) suggests that these genes are closely related to immune cell infiltration. Immunofluorescence assay also showed that exercise significantly reduced inflammatory infiltration of M1 macrophages.

CONCLUSION: This study suggests that aerobic exercise preconditioning can down-regulate tumor glycolysis activity and inflammatory infiltration of M1 macrophages through PI3K/AKT signaling pathway, thereby inhibiting subcutaneous tumor growth.

**SPORT AND PHYSICAL ACTIVITY PARTICIPATION IN HUNGARIAN GIRLS AND BOYS**

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INTRODUCTION: Physical activity is essential for health and wellbeing. According to the last HBSC data collection, less than 25% of students do enough physical activity in Hungary (Németh 2024). Monitoring the different activities of children is essential to understand the reasons. The aim of the study was to collect data about primary school children's physical activity and analyse the gender difference. The questionnaire was compiled by the Global Matrix 4.0 indicators. We asked parents about the children's overall physical activity, daily physical activity, sport participation, and active transport.

METHODS: In the online data collection, 677 parents (42.85±6.49 years old) provided information about 677 children (10.98±2.53 years old). Data were collected in 2023 spring using social media platforms and online correspondence. Our questionnaire was edited with the Qualtrics program; the data were analysed with TIBCO 14.0 Statistics; the gender differences were tested with t-tests and chi square tests.

RESULTS: We found a significant difference in overall PA where 73% of girls and 82% of boys achieved the 60 min. MVPA/day on average. However, the number of days spent physically active was similar: 4.54 days (girls) vs. 4.81 days (boys). Altogether, 46% of children participated in club sports (44% of girls and 48% of boys). Girls preferred sports were handball and basketball; meanwhile, boys chose mostly football and kayaking & canoeing. Active transport was present at the same level in both genders, 78% of girls and 81% of boys reported this type of activity.

CONCLUSION: We have found that daily physical activity and active transport were reported at a higher rate compared to the last representative data collection. We believe that parents can better predict their children's physical activity than children. Our data showed that in primary school children, the gender difference was not significant. The increased physical activity might be explained with the daily PE in schools and with the governmental support of sports and the higher rate of educated parents.

**SCALING SUCCESS: PARENTAL PERCEPTIONS OF THE BENEFITS OF A 20-WEEK FOOTBALL LIVING-LAB APPROACH FOR CHILDREN LIVING WITH CEREBRAL PALSY**

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INTRODUCTION: Living-lab approaches have been successful in bridging the gap between university research and communities. However, these have never been used to promote physical activity opportunities for children living with cerebral palsy (CP) and the effects on childrens development are yet to be known. Therefore, we created a 20-week football program inspired by Football is Medicine and Physical Literacy for children between the ages of 5-10 living with CP and subsequently explored parents perceived benefits of the program for their children using a qualitative approach.

METHODS: Seven one-to-one semi-structured interviews were conducted with the parents of the children who participated in the programme to gauge the impact of engagement on the children's lives. Following this, deductive thematic analysis was performed and pen profile diagrams created to explore parents perceived benefits of the program for their children.

RESULTS: Parents reported that participation in the programme was beneficial for their children fostering physical literacy. They highlighted improvements in their childrens competence and confidence (n=7), motivation and enjoyment (n=7), as well as increased social interaction (n=7). Furthermore, parents noted that the sessions were inclusive (n=6), fostering a sense of community, and were tailored to their needs (n=5). Some parents perceived their childs participation in the programme as a form of treatment, equating involvement in the football programme to additional physiotherapy and rehabilitation sessions commonly undertaken by children living with CP. Additionally, parents valued the opportunity to share and develop new strategies to support their child's well-being in daily life.

CONCLUSION: Parents reported improvements across multiple aspects of physical literacy, noting progress in social, psychological, and physical domains. Consequently, the football programme has fostered a welcoming environment that supports the holistic development of children living with CP.

**EFFECTS OF EXERCISE ON DEPRESSION IN ADOLESCENT PATIENTS WITH OBESITY AND T2 DIABETE MELLITUS**

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INTRODUCTION: Exercise is recognized to reduce depression in adults. Although there is an increase in the prevalence of depression in adolescents, especially among those who have chronic diseases such as obesity and type 2 Diabetes Mellitus (T2DM), the effect of exercise on depression symptoms has not been adequately studied. This study aims to ex-

amine the relationship between exercise and depression symptoms in a clinic-based adolescent group who are seen for obesity and T2D management

METHODS: A retrospective chart review of patients with obesity who were consecutively seen at a university-based multidisciplinary pediatric weight management clinic between July 1, 2018, and June 30, 2021, was performed. Demographic, anthropometric, clinical, physical activity and laboratory data, psychiatric history, and depression status using PHQ-9 score were abstracted. Selection criteria were age 12-18 years, BMI % > 95th%; and charts include data on: BMI; PHQ9 scores, physical activity in minutes/week; and T2D status (defined as HgA1c > 6.5, history of T2D diagnosis, and/or receiving metformin or/and insulin). R 4.1.2, packages: ggplot2, epitools, and ggpubr were used for Data analysis.

RESULTS: Charts of 178 subjects were identified. Female adolescents had a significantly higher PHQ9 score compared to males ($p < 0.05$). There was no significant difference in PHQ9 scores when patients were compared based on T2DM status. In a regression model that included T2DM status and psychiatric diagnoses, every minute added of exercise decreased the total PHQ9 score by 0.006 ($P< 0.05$). For a group that included only patients who have T2DM and reported physical activity at least 3 hrs/ week, there was a moderate negative correlation between PHQ9 scores and min/ week exercise with $r = - 0.54$ ($p=0.057$). In subjects who do not have T2DM, the correlation was not statistically significant ($r= -0.05$ with $P=0.6$).

CONCLUSION: In adolescents who had both obesity and T2DM and exercised at least 3 hours/week, increased exercise was associated with lower total PHQ 9 scores. Though our finding was not statistically significant, likely because of the small sample size, promoting physical activity for a minimum of 3 hours/ week may improve the depression symptoms in this group of patients.

Further studies with larger samples are needed to confirm our results.

**EXERCISE-ASSOCIATED ALTERATIONS OF CIRCULATING MICRORNA IN PATIENTS WITH HEART FAILURE**

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INTRODUCTION: Emerging evidence suggests that circulating microRNA (miRNA) profiles can be affected by physical activities. High-intensity interval training (HIIT) is known to be associated with anti-cardiac fibrosis by modulating DNA methylation. The study identified miRNA profile changes after high-intensity interval training (HIIT) in patients with heart failure (HF).

METHODS: Among 40 included HF patients under guideline-directed medical treatment (GDMT), 20 were randomized to have additional 36 sessions of HIIT and 20 without HIIT were considered GDMT participants. The HIIT participants underwent supervised HIIT at alternating 80% and 40% of VO2peak for 30-min in each session. Baseline information, and cardiopulmonary exercise test and 2-D echocardiography for left ventricular (LV) geometry. Next generation sequencing for human serum to identify circulating miRNA profiles before and after interventions in both groups of patients.

RESULTS: Compared to GDMT participants, a significant increase of VO2peak as well as heart rate reserve (HRR) and a significant decrease of VE-VCO2 slope after completing HIIT. Significantly decreased LV mass was observed in HIIT participants in comparison with patients underwent GDMT. HIIT-associated significant improvement of VO2peak, oxygen uptake efficiency slope, and HRR were observed, but a significant decrease of VE-VCO2. Significant changes of LV geometry were observed in HF patients underwent GDMT and HIIT. However, HIIT rather than GDMT resulted in a significant decrease of LV mass. There were 9 (miR-93-3p, miR-361-3p, miR-181a-5p, let-7e-5p, miR-106b-3p, hsa-miR-6765-3p, miR-421, miR-425-5p, miR-29a-3p) among 244 identified miRNAs expressed significantly different between GDMT and HIIT participants. The above circulating miRNAs were significantly involved in the muscle cell differentiation and cell survival after ingenuine pathway analysis.

CONCLUSION: The HIIT-induced physiological adaptations may be associated with circulating miRNA expressions. This epigenetic modulation could further contribute to the improvement of cardiac functions as well as aerobic fitness in HF patients.

**MISSING LINK IN THE EARLY DETECTION OF A CONDITION LEADING TO RELATIVE ENERGY DEFICIENCY IN SPORT (REDS): METABOLITE LOGISTIC ADAPTATION OF SPIROERGOMETRY**

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INTRODUCTION: The International Olympic Committee (IOC) firmly states the importance of recognising REDs. 90% of adolescent athletes will suffer at least one injury requiring invasive treatment by the age of 18. How can this be prevented? The answer is sought by many non-standardized methods, involving wearable technologies, but mostly only physiological limits are measured and maximized.

The care of athletes is teamwork, from which pathophysiological factors are thus left out. The answer is the measurement of energy expenditure (EE) during exercise, which detects excessive training, but also growth reserves and, in addition, characterises the athletes lifestyle outside training time.

METHODS: Metabolically oriented adaptation of spiroergometry (CPET) measures muscle biochemistry, i.e. if EE happens from free fatty acids (FFA) or carbohydrates (CHO).

With addition of the dynamics of by-product elimination and hormonal characteristics, competitive conditions can be modelled, as opposed to e.g. Vitamax or similar protocols where we can usually observe only a short peak performance.

56 active adolescent athletes were measured with CPET (Group A), of which 15 (Group A-OB) were members of the EFL US soccer team with BMI 30+. As pathophysiological controls, 77 amateur athletes (Group OB) BMI 30+ were selected.

Their training was divided into 20 min warm-up, 30 min individual gymnastics, for A and A-OB an additional 15 min intense exercise (on the field by portable devices), and 20 min recovery. Metabolite logistics were measured in stages, muscle oxygen saturation, by-products, insulin and adiponectin were also assessed.

RESULTS: Metabolite logistics: complete training, rate of FFA utilization: A=36.7+/-7.49%, A-OB=20.54+/-4.9%, OB=35.1+/-9.4%,

Intense 15min: rate of FFA A=19.36+/-9.98%, A-OB=3.68+/-1.83%, p<0.001, load (in METS): A=6.84+/-1.31, A-OB=7.433+/-1.06 (NS).

Individual gymnastics rate of FFA utilization: A=38,4+/-6,95%, A-OB=22,4+/-6,1%, OB=33,9+/-7,4%, intensity (in METS): S=4,72+/-0,72, S-OB=5,06+/-1,19 OB=2,9+/-0,84 (p<0,05 in OB vs. A, and in OB and A-OB). During training, the mean CHO utilization was A=106+/-25.9g, A-OB 145+/-31.3 g. (cf.: muscle glycogen stores: 400g CHO)

Mean adiponectin A-OB=4.1+/-0.4, A=7.8+/-1.9, OB= 4.05+/-0.7 µg/ml. By-product elimination time correlates with aerobic/anaerobic switching and with CHO/FFA utilization ratio. Blood pH decrease and VO2

CONCLUSION: Pathophysiology should be introduced into performance diagnostics, at least in cases of insufficient development of the athlete, underperformance, periodically with advancing age. EE must be optimised to ensure genetically determined anthropometric development.

Assessment of by-product elimination helps to determine recovery time and emphasizes the importance of stretching. Biochemical results interpret the background of pathophysiology of REDs.

**EFFECTS OF ACUTE AEROBIC EXERCISE AND WHOLE-BODY VIBRATION INTERVENTIONS ON NEUROCOGNITIVE PERFORMANCE AND BIOCHEMICAL INDICES IN POSTMENOPAUSAL WOMEN**

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INTRODUCTION: Engaging in acute aerobic exercise has been shown to significantly enhance neurotransmitter activity and neurotrophic factor levels, thereby improving neural function in late middle-aged and older adults [1]. Similarly, a single session of whole-body vibration (WBV) has been reported to elicit acute hormonal responses, promote the release of neuroprotective growth factors, and activate the brain cortex [2]. Postmenopausal women tend to perform worse on cognitive interference tasks compared to their premenopausal counterparts [3]. However, no studies to date have examined the combined effects of aerobic exercise and resistance exercise performed on a WBV platform on inhibitory control in this population. Furthermore, the neurophysiological and molecular mechanisms underlying acute exercise-induced neuropsychological changes, as well as the interconnections among these factors, remain unclear. Therefore, this study aimed to evaluate the effects of moderate-intensity aerobic exercise (MIAE) and a combination of MIAE with isometric resistance exercise on a WBV platform (MIAE+WBV), in comparison to no exercise (NEI), on neurocognitive performance and molecular biomarkers in postmenopausal women.

METHODS: Sixty-six participants were randomly allocated into three groups: MIAE (n = 22), MIAE+WBV (n = 22), and NEI (n = 22). Neurocognitive performance was assessed using measures such as accuracy rate (AR), reaction time (RT), and brain event-related potential (ERP; P3 component) during the Stroop task. Serum levels of insulin-like growth factor 1 (IGF-1), norepinephrine (NE), osteocalcin (OC), and uncarboxylated OC (ucOC) were also evaluated before and after the intervention (or resting period for the NEI group).

RESULTS: No significant changes in RTs, ERP P3 latency, or P3 amplitude for the compatible condition were observed in either exercise group. However, both MIAE and MIAE+WBV groups showed significant increases in AR (ps < .007) and P3 amplitude (ps < .003) during the incompatible condition. Notably, only the MIAE+WBV group demonstrated significant improvements in AR for the compatible condition (p = .007). Both exercise groups exhibited elevated post-exercise levels of IGF-1 (ps < .003), NE (ps < .008), OC (ps = .001), and ucOC (ps < .024). Additionally, significant correlations were identified between NE and P3 amplitude changes in both exercise groups (ps < .028) and between ucOC and AR changes in the MIAE+WBV group (p = .041), underscoring the link between molecular and neurocognitive outcomes.

CONCLUSION: These results indicate that both MIAE and MIAE+WBV effectively improve neurocognitive function in postmenopausal women, with MIAE+WBV demonstrating greater efficacy compared to MIAE alone.

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**SMART CIRCUIT AEROBIC EXERCISE IMPROVES PLATELET MITOCHONDRIAL BIOENERGETIC EFFICIENCY IN SEDENTARY MEN**

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INTRODUCTION: Physical exercise paradoxically imposes platelet function according to responses dependent on exercise type/intensity/volume. This study aimed to compare the effects of smart circuit- and single-based exercise regimens on platelet mitochondrial bioenergetics at the same exercise intensity/volume in sedentary men.

METHODS: Fifty healthy sedentary men were randomly assigned to participate in a circuit exercise group (CIR, n=17, circuit exercise on bicycle, rowing, and elliptical ergometers at 60% heart rate reserve,10 minutes of each exercise followed by 1 minute of rest) or cycling exercise group (CYC, n=17, three sets of cycling at 60% heart rate reserve for 10 minutes followed by 1-minute rest), or to a control group (CON, n=16) that did not receive exercise intervention. The smart training programs on CIR and CYC were conducted using real-time heart rate and workload feedback. Systemic aerobic capacity and platelet mitochondrial oxidative phosphorylation (OXPHOS) and electron transport chain (ETC) were measured through automatic gas analysis and high-resolution respirometry, respectively.

RESULTS: Both CIR and CYC significantly improved VO2max by 21% and 28%, respectively. Although both CIR and CYC significantly increased platelet OXPHOS and ETC capacities, CIR revealed higher platelet ETC–OXPHOS excess capacity than CYC. Moreover, training-induced ΔVO2max was positively correlated with ΔETC (r=0.34, P=0.028).

CONCLUSION: Smart aerobic exercise improves cardiorespiratory fitness and platelet mitochondrial OXPHOS capacity. Moreover, CIR is superior to CYC in improving mitochondrial bioenergetics efficiency.

**THE ROLE OF PHYSICAL EXERCISE ON HIPPOCAMPAL VOLUME IN DEPRESSIVE SYMPTOMS: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Hippocampal atrophy is a frequently observed structural impairment in depressive disorders [1]. The positive impact of physical exercise on hippocampal volume could be shown in both animal and human models. Still, heterogeneous results can be observed regarding exercise within the context of depressive disorders [2]. Accordingly, this systematic review and meta-analysis aim to evaluate whether exercise inhibits hippocampal decline in animal and human depression models or could even enhance hippocampal volume.

METHODS: We searched Web of Science, SportDiscus, PubMed (MEDLINE), PsycINFO, Google Scholar, and Cochrane until the 30th of March 2023, and conducted independent meta-analyses for animal and human studies (combining results on cellular composition and total volume). Both meta-analyses were based on a random-effect model. All data is on open access (osf.io/mdvqz). Inclusion decisions were based on the following PICOS criteria: Participants with depressive symptoms or any diagnosis of depression, intervention of any type, comparison of hippocampal volume pre- and post-intervention, outcome focusing one volume changes, study design peer-reviewed studies in English.

RESULTS: Out of 1275 identified, 789 were screened by title and abstract. Forty-nine studies in full-text screening were excluded based on the wrong publication type (1 animal), missing depression assessment (18 human/6 animal), missing intervention (11 human) or volume assessment (15 human/7 animals). The review included nine studies (four animal and five human). The meta-analysis for the animal model, which included male rodents (k =5, n = 87 [45 intervention, 42 control]) showed a large but insignificant (p=.081) average effect for hippocampal growth (Hedges' g =1.13, 95% Confidence Interval (CI) = -0.22 to 2.48) and exhibited extreme heterogeneity (Predicted Interval (PI)=-2.53 to 4.78, I2=67%, tau2=1.052). The meta-analysis for the human model (k=5, n=249 [126 intervention, 123 control]) showed a very small and non-significant average effect (g=0.08, 95% CI -0.19 to 0.36, p=.435) with substantial heterogeneity (PI=-0.69 to 0.86, I2=0%, tau2=0.043). Participants did either aerobic, aerobic and resistance training or yoga for 20 to 60 min, 3-7 times a week with low to moderate intensity. No moderator analyses were conducted due to sample size and heterogeneity limitations. None of the studies met all risk of bias criteria, indicating potential bias .

CONCLUSION: Our systematic review and meta-analysis found no conclusive evidence that physical exercise affects hippocampal volume in animals and humans with depressive symptoms. Despite larger average effects in animal studies compared to human studies, heterogeneity was substantial in both. Further research is needed, including longer intervention durations and varied intensity settings.

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**UPPER LIMB FUNCTION IS THE IMPORTANT INDICATOR OF SARCOPENIA IN FEMALE OLDER ADULTS**

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INTRODUCTION: The physical activity of older people decreases with age, which is likely to cause the loss of muscle mass, muscle strength, and functional fitness. While prior research on sarcopenia has predominantly examined the relationship between grip strength and lower limb functional movements in older adults, relatively few studies have focused on the

physical function of the upper limbs. This study aimed to assess upper limb reaction and agility among older women with varying levels of sarcopenia risk.

METHODS: A total of 98 community-dwelling females aged 65 years and older (mean age: 74.38 ± 6.95 years; BMI: 23.28 ± 3.98 kg/m²) were categorized into four groups based on the risk of sarcopenia. This classification was determined according to the skeletal muscle index (SMI), handgrip strength, and gait speed cut-off points outlined by the Asian Working Group for Sarcopenia 2 (AWGS2). The groups were defined as follows: (1) no risk group (NR, n = 29), (2) low sarcopenia risk group (LR, n = 31), (3) medium sarcopenia risk group (MR, n = 22), and (4) high sarcopenia risk group (HR, n = 28). Upper extremity muscle mass and endurance (30-second arm curl test), upper extremity flexibility (back scratch), dynamic balance (8-foot up-and-go), static balance (Clinical Test of Sensory Integration of Balance; CTSIB), reaction time (whole-body reaction) were evaluated. One-way ANCOVA was conducted to analyze differences among the groups. Pearson's product-moment correlation was also employed to determine the correlation between muscle mass, functional fitness, and agility.

RESULTS: The skeletal muscle index (SMI) and upper extremity muscle mass demonstrated significant positive correlations with handgrip strength, 30-second arm curl performance, and closed eyes static balance ($p < .05$). The no-risk (NR) group exhibited significantly better handgrip strength compared to the low-risk (LR, 23.3% lower), medium-risk (MR, 45.7% lower), and high-risk (HR, 67.1% lower) groups ($p < .001$). Additionally, the LR group displayed stronger grip strength than the MR group (27.7% lower) and the HR group (46.5% lower) ($p < .001$). In static balance (closed-eye standing on a cushion), the NR group achieved a significantly higher stability index (3.31) compared to the MR group (2.67) and the HR group (2.39) ($p < .05$). Regarding whole-body reaction time, the NR (529.32 ms), LR (435.20 ms), and MR (465.14 ms) groups were significantly faster than the HR group (743.50 ms). In dynamic balance, the NR group (6.23 seconds), LR group (5.95 seconds), and MR group (5.93 seconds) were significantly faster than the HR group (9.07 seconds) ($p < .05$). The upper limb flexibility and muscular endurance showed no significant differences among the four groups. Moreover, SMI was influenced by 37.7% through variables including back scratch performance, 30-second arm curl, and handgrip strength.

CONCLUSION: Based on the results of this study, older adults with low muscle mass do not experience influenced functional fitness unless their grip strength is significantly low. Especially in older women, the risk of sarcopenia increases with a decline in upper limb strength, further driving the occurrence of multiple sarcopenia-related symptoms. This highlights the importance of maintaining or increasing upper limb strength, a key factor in maintaining good physical function with high-risk sarcopenia. It is recommended that future studies investigate the impact of sarcopenia on upper limb functional movements in older adults of different genders.

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**FACTORS ASSOCIATED WITH INSUFFICIENT OUTDOOR PLAY AND SPORTS PARTICIPATION AMONG CHINESE CHILDREN AGED 6-10 YEARS: EVIDENCE FROM A TWO-WAVE SURVEY**

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INTRODUCTION: This study investigated the risk factors associated with insufficient engagement of Chinese early school-aged children in outdoor activities, including play and sports.

METHODS: Data were gathered from two-wave parent-proxy surveys. The analysis involved 1612 children (46.15% girls; mean age = 7.83 years) who had participated in outdoor activities. Responses were analyzed using Generalized Estimating Equations to identify relevant correlates impacting childrens outdoor play or outdoor sports. Children were assessed on their outdoor activities' levels, and variables were analyzed for their impact on these levels.

RESULTS: Maternal outdoor activity (<1 hour/day) and less clear requirements for outdoor play are correlated with children's outdoor activity time (<2 hour/day) ($p < 0.05$). The number of outdoor playfields also significantly associated with insufficient outdoor activity, particularly on weekends ($p < 0.05$). For outdoor sports (<1 hour/day), the male gender of the child was a protective factor (OR = 0.33, $p < 0.001$), while paternal outdoor activity time (<1 hour/day) and unclear outdoor activity requirements were risk factors ($p < 0.01$).

CONCLUSION: The risk factors of insufficient engagement of Chinese early school-aged children in outdoor pursuits were included the lack of time parents spend on outdoor activities, their unclear requirements, and the limited availability of outdoor playfields. Specifically, mothers outdoor activities time is linked to childrens outdoor play, while the male gender of the child and fathers' outdoor activities are associated with children's outdoor sports participation.

**THE EFFECTS OF A SMARTPHONE-BASED SELF-CARE APPLICATION ON LOWER LIMB MUSCLE TIGHTNESS IN PHYSICALLY ACTIVE INDIVIDUALS**

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INTRODUCTION: Muscle tightness is a common yet often overlooked condition that can significantly affect sports performance and daily activities while increasing the risk of injury. Excessive muscle tension may lead to a diminished range of motion in joints, altering biomechanical function during physical activities and consequently increasing the risk of sports-

related injuries. For lower limb muscles, muscle tightness can impose additional stress on other joints within the kinetic chain, potentially leading to chronic pain conditions. Given the high prevalence of muscle tightness and its associated adverse effects, the development of effective preventive and therapeutic strategies is of growing importance.

With the rapid advancement of technology, smartphones have become increasingly integrated into healthcare, offering significant benefits. This technological evolution has supplemented traditional rehabilitation methods and facilitated personalized, continuous care and early intervention strategies, potentially improving long-term health outcomes. This study aims to evaluate the efficacy of a smartphone-based self-care application in relieving lower limb muscle tightness among physically active individuals.

METHODS: Fifteen physically active participants (11 males, 4 females; mean age = 21.5 ± 3.3 years) were recruited for this study. A self-care application was developed using Android Studio (Iguana | 2023.2.1) and included instructional modules on basic self-myofascial release techniques and stretching exercises targeting the lower limbs. Outcome measures were assessed before the initiation of the home program (pre-test) and after the four-week intervention period (post-test). Key measurements included changes in range of motion (ROM), performance on the agility T-test, and scores on a visual analog pain scale. Paired t-tests were conducted using SPSS 17.0, with statistical significance set at $\alpha = 0.05$.

RESULTS: Significant ROM improvements were observed in hip flexion (Right: pre-test 99.1 ± 14.2° vs. post-test 113.5 ± 6.9°, $p = 0.001$; Left: pre-test 89.9 ± 26.1° vs. post-test 107.3 ± 9.0°, $p = 0.016$) and ankle plantarflexion (Right: pre-test 56.4 ± 11.9° vs. post-test 63.7 ± 7.9°, $p = 0.003$; Left: pre-test 58.9 ± 10.5° vs. post-test 63.7 ± 8.9°, $p = 0.007$). Agility also improved significantly (T-test: pre-test 4.9 ± 2.4 sec vs. post-test 3.2 ± 2.7 sec, $p = 0.001$), as did pain scores (pre-test 3.2 ± 2.7 vs. post-test 2.1 ± 2.7, $p = 0.007$). These findings suggest smartphone applications can effectively support home-based interventions for muscle tightness.

CONCLUSION: This study demonstrates that a smartphone-based self-care application can improve ROM, agility, and pain perception in physically active individuals. These findings highlight the potential clinical applications of smartphone-assisted interventions in addressing lower limb muscle tightness. Future research should explore long-term effects and broader applications in diverse populations.

**DO FOAM ROLLERS COUNTERACT THE FATIGUE OF NORDIC HAMSTRING EXERCISE?**

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INTRODUCTION: The Nordic Hamstring Exercise (NHE) is an effective method for strengthening hamstring muscles and reducing the risk of injury [1]. The acute fatigue and delayed onset muscle soreness (DOMS) from NHE emphasize the need for effective recovery strategies. Foam rolling (FR) is a common and simple method used that might help speed up recovery [2]. Hence, this study aimed to evaluate the potential recovery effects of FR following NHE on muscle stiffness, pain pressure threshold (PPT), flexibility, countermovement jump (CMJ), and maximal voluntary isometric contraction (MVIC) immediately and 48 h after the FR application.

METHODS: Thirty-two physically active males (aged 18–30 years; mean ± SD: 23.2 ± 3.5 years, height: 179 ± 6 cm, weight: 75.3 ± 11.6 kg) were randomly assigned to either an FR group (n = 16) or a control group (CON, n = 16) group. Measurements were taken at three time points: pre-test, post-test_0h (immediately after exercise), and post-test_48h (48 hours after exercise). Participants completed 3 sets of 10 repetitions of the NHE before undergoing the recovery interventions. The intervention group performed 2 sets of 60 seconds of foam rolling on the hamstring muscles (both legs, totaling 240 seconds), whereas the CON group remained seated on a chair for the same duration. The evaluated variables included muscle stiffness, flexibility, pain pressure threshold, jump performance, and maximal isometric contraction peak power.

RESULTS: FR enhanced acute flexibility after NHE (12.7%, $p < 0.001$) and helped to maintain flexibility over 48 hours, compared with the CON group. However, no significant differences were observed between the FR and control groups for muscle stiffness, PPT, CMJ, or MVIC, both acutely and at 48 hours ($p > 0.05$).

CONCLUSION: Our hypotheses were partially supported in this study. FR can help to speed up recovery following NHE as well as can acutely increase flexibility [3]. However, its effects on muscle stiffness, pain tolerance, and performance indicators are limited immediately after and 48 hours following NHE. Future studies need to further investigate the acute benefits of FR and its effectiveness across diverse populations and different recovery conditions.

**PREVALENCE OF CHRONIC NONCOMMUNICABLE DISEASES AND MODIFIABLE RISK FACTORS IN ELDERLY WOMEN**

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INTRODUCTION: Chronic non-communicable diseases (NCDs) are among the leading causes of global morbidity and mortality, exacerbated by modifiable risk factors such as physical inactivity, smoking, and inadequate nutrition. Regular physical activity is recognized for mitigating the effects of these conditions; however, its relationship with comorbidity management in specific populations, such as elderly women, remains underexplored. This study aimed to investigate the prevalence of NCDs and their association with modifiable risk factors, such as smoking and obesity, in elderly women engaged in supervised physical activities.

METHODS: A cross-sectional study was conducted with 23 elderly women from southern Brazil who had been regularly participating in physical activities, including functional gymnastics and walking, over the past seven years. Individual and

collective data were collected on smoking, medication use, and health-related physical fitness, including flexibility, muscle strength, body composition, and cardiorespiratory fitness. Additionally, cardiovascular disease (CVD) risk factors, such as hypertension, hypercholesterolemia, diabetes mellitus, and obesity, were assessed. The study outcomes included the presence of CVD risk factors and the number of risk factors per individual (0, 1, 2, or ≥ 3 risk factors). Logistic and multinomial regression analyses were performed, with a statistical significance level set at 5%.

RESULTS: The participants had a mean age of 66.5 ± 8.4 years. Among them, 21.7% exhibited values indicative of high cardiovascular risk. The presence of 1, 2, or ≥ 3 NCD risk factors was significantly associated with an increase in abdominal circumference (AC). Former smokers showed a higher prevalence of hypertensive blood pressure levels ($p < 0.05$), while obese women had a significant correlation with increased AC ($p < 0.05$). Findings also indicated that regular physical activity was associated with lower continuous medication use among overweight elderly women with NCDs.

CONCLUSION: The results reinforce the importance of weight control and smoking cessation in reducing cardiovascular risk among elderly women, particularly those engaged in physical activity. Furthermore, the significant association between abdominal circumference and cardiovascular risk factors underscores the need for early identification and intervention to prevent adverse health outcomes. The association between regular exercise and favorable clinical outcomes, such as reduced medication use and hospitalizations, highlights the protective role of physical activity in managing NCDs. These findings have implications for clinical practice and suggest the need for personalized prevention and rehabilitation strategies in this population.

**THE INFLUENCE OF TRAINING AND COMPETITION ON SLEEP BEHAVIOUR OF SOCCER REFEREES**

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INTRODUCTION: The aims of the present study were to (1) quantify the in-season sleep behaviours of soccer referees and (2) compare sleep behaviours between nights before training, before matches and after matches.

METHODS: Fourteen professional soccer referees (mean±SD; age 34±4 years; sex: 11 males, 3 females) participated in this observational study. Referees' sleep behaviours were examined using self-report sleep diaries and wrist activity monitors for 31 nights during the 2018-2019 A-league season. Separate linear mixed models were conducted to assess the differences in sleep behaviours between nights before training, before matches and after matches.

RESULTS: Referees did not obtain the recommended 7–9 hours of sleep on 70% of all nights before training, 45% of all nights before matches and 72% of all nights following matches. Referees went to bed later, spent less time in bed, and slept significantly less post-matches compared to pre-training and pre-match nights ($p<0.05$). No differences in sleep quality were apparent between nights as indicated by sleep efficiency, sleep onset latency, wake in sleep and movement fragmentation index.

CONCLUSION: The poor sleep behaviours of referees may negatively affect their physical and cognitive abilities, and thus performance during matches. The findings related to poor sleep behaviours highlight the importance of implementing monitoring systems to understand the sleep behaviours of referees, with further research encouraged to ascertain the efficacy of various sleep hygiene practices to optimise sleep in this population.

**THE RELATIONSHIP BETWEEN CHANGES IN VARIOUS PHYSICAL FITNESS LEVELS AND CHANGES IN THE SPORT COMPETENCE AMONG JUNIOR HIGH SCHOOL STUDENTS AS THEY ADVANCE TO THE NEXT GRADE**

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INTRODUCTION: The sport competence is confidence in exercise and the ability to participate in sports independently (Inoue et al., 2016; Obata et al., 2015). There are reports that a relationship exists between some types of physical fitness and sport competence in junior high school students. In this study, we examined whether changes in physical fitness and sport competence over time are related.

METHODS: All first and second grade students (111 students) at a certain junior high school were measured for rebound jump (RJ) index, vertical jump, and grip strength (left and right) at the same time over a two-year period. RJ index was obtained from the ground contact times and jump heights. At the same time, the Sport Competence Scale (Okazawa et al., 1996) was used to score three items: "perceived of physical competence," "feeling of control," and "peer and teacher acceptance," and these were then summed to calculate a "sport competence" score. The changes in the subjects various physical fitness and sport competence over the two-year period were classified into "improvement" and "unchanged/decline," and cross-tabulated, and a chi-square test was used to examine whether there were differences in the proportions of the subjects.

RESULTS: As a result, no significant differences were found in the proportions of any items for the RJ index and sport competence. For vertical jump and grip strength (right), significant differences were only observed in the subcategory "perceived of physical competence." Similarly, for grip strength (left), differences were observed in all items, including "sport competence," except for "peer and teacher acceptance."

CONCLUSION: These results suggest that changes in vertical jump and grip strength, which primarily reflect muscle strength, are associated with changes in some items of sport competence, but that the RJ index, whose value is influenced not only by muscle strength but also by complex physical functions such as the stretch-shortening cycle, is not

associated with sport competence. Therefore, it can be inferred that improving muscle strength may be necessary for junior high school students to feel an increase in their sense of sport competence after one year.

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**CAN LONG-TERM PARTICIPATION IN COMMUNITY-BASED EXERCISE MAINTAIN OR IMPROVE COGNITIVE SCORES IN OLDER WOMEN?**

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INTRODUCTION: The authors focused on the effectiveness of square stepping exercise (SSE) and fostered resident-led exercise salons for older adults practicing SSE. However, the longitudinal effect of long-term voluntary activities in exercise salons practicing SSE on cognitive function has not yet been examined. Therefore, in this study, we examined longitudinal changes in the cognitive function of older women living in the community who had continuously participated in an exercise salon for older adults practicing SSE for 3–5 years.

METHODS: This study included 228 older women living in the community who had continuously participated in an exercise salon for older adults for 3–5 years, where SSE was practiced once weekly. The Five Cognitive Functions test, a group cognitive test for older adults, was administered as a cognitive function test.

RESULTS: Both the young–old (aged ≥65 years; 83 participants) and old–old (aged ≥75 years; 145 participants) groups showed significant improvement in memory scores, verbal fluency scores, thinking scores, and overall scores after 3–5 years of salon participation. In addition, the rate of improvement in memory score and overall score was higher in the young–old group than in the old–old group. The high (41 participants) and low (36 participants) cognitive score groups at the start of salon participation also showed improvement in memory score, thinking score, and overall score. In addition, the low-score group had a higher rate of improvement in the attention segmentation function score, thinking score, and overall score.

CONCLUSION: SSE is an exercise program implemented in Japan to reduce the need for long-term care. Although the effect of SSE on cognitive function within a short period during salon development has been verified, the longitudinal effect of long-term voluntary activities in exercise salons practicing SSE on cognitive function has not yet been examined. Therefore, we examined longitudinal changes in the cognitive function of older women who had continuously participated in an exercise salon for older adults practicing SSE for 3–5 years. The results showed considerable improvement in memory scores, verbal fluency scores, thinking scores, and overall scores after 3–5 years of salon participation. Thus, older adults can prevent and improve age-related decline in cognitive function by voluntarily practicing SSE for 3–5 years.

**EFFECTS OF DIFFERENT TYPES OF EXERCISE INTERVENTIONS ON INSULIN RESISTANCE IN PATIENTS WITH TYPE2 DIABETES MELLITUS: A SYSTEMATIC REVIEW AND NETWORK META-ANALYSIS**

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INTRODUCTION: The objective of this meta-analysis is to evaluate and compare the effectiveness of different types of exercise interventions in improving insulin resistance (IR) in patients with type 2 diabetes mellitus (T2DM).

METHODS: A comprehensive systematic search was conducted across multiple databases, including PubMed, CINAHL, Embase, the Cochrane Library, Web of Science, SPORTDiscus, and Scopus. Randomized controlled trials (RCTs) evaluating the effects of exercise interventions on IR in T2DM patients were included. The search period extended from the inception of each database through October 15, 2024. The methodological quality of the trials was assessed using the Cochrane risk of bias tool. A network meta-analysis (NMA) was performed to compare the effects of various exercise modalities, including aerobic exercise (AE), resistance training (RT), combined exercise (CE), mind-body exercise (MBE), and high-intensity interval training (HIIT).

RESULTS: The analysis included 19 randomized controlled trials (RCTs), involving a total of 1,327 subjects. The NMA revealed that HIIT, CE and AE led to significant improvements in IR. Specifically, HIIT demonstrated the most pronounced improvement in the homeostasis model assessment of insulin resistance (HOMA-IR) with a SUCRA of 92.3%, followed by CE (70.4%) and AE (60%) among patients with T2DM.

CONCLUSION: The results of this study indicate that HIIT is the most effective intervention for improving IR in patients with T2DM. CE and AE also demonstrated significant efficacy, while RT and MBE showed no significant effects. However, further research is needed to validate these findings as more high-quality studies emerge.

**THE ASSOCIATION BETWEEN PHYSICAL ACTIVITY, SOCIAL JET LAG AND PREMENSTRUAL SYMPTOMS IN FEMALE ADULTS**

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INTRODUCTION: Physical activity (PA) reduces sleep complaints and Premenstrual symptoms (PMS)-related discomfort while enhancing mood and sleep quality [1,2]. Social jet lag (SJL), or weekday-weekend sleep discrepancies, can cause fatigue [3]. This study examines the relationship between PA, SJL, and PMS in females, exploring how PA and SJL contribute to PMS to provide insights into improving female health.

METHODS: A total of 344 females aged 20–45 were included, excluding those with severe sleep disorders, drug use, smoking, or pregnancy. PA (MET-min/week), including intensity levels (vigorous, moderate, and walking), was assessed via International Physical Activity Questionnaire (IPAQ). SJL was measured using Munich ChronoType Questionnaire (MCTQ), which tracks primary sleep times, wake times, and discrepancies between work and free days. PMS was evaluated with Daily Record of Severity of Problems (DRSP), a validated tool assessing a wide range of physical, emotional, and behavioral symptoms. Pearson's correlation was used to examine the relationships among PA, SJL, and DRSP, with data analysis conducted in Excel. The statistical significance level was set at $\alpha = 0.05$.

RESULTS: Participants (mean age 37 ± 6 years) had an average total PA of 714 ± 1761 MET-min/week, including vigorous (8 METs), moderate (4 METs), and walking (3.3 METs). PA levels varied widely among individuals, with some engaging in high-intensity exercise while others reported lower levels of daily movement. The mean SJL, defined as the difference in mid-sleep time between workdays and free days, was 3 ± 7 hours, indicating substantial variability in sleep patterns across participants. PMS severity, measured using DRSP scores, had an average score of 20 ± 9 out of a possible 48, reflecting a range of mild to severe symptoms reported by participants. No significant associations were observed between SJL and PA ($r = -0.016$, $p = 0.763$), PA and DRSP ($r = -0.035$, $p = 0.515$), or SJL and DRSP ($r = 0.043$, $p = 0.430$).

CONCLUSION: This study did not find statistically significant associations between PA, SJL, and PMS severity. Although the results did not indicate clear relationships, maintaining regular sleep patterns and engaging in PA remain important for overall well-being. The variability in sleep behaviors, PA patterns, or the subjective nature of PMS symptoms may have influenced the findings. Future studies with larger sample sizes or different methodologies may help clarify these potential links.

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**EFFECTS OF HOME-BASED PROGRESSIVE ELASTIC BAND RESISTANCE EXERCISE ON PHYSICAL FITNESS FOR INDIVIDUALS WITH CHRONIC KIDNEY DISEASE**

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INTRODUCTION: Patients with chronic kidney disease (CKD) are often in a state of catabolism, oxidative stress, and protein loss for a long time, leading to reduced muscle synthesis, uremic toxin accumulation, and impaired physical function and activity levels, which may increase the risk of mortality [1]. Progressive resistance exercise training has been shown to improve cardiorespiratory function, quality of life, and physical performance. The study aimed to investigate the effects of progressive resistance exercise home-based intervention in patients with late-stage CKD.

METHODS: Thirty-seven patients with CKD stages IIIb to V were randomized to the intervention and control groups. The intervention group(IG) received 12 weeks of home-based progressive resistance exercise using elastic bands, with resistance adjustments made during the follow-up visit in the fourth and eighth weeks. The control group(CG) maintained regular nursing care and nutritional education. Data on demographics, physical fitness (body composition, muscle strength, functional performance), nutritional assessment, and physiological indicators were collected pre-and post-intervention. Statistical analyses of within-group and between-groups were conducted based on data normality. A statistical level of $p < 0.05$ was accepted.

RESULTS: 37 participants completed the study (IG: n=20; CG: n=17) with similar baseline characteristics. At baseline, approximately 50% of participants in both groups were classified as stage IIIB (IG: 55%; CG: 47%). Both groups classified the primary intensity level of activity as mild or lower. The three most prevalent chronic conditions observed in both groups were diabetes, hypertension, and urinary system diseases. The sit-to-stand 30-second test (STS) and the six-minute walk test (6WMT) exhibited significant differences within the intervention group (STS pre/post: 14.1 ± 7.2 / 16.6 ± 7.4 times; 6WMT pre/post: 372.3 ± 107.0 / 438.9 ± 77.5 m), while the control group showed no change. The intervention group experienced a noteworthy decline in serum total triglycerides after home-based exercise (median (IQR): pre/post: 207.0 (106.0~275.2) / 160.5 (102.2~164.4) mg/dL), whereas the control group exhibited an increase (pre/post: 177.8 (84.0~235.8) / 318.1 (94.4~256.0) mg/dL). The two groups had no significant differences in blood glucose, glycated hemoglobin, renal indicators, or body composition.

CONCLUSION: CKD patients undertaking home-based progressive resistance exercises help improve body weight and triglycerides while maintaining or enhancing physical performance, such as the speed of sitting to standing. This home-based exercise method is low-cost, easy to carry, and space-efficient, making it a feasible option for CKD patients to initiate exercise in home situations.

**THE EFFECT OF RESPIRATORY MUSCLE ENDURANCE TRAINING ON EXERCISE TOLERANCE IN PATIENTS WITH SPINAL CORD OR BRAIN INJURY: A PILOT STUDY**

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INTRODUCTION: The aim of this pilot study was to investigate the effects of respiratory muscle endurance training (RMET) using SpiroTiger® on stabilized spinal cord or brain-injured patients. The hypotheses were that RMET would improve exercise tolerance, lung function, and quality of life in these patients when used as an adjunct to a standard physiotherapy program.

METHODS: Four adult male patients with spinal cord or brain injuries were recruited for this pilot study. In addition to their regular physiotherapy sessions, participants performed twelve RMET sessions over a period of 3 to 5 weeks. These additional training sessions were administered by a kinesiologist using the SpiroTiger® equipment.

A time-to-exhaustion (TTE) test on the arm cycle ergometer was performed before and after the RMET. During this test, heart rate (HR) was measured with an HR monitor, and dyspnea and arm effort were rated using specific instructions and the category-ratio 10 rating of perceived exertion (RPE) scales. These responses during the TTE test were analyzed using the Group Isotime method described by Nicolò et al. (2019) and correspond to the values recorded at the third minute.

Additionally, health-related quality of life (SF-36) and respiratory function (spirometry) were assessed before and after RMET. Due to the small sample size, data are presented as median (range), and pre-test to post-test differences were tested using a one-tailed Wilcoxon test for paired samples. Given the pilot nature of this study and its small sample size, trends were considered significant at $p < 0.10$.

RESULTS: All four patients completed the study. There was a trend ($p = 0.063$) toward a significant improvement in TTE, which increased from 363 (395) to 580 (820) seconds. This improvement in TTE was accompanied by reductions in HR [pre-test 135 (28) post-test 127 (11) beats/min, $p = 0.063$], RPE-Dyspnea [pre-test 6 (2) post test 4.5 (4) a.u., $p = 0.087$], and RPE-Arm Effort [pre-test 7 (1) post-test 4.5 (6) a.u. post-test, $p = 0.091$]. Additionally, there was a trend for a significant increase in forced vital capacity [pre-test 4.41 (0.710) post-test 4.5 (0.9) liters, $p = 0.091$]. No significant trends were observed for SF-36 scales or other spirometric variables.

CONCLUSION: This brief RMET program was well tolerated by this small group of patients. The improvements in exercise tolerance, as observed using both objective (HR, TTE) and subjective (RPE-Dyspnea and RPE-Arm Effort) metrics, suggest that this type of respiratory training may be a beneficial adjunct to standard physiotherapy in patients with stabilized spinal cord or brain injury. Future randomized controlled studies with a larger group of patients are required to confirm the findings of this pilot study.

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**EFFECTS OF HIGH-INTENSITY FUNCTIONAL TRAINING ON BODY COMPOSITION AND GREATER RESPONSIVENESS IN REDUCING DIASTOLIC BLOOD PRESSURE AND RESTING HEART RATE IN SEDENTARY BOYS**

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INTRODUCTION: Anthropometric indicators, body composition (BC), cardiorespiratory fitness (CRF), and blood pressure (BP) are clinical and non-invasive health parameters in the pediatric population. These parameters are used to diagnose children and adolescents at cardiometabolic risk and to monitor therapeutic responses, especially early changes in BP in boys. The aim of this study was to analyze the effects and responsiveness of BC, CRF, and BP in sedentary boys after 12 weeks of high-intensity functional training (HIFT).

METHODS: 26 boys participated in the study, aged 12 to 16 years, distributed into the HIFT group (n=13) and the control group (CG, n=13). Body mass (BM), height, waist circumference (WC), waist-to-height ratio (WHtR), fat mass (FM), fat-free mass (FFM), muscle-to-fat ratio (MFR), maximal oxygen uptake relative (VO2ml/kg/min), absolute (VO2l/min), and resting heart rate (HRrest) were assessed. The HIFT was performed without equipment, using body weight as an overload, for approximately 35 minutes per session, three times per week, for 12 weeks of intervention. The CG participants maintained their usual physical activity during the study period. ANOVA was used for comparisons at baseline and at 12 weeks ($p<0.05$), and the effect size (ES) was calculated to compare the magnitude of the effect of the intervention and the prevalence of responders.

RESULTS: No significant differences were found between the groups at baseline, except for higher FFM in the CG (p=0.006). After 12 weeks, the HIFT showed a trivial reduction in FM (p=0.033, ES=-0.16) and possibly beneficial reductions in %FM (p=0.011, ES=-0.24), DBP (p=0.367, ES=-0.31), and HRrest (p=0.405, ES=-0.34). In addition to trivial increases in height (p=0.022, ES=0.05), FFM (p=0.001, ES=0.16) and possibly beneficial increases in MFR (p=0.002, ES=0.23) and VO2peak

relative (p=0.313, ES=0.21) were observed. The CG increased only in height (p=0.005, ES=0.05) and MFR (p=0.023, ES=0.21). The prevalence of responders indicated that adolescents participating in HIFT were more responsive in reducing DBP (responders=69.2 vs. 30.8%, β=0.385, p=0.034) and HRrest (responders=61.5 vs. 23.1%, β=0.385, p=0.031) than those in the CG.

CONCLUSION: Regular physical activity provided health benefits in sedentary boys, but HIFT did not result in a significant increase in CRF, probably due to the type of muscle overload. We conclude that adolescents who participated in the HIFT presented a significant improvement in body composition and greater responsiveness in reducing diastolic blood pressure. It should be noted that both health problems have increased in adolescents and can be controlled by changes in daily life such as regular physical exercise.

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**THE EFFECTS OF RESISTANCE TRAINING ON METABOLIC PARAMETERS, MUSCLE STRENGTH, AND PHYSICAL FUNCTION AMONG INDIVIDUALS WITH TYPE-2 DIABETES MELLITUS**

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INTRODUCTION: Type-2 diabetes mellitus (T2DM) is a global epidemic that is on the rise due to lifestyle changes. Resistance training has the potential to improve health outcomes for individuals with T2DM. There are a limited number of studies that have been done on individuals with T2DM in developing countries, like South Africa, to evaluate the effects of resistance training among individuals with T2DM. The study aimed to determine the effect of a 12-week resistance training programme on metabolic parameters, muscle strength, and physical function among individuals with T2DM.

METHODS: A total of forty-five (n=45) untrained participants with T2DM aged 67.09 (SD ±10.58) participated in the study. Participants were randomly assigned to either the control group (n=23) or the experimental group (n=22). The experimental group participated in a 12-week resistance training and nutrition education programme, whilst the control group participated in a nutrition education programme. Pre- and post-measurements included glycosylated haemoglobin (HbA1c); fasting blood glucose; lipid profile; muscle strength measured using 1 RM on the pressure air biofeedback (PAB®); and physical function measured using the timed up-and-go test (TUG).

RESULTS: The intervention group demonstrated a significant decrease in HbA1c (8.58%-7.84%; p<0.01) mmol/L, fasting glucose 8.83 (SD±4.07) mmol/L to 7.84 (SD±3.22); p<0.05) mmol/L and triglycerides (333.50 mg/L to 258.64 mg/L; p<0.05) levels post-intervention compared to the control group. Both upper and lower body grip strength increased from 35.11 (SD±4.75) kg pre-intervention to 42.88 (SD±174.95) kg post-intervention. The TUG test was significantly (13.56s-12.55s; p<0.05) reduced by 5% in the intervention group.

CONCLUSION: This studys findings indicated that a twelve-week resistance training programme effectively reduced metabolic parameters such as blood glucose levels, HbA1c, triglycerides, and total cholesterol in the experimental group, when compared to the control group. Additionally, it improved muscle strength and physical function in individuals with T2DM. Resistance training consistently yields significant improvements in functional tasks and enhances health-related quality of life. Integrating a structured nutrition education programme with resistance training can greatly improve the management of T2DM.

**EFFECTS OF A 36-WEEK CIRCUIT AND BODYWEIGHT TRAINING PROGRAM ON BODY COMPOSITION IN OLDER ADULTS: A PRE- AND POST-TEST ANALYSIS**

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INTRODUCTION: According to existing literature, exercise training has a significant impact on increasing muscle mass, reducing body fat, and managing body weight. This study is based on the 111-year Silver Fitness Club body composition data to explore the effects of 36-week circuit and bodyweight training on body weight, body fat, and skeletal muscle mass, and to evaluate the impact of different training phases on individual physical fitness.

METHODS: Study Design : This study is a pre- and post-test comparison. Participants underwent a 36-week exercise program, with body weight, body fat, and skeletal muscle mass data collected before, during, and after training for analysis.

Participants : Participants were recruited from the local Silver Fitness Club, age from 65 to 82 , excluding those with severe cardiovascular diseases or musculoskeletal disorders.

Training Program: Weeks 1-18: Circuit training using six machines, performed three times per week, each session lasting 40-60 minutes, including chest press, leg press, and rowing machine exercises.

Weeks 19-36: Bodyweight training (TRX, kettlebell, resistance bands), performed three times per week, each session lasting 40-60 minutes, with gradually increasing intensity.

Data Collection: Body weight (kg): Measured using an electronic scale.

Body fat (%): Measured using bioelectrical impedance analysis (BIA).

Skeletal muscle mass (kg): Measured through BIA.

Data Analysis :

Paired sample t-tests were used to analyze pre- and post-training differences.

ANOVA was used to assess trends across different training phases.

RESULTS: Body Weight Changes: Average weight decreased by 0.39% (range: -2.3% to +1.1%), indicating that exercise training contributes to weight management.

Body Fat Changes: Average body fat percentage decreased by 4.52% (range: -13.0% to 0%), demonstrating the effectiveness of training in fat reduction.

Skeletal Muscle Mass Changes: Average skeletal muscle mass increased by 2.68% (range: 0% to 5.55%), confirming the positive impact of training on muscle growth.

CONCLUSION: The results of this study show that the 36-week circuit and bodyweight training significantly influenced weight management, fat reduction, and skeletal muscle growth. The bodyweight training phase, in particular, exhibited greater muscle growth, suggesting that such training effectively stimulates muscle development. Furthermore, the findings support the integration of circuit and bodyweight training as an effective strategy for improving physical fitness and overall health.

CONCLUSION: A well-structured exercise training program can effectively promote weight management, reduce body fat, and increase skeletal muscle mass. This study recommends incorporating both machine-based circuit training and bodyweight training in exercise prescriptions to achieve optimal training

**WALKING FOOTBALL FOR PERSONS WITH DEMENTIA: TEAMING UP FOR HEALTH AND WELLBEING AMONG PLAYERS AND VOLUNTEER COACHES.**

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INTRODUCTION: The public health issues of loneliness and mental health challenges can, according to the ABC-model, be met with volunteering in social, cultural and/or physical activities (Santini et al., 2018). Together with another public health issue, i.e., the decline in physical activity, health and wellbeing and need for health services in persons with dementia, this pilot study aimed to explore how walking football for persons with dementia can counteract both these public health issues.

METHODS: A total of four persons with mild to moderate dementia wore triaxial accelerometers for eight walking football sessions over a period of eight weeks, the same sessions were observed using structured and unstructured observations. Each player had one or two volunteer coaches closely following them and their moves on every session. Focus group interviews were conducted with 10 volunteer coaches. We framed the analyses in the Self-Determination Theory (Ryan & Deci, 2017) with special emphasis on the satisfaction of the basic psychological needs of autonomy, competence and relatedness.

RESULTS: The 60-minute walking football sessions were organized using sport specific training principles to promote motor learning, particularly balance and coordination, with progression of types and complexities of exercises. Each session was characterized by bodily movements, and with little or no sedentary time among the players. Observations suggested improved physical and social competence among the players, and improved competence among the volunteer coaches on how to interact with persons with dementia. Observations together with interviews of the volunteer coaches gave impressions of mutual enjoyment and social connectedness. The volunteer coaches reported an experience of volunteering in walking football for persons with dementia as very meaningful, social and enjoyable.

CONCLUSION: Walking football for persons with dementia is a promising activity that is suitable for improving health and wellbeing among both players and volunteer coaches. A satisfaction of especially the basic psychological needs of relatedness and competence was identified. For volunteer coaches with little or no knowledge about dementia, this can also serve as a way to increase understanding and knowledge about the illness, and thus reduce stigma and barriers for interacting with persons with dementia.

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**ACTIVE PREGNANCY - PROMOTING AN ACTIVE AND HEALTHY LIFESTYLE DURING PREGNANCY TO IMPACT MATERNAL HEALTH AND FITNESS. EXERCISE TRIAL PROTOCOL**

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INTRODUCTION: Maintaining light to moderate physical activity (PA) and a healthy lifestyle during pregnancy has several benefits for the health of the woman and the fetus. Physical fitness is considered a powerful marker of health since it is associated with a lower risk of cardiovascular events, cancer, and all-cause mortality in all ages. A few studies with pregnant women highlighted the potential impact of higher physical fitness levels on better maternal and fetal health.

It is pertinent to implement comprehensive prenatal exercise programs and to contribute to evidence-based knowledge about their impact on PA, fitness, functionality, and health parameters (weight gain, common pregnancy complaints and diseases, quality of life, pregnancy outcomes, new-born health, and postpartum recovery), regardless of maternal age, healthy lifestyle compliance, and context of intervention.

This communication will describe the exercise trial protocol regarding the primary objectives of the Active Pregnancy project (1), which aims to implement an exercise-based multi-center control trial and assess its effects on women's PA, fitness, and health parameters depending on the context of intervention (virtual vs presential); PA and healthy lifestyle compliance with guidelines; and maternal age (< or >35 years).

METHODS: The ACTIVE PREGNANCY exercise trial protocol follows the SPIRIT guidelines (2). The exercise program, supervised by qualified exercise professionals, was previously developed and tested (3) in collaboration with multidisciplinary researchers. Ethical approval was obtained. Pilots were conducted in 2023/2024. Functional field tests and questionnaires will be the main tools to collect baseline and post-intervention variables. We expect to reach more than 300 pregnant women by the end of the project.

RESULTS: The main expected results are the development and implementation of effective exercise programs and strategies aimed at improving maternal health and fitness parameters, updating evidence-based educational resources, raising individual awareness, and empowering women to participate in the management of their health and their babies' health; and boosting research and knowledge in this field.

CONCLUSION: Considering the increasing risk of non-communicable diseases resulting from a sedentary lifestyle and low levels of PA during pregnancy in many countries, conducting multidisciplinary and multifaceted experimental studies in this area is necessary. New data can support evidence-based recommendations and strategies to promote physical activity during pregnancy and enhance the health of the mothers and their children.

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2. https://spirit-statement.org/

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**THE RELATION OF BODY MASS INDEX WITH PERIOSTIN AND RESPIRATORY PARAMETERS IN COLLEGIATE FOOTBALL ATHLETES**

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INTRODUCTION: Athletes have the right physical characteristics for performance, with training appropriate to their athletic characteristics and position. Some competitive sports have heavyweight positions and is overweight athletes. Although overweight in athletes is different from obesity resulting from general inactivity, it has been reported to have health risks such as sleep apnea and cardiovascular disease. On the other hand, while it is known that many athletes have respiratory diseases, there are few studies on the effects of being overweight on respiratory parameters.

Recently, periostin, a matricellular protein, is a known biomarker for type 2 and has been reported to be inversely correlated with BMI in asthma. It has also been reported that respiratory function is low to obesity, but it is not clear whether the same trend is observed in overweight athletes.

Objective: To determine whether periostin and respiratory parameters differ by BMI category in college football athletes.

METHODS: A total of thirty-seven collegiate football athletes participated in this study (age 20.8 ± 1.9). All participants were non-smokers and were not taking medications. Participants were categorized into three groups based on body mass index (BMI): BMI < 25 (normal weight, NW, n=11), 25 ≤ BMI < 29.9 (overweight, OW,n=17), and BMI ≥ 30 (obesity, OB, n=9).

Participants' body weights were measured by health meters (UC411PBT-C, A&D, Japan). The respiratory function was used the HI-801 spirometry (Chest, Japan), and respiratory impedance was performed using the FOT using the Most Graph-01 (Chest M.I., Tokyo, Japan). The parameters used were resistance at 5 Hz (R5), resistance at 20 Hz (R20), reactance at 5 Hz (X5), and resonant frequency (Fres), where the reactance crossed zero and the elastic and inertial forces were equal in magnitude and opposite in direction. Blood samples were collected on the same day. The periostin levels were measured using an ELISA kit from Shino Test Co., Ltd. (Tokyo, Japan). Two samples were below the detection threshold and were excluded from further analysis.All data were expressed as mean ± SD.

RESULTS: The BMI of NW, OW, and OB were 23.1 ± 1.4, 26.7 ± 1.3 and 33.1 ± 2.6. BMI was significantly negatively correlated with periostin ($p<0.05$) and X5 ($p<0.05$), positively correlated with R5 ($p<0.01$) and R5-R20 ($p<0.01$). Periostin was significantly higher in the NW (37.6 ± 6.9 ng/ml) than in the OB (32.0 ± 4.6 ng/ml) but not in the OW (33.9 ± 3.3 ng/ml). R5 was significantly higher in the OB (3.0 ± 1.0 $cmH_2O/L/s$) than in the NW (1.8 ± 0.4 $cmH_2O/L/s$) but not in the OW(2.3 ± 0.6 $cmH_2O/L/s$).R5-R20 was higher in the OW and OB (0.0 ± 0.3, and 0.3 ± 0.2 ($cmH_2O/L/s$)) than in the NW(-0.4 ± 0.4 $cmH_2O/L/s$). Fres was significantly higher in the OB(7.7 ± 2.6 Hz) than NW (5.1 ± 1.1 Hz). Respiratory function was not significant between groups.

CONCLUSION: BMI is associated with decreased periostin and increased respiratory impedance in collegiate football athletes.

**CHANGES IN PLASMA AMINO ACID PROFILE FOLLOWED BY 3-MONTHS COGNITIVE TRAINING**

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INTRODUCTION: Age-related cognitive decline, which triggers dementia, has become one of the major health problems. The number of dementia patients in Japan is estimated to reach 5.23 million by 2030, and if the number of patients with mild cognitive impairment is added, the number of dementia patients may exceed 11 million. To maintain the quality of life of the elderly and control medical costs, early detection of dementia, as well as primary prevention, will be important issues. AminoIndex®, which can assess the risk of various diseases based on plasma amino acid profiles from a single blood sample, is considered to be an effective test in terms of early detection. As for primary prevention of dementia, cognitive training, which improves cognitive functions such as thinking, attention and judgement, has been reported to be useful. Square stepping exercise (SSE) and CogEvo, are known as such trainings and have been reported to improve cognitive function. The aim of this study was to investigate changes in plasma amino acid profiles followed by a 3-months cognitive training comprising SSE and CogEvo.

METHODS: Sixteen community-dwelling elderly Japanese females (70.8±1.0 yrs) participated in cognitive training after providing written informed consent. The training took place twice a week for a total of 24 sessions over a period of 3 months. Each session consisted of CogEvo and SSE, which was implemented for about 15 and 45 minutes respectively. For CogEvo, five basic tasks were performed each time using touch panel monitor screens. For SSE, 5 to 12 step patterns were performed per day, starting at the beginner level and gradually increasing in difficulty throughout the 3 months. Before and after the 3-month training sessions, venous blood samples were collected from the participants and the plasma free amino acid (PFAA) levels were assessed. The risk of cognitive decline in AminoIndex® was calculated using the plasma free amino acid levels. Body composition and physical function (Functional Reach test and Timed Up & Go test) were also measured before and after training. Paired t-tests were applied for comparison between pre- and post-training measurements and a 5% threshold for significance was set.

RESULTS: Three months of training significantly improved cognitive function as assessed by CogEvo ($p<0.01$). In contrast, body composition and physical function remained unchanged. In addition, there was a decreasing trend in the risk of cognitive decline as assessed by the AminoIndex® ($p<0.1$), with a significant difference when low-risk individuals in AminoIndex® (5 subjects) before the training were excluded ($p<0.05$).

CONCLUSION: Twice-weekly, 3-month cognitive training combining CogEvo and SSE may improve cognitive function in community-dwelling elderly females, and may reduce the risk of subjects at high risk of cognitive decline. On the other hand, to improve body composition and physical function, it may be necessary to perform additional activities.

**EFFECTS OF MOLECULAR HYDROGEN SUPPLEMENTATION ON GLYCOLIPID METABOLIC DISEASES: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Glycolipid metabolic disease (GMD) is a complex chronic metabolic disease with a rapidly growing number of patients due to obesity and sedentary lifestyles, and it has become one of the major chronic diseases causing public and clinical problems worldwide. Studies indicate that molecular hydrogen (H2), with antioxidant and anti-inflammatory properties, may be a promising strategy to alleviate GMD and decline cardiovascular risks. This study aimed to systematically review and meta-analyze the impact of H2 supplementation on GMD.

METHODS: This study systematically evaluated the impact of H2 intake on glycolipid metabolic diseases, following PRISMA guidelines and registered with PROSPERO (CRD42023476671).

RESULTS: Eleven publications (11 studies) consisting of 425 participants were included. The pooled effect sizes of H2 on TC (SMDpooled = −0.23, 95%CI −0.42 to 0.04, p = 0.02, I 2 = 0%, p = 0.81) and TG (SMDpooled = −0.40, 95% CI −0.64 to 0.15, p = 0.001, I 2 = 0%, p = 0.52) were significant with low heterogeneity. The pooled effect sizes of H2 on HDL (SMDpooled = 0.05, 95% CI −0.18 to 0.28, p = 0.67, I 2= 32%, p = 0.15) and CRP (SMDpooled = -0.10, 95% CI −0.41 to 0.21, p = 0.54, I 2 = 0%, p =0.67) were not significant and trivial without heterogeneity. Subgroup analysis revealed that the e ffects of H2 on Glycolipid metabolic were impacted significantly by the intervention time of H2 implementation, and intervention types (i.e., water or gas).

CONCLUSION: This review suggests hydrogen supplementation may improve total cholesterol (TC) and triglyceride (TG) levels in glycometabolic disorder (GMD) patients, with no effect on blood glucose, hormones, enzymes, or inflammation. The duration and method of hydrogen intake may influence its effects, requiring further study.

Hydrogens molecular mechanisms are complex, primarily involving anti-oxidative, anti-inflammatory, and cytoprotective properties. The study found a significant reduction in TC, but no significant change in LDL levels, possibly due to targeting modified LDL or measurement limitations. Hydrogen inhalation might enhance LDL therapeutic effects, needing more research. Hydrogen may also improve HDL function without changing its levels, suggesting effects on composition and enzymatic activities.

Longer hydrogen treatment durations (over six weeks) may yield better glucose-lowering results, aligning with previous studies, but more data is needed. The liver, crucial for sugar and lipid metabolism, accumulates hydrogen well, especially after ingestion, significant for conditions like nonalcoholic fatty liver disease (NAFLD). Hydrogen intervention in NAFLD reduces liver fat and inflammation, potentially by alleviating oxidative stress.

Hydrogen supplementation significantly reduces certain cardiovascular risk factors (TC, TG) in GMD patients but does not affect body weight or other factors. More rigorous studies are needed to confirm these findings and optimize hydrogen's therapeutic potential.

**THE EFFECT OF 12 WEEKS OF CONCURRENT TRAINING ON BLOOD SAMPLES AND FUNCTIONAL FITNESS PERFORMANCE IN SUB-HEALTHY OLDER ADULTS**

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INTRODUCTION: Evidence suggests moderate-intensity aerobic exercise training improves CVD risk factors, and resistance training improves skeletal muscular fitness. However, whether health benefits can be achieved through other exercise modalities, such as concurrent training, is unclear. This study explores which modality of 12 weeks of aerobic and resistance concurrent training has the best health benefits for older adults.

METHODS: Forty-four sub-healthy older adults (age 65 years) were randomized to perform resistance before high-intensity aerobic interval training (RE+AE), AE before RE, or a walking group. Subjects show at least one symptom of metabolic syndrome, such as hyperlipidemia, hyperglycemia, hypertension, or others. The training program of AE consisted of jogging in place, burpees, rope skipping, mountain climbers, air squats, jumping lunges, push-ups, and squat jumps. The program of RE consisted of a loading barbell or two dumbbells with a back squat, single-step squat, bench press, standing rowing, deadlift, and shoulder press. Body composition, functional fitness tests, and blood measurements were taken before and after 12 weeks of training.

RESULTS: There were significant improvements from pre-training to post-training in the 8-foot up-and-go test (AE+RE: 20%; RE+AE: 19%; Walk: 15%), arm curl test (16%, 16%, 10%), and 6-minute walk test (19%, 20%, 7%) ($p < .05$). Comparing the changes between the experimental groups, body fat percentage were significantly lower in the AE+RE (-8.8%) and RE+AE (-5.7%) than Walk, muscle mass was significantly higher in the AE+RE (+5.3%) and RE+AE (5.6%) than Walk ($p < .05$). High-density lipoprotein (HDL) increased dramatically in three groups (AE+RE: 8%; RE+AE: 7%; Walk: 9%) when compared with pre-training ($p < .05$), but only the blood glucose (-5.6%), HbA1c (-1.7%), and total cholesterol (-8.8%) levels were significantly decreased after training in the AE+RE group.

CONCLUSION: Twelve weeks of aerobic exercise followed by resistance training, resistance training followed by aerobic exercise, or walking exercises lead to specific improvements in functional fitness performance for older adults. However, choosing aerobic exercise before resistance training in concurrent training yields more significant benefits for body fat, muscle mass, functional physical performance, and blood metabolism improvement.

**SLEEP DURATION DOES NOT AFFECT PULSE WAVE VELOCITY IN NOVICE-RESISTANCE-TRAINED YOUNG ADULTS: A PILOT STUDY**

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INTRODUCTION: Short sleep duration (≤6 hours) is a risk factor for cardiovascular disease (CVD) and mortality (1). Arterial stiffness (AS) is an endothelial function marker considered to be a risk factor of CVD (2). It is unclear if short sleep duration affects AS in young, physically active individuals. The purpose of this pilot study was to compare sleep duration and AS in novice-resistance-trained (RT) young adults.

METHODS: Thirteen participants (3 men, 10 females; 19.5±1.1 y.o.; height 167.9±8.5 cm; weight 65±15.6kg) were included in the study. Sleep duration was monitored using Actigraph (model wGT3X-BT) for 24 hours over 7 days. AS was assessed using the SphygmoCor XCEL device, that measured the pulse wave velocity (PWV) and augmentation index (AIx). Participants who slept less than six hours per day were defined as short sleepers, and those who slept more than seven hours per day were defined as long sleepers. An independent samples t-test was performed to compare PWV and AIx among both groups. All data was analyzed using MS Excel and Jamovi (version 2.3.28).

RESULTS: No significant difference was found in PWV between short sleepers (5.22±0.76m/s, CI [4.68, 6.44]) and long sleepers (5.2±0.76m/s, CI: [4.59, 5.86]); $p = 0.45$). Also, there was no significant difference in AIx between short sleepers (6.20±3.70, CI: [1.60, 10.80]) and long sleepers (5.88±4.58, CI: [2.05, 9.70]; $p = 0.9$).

CONCLUSION: Sleep duration does not affect AS among novice RT young adults. Contrarily, previous research in older population has shown that sleeping less than 6 hours per night was associated with increased AS (1,2). However, since our population was young adults and the sleep data was collected within seven consecutive days, the quantity of sleep may not influence AS measures of PWV and AIx. Further investigation should examine larger sample sizes of young, physically active adults.

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**AGE-RELATED DIFFERENCES IN BONE STRAIN MAGNITUDE AND RATE UNDER MECHANICAL LOADING IN RATS**

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INTRODUCTION: Mechanical stress regulates bone metabolism, with both strain magnitude and strain rate serving as key modulators of mechanotransduction. Age-related changes in bone microstructure and mineralization can alter how bone responds to mechanical loading, potentially modifying strain magnitude and strain rate. Thus, elucidating how aging influences in vivo bone strain magnitude and strain rate under mechanical loading is essential for understanding age-related changes in bone adaptation. We measured in vivo bone strain magnitude and strain rate under mechanical loading and investigated the effects of aging on these parameters.

METHODS: Male Fischer 344 rats were assigned to young or middle-aged groups. In vivo bone strain was measured by attaching thin-film strain gauges to the medial surface of the tibia under anesthesia. Loads were applied to the bone using a mechanical testing device or a vertical vibration device at various magnitudes (2.5-30N, 6-590με) and rates. Time-series data of load (N) and strain (με) were analyzed to determine peak load magnitude (N), load rate (N/s), peak strain magnitude (με), and strain rate (με/s).

RESULTS: Both young and middle-aged rats exhibited a positive correlation between load and bone strain magnitude. However, middle-aged rats showed reduced bone strain magnitude responsiveness to load compared to young rats. Bone strain magnitude and strain rate also showed a positive correlation in both groups. Middle-aged rats showed a greater strain rate per unit of strain magnitude compared to young rats.

CONCLUSION: These data demonstrated age-related differences in bone strain magnitude and strain rate. Age-related structural changes, coupled with promoted bone mineralization, may have influenced the mechanical properties of bone, resulting in alterations in strain magnitude and strain rate. Given the critical role of strain magnitude and strain rate in bone formation, consideration of age-related changes in these parameters may be essential for optimizing exercise interventions aimed at maintaining bone health across different age groups.

**COMPLIANCE WITH THE 24-H MOVEMENT GUIDELINES AND THE RELATIONSHIP WITH BODY MASS INDEX IN JAPANESE TODDLERS**

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INTRODUCTION: Although recent 24-h movement guidelines for toddlers established recommendations for physical activity (PA), screen time (ST) and sleep [1,2], little evidence is available regarding the compliance with meeting the guidelines and their associations with body mass index (BMI) in Japanese toddlers. Thus, we aimed to investigate compliance with the 24-h movement guidelines for toddlers and associations between compliance and BMI in Japanese toddlers.

METHODS: Five pre-schools were selected. All toddlers (42 boys and 42 girls) aged 3-4 years attending these pre-schools were participated in this study. Pre-school teachers reported participants' PA, ST and sleep at pre-schools. Parents reported participants' PA, ST and sleep when participants were not at pre-schools. Parents also reported their own PA, ST and sleep and the height and weight of themselves and participants. Participants were classified as meeting the guidelines if they averaged ≥180 min/day of PA, which consisted of ≥60 min of moderate-to-vigorous intensity; ≤60 min/day of ST; and 10–13 h/day of sleep. The compliance with meeting the 24-h movement guidelines was calculated for each behaviour separately and in combinations. Unpaired t-test was performed to test differences in BMI z-scores between participants complying with (i) none or any individual guideline, (ii) any combination of meeting two guidelines, and (iii) those who met all three guidelines. The correlation coefficient between the BMI z-score of the parents and the participants was calculated using the Pearsons product-moment correlation test. The chi-square test was performed to compare the frequency of the PA guideline compliance between parents and participants in weekend days.

RESULTS: Only 14.1% of the sample met the overall 24 h movement guidelines. The compliance ratio was higher in ST (63.3%) and sleep (71.4%) guidelines than in PA (35.7%). The compliance ratio for PA on weekend days (44.0%) was lower than on weekdays (73.8%). There was a compliance difference for the PA guideline between parents and participants in weekend days ($p = 0.002$). Odds ratio for meeting PA guideline in participants was 4.56 when the parents met with the PA guidelines. Mean BMI z-scores did not significantly differ between participants who complied with none or any individual guideline, any combination of meeting two guidelines, and those who met all three guidelines ($p > 0.05$). A significant correlation for BMI z-score was found between parents and participants ($r=0.398$, $p<0.001$).

CONCLUSION: The present study demonstrated the low ratio of toddlers who met all the guidelines and no association between BMI and compliance with the 24-h movement guidelines. These results are consistent with previous studies [1,2]. However, the compliance with the PA guideline, especially on weekend days, was low in the present study. Even on holidays, interventions that improve parent-child PA are important.

1: Leppänen et al. (2019); 2: Santos et al. (2017)

**AN ASSOCIATION BETWEEN POSSIBLE SARCOPENIA AS PREVENTIVE PREDICTOR AND MILD COGNITIVE IMPAIRMENT**

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INTRODUCTION: The aging global population presents significant health challenges, particularly with the rising prevalence of sarcopenia and mild cognitive impairment among older adults. Understanding the association between sarcopenia as a preventive measure before its diagnosis, and mild cognitive impairment, would be helpful in preventing sarcopenia and mild cognitive impairment. The purpose of this study is to investigate the association between possible sarcopenia, considered as a preventive predictor before its diagnosis, and mild cognitive impairment.

METHODS: A cross-sectional study was conducted involving 60 physically inactive participants aged 40-69. Assessments included body composition, physical activity, and cognitive evaluations.

RESULTS: Participants with possible sarcopenia were found to have a 12.25 times higher risk of developing mild cognitive impairment (OR: 12.250, 95% CI: 1.692–88.711, p = 0.013).

CONCLUSION: The findings highlight the critical role of early diagnosis and intervention in sarcopenia to prevent cognitive decline. Future longitudinal studies are necessary to clarify causal relationships and optimize preventive strategies.

**EFFECTS OF COGNITIVE STIMULATION THERAPY AND FALL PREVENTION EXERCISE ON BALANCE, GAIT, MUSCLE FUNCTION, COGNITIVE ABILITY AND DEPRESSION IN OLD ADULT WITH DEMENTIA**

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INTRODUCTION: Dementia is a leading cause of disability and dependency in older adults, significantly increasing fall risk due to cognitive decline and impaired gait〔1〕. While exercise interventions help prevent falls, research on combined cognitive and physical training for dementia patients remains limited〔2〕. Cognitive stimulation therapy improves cognitive function, while exercise enhances balance and mobility〔3〕. Integrating these approaches may be key to reducing falls and improving overall function in dementia patients. This study aims to develop and evaluate a combined cognitive and fall prevention program tailored for dementia care.

METHODS: Twenty-one older adults with dementia were randomized into two groups: a cognitive stimulation and fall prevention exercise program (CogEx) and a fall prevention exercise-only program (Ex) during 7 weeks. Participants completed pre- and post-intervention assessments for balance(single leg stand), gait(Timed Up and Go), muscle function(chair stand, grip strength) cognitive function(Mini Mental State Examination), and depression(Geriatric Depression Scale). Statistical analysis was conducted using repeated measures ANOVA to examine interaction and main effects.

RESULTS: : A significant interaction effect between group and time was observed for Chair Stand (F = 5.39, p = 0.032) and depression (F = 5.65, p = 0.229). However, no significant interaction effects were found for balance, grip strength, TUG, or cognitive function. A significant main effect of time was observed for balance (F = 17.91, p = 0.001), TUG (F = 48.60, p < .001), Chair Stand (F = 11.81, p = 0.003), and depression (F = 11.48, p = 0.003), while grip strength and cognitive function showed no significant changes.

CONCLUSION: This study suggests that a combined cognitive and fall prevention exercise program can improve lower limb strength, balance, and depressive symptoms in dementia patients. While mobility and functional performance showed significant improvements, cognitive ability remained unchanged, highlighting the need for further research. These findings underscore the importance of tailored interventions to enhance quality of life and reduce fall risk in dementia care.

**EXERCISE ENGAGEMENT AND ITS ASSOCIATED BARRIERS AMONG OLDER ADULTS**

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INTRODUCTION: Identifying the factors that serve as barriers to exercise engagement among older adults is essential for promoting and encouraging their participation. This study aims to analyze the characteristics of exercise participation and examine the factors that limit older adults involvement in exercise.

METHODS: A total of 312 older adults (80.5 ± 6.8 years) participated in this study. A 26-item questionnaire, based on U.S. CDC guidelines with study-specific additions, assessed exercise participation and barriers. It covered 5 socio-demographic factors (sex, age, education, economic status, residence) and 21 barrier-related items across five domains: economy, psychology/emotion, information-seeking skills, environment/physical constraints, and exercise program aspects/personal concerns. Frequency analysis categorized participants by weekly exercise: no participation, 1–2 days, or ≥3 days per week. Linear regression estimated odds ratios (ORs) for socio-demographic and barrier associations using two models: <3 times per week (Model 1) and no exercise (Model 2).

RESULTS: The proportion of older women who did not exercise (38.9%) was higher than that of men (32.9%), while regular exercise (≥3 times per week) was lower in women (23.4%) than men (26%). Additionally, non-exercise rates increased with age, with the lowest regular exercise participation (18.2%) observed in those aged 85 and older. Among education

levels, those with16 or more years of education had the highest rate of exercising three times per week (62.5%). The odds ratio (OR) analysis identified age as a significant factor in both models. In Model 1, participants aged 81–85 years (OR = 2.2, p = 0.023) and ≥86 years (OR = 2.45, p = 0.021) showed significance, while in Model 2, only the ≥86 years group was significant (OR = 2.36, p = 0.014). Individuals with ≥16 years of education showed significant ORs in both models: Model 1 (OR = 0.10, p < 0.001) and Model 2 (OR = 0.19, p = 0.015). All five exercise barrier domains showed significant ORs. In the Psychology/Emotion domain, "absence of someone to exercise with" had a high OR of 14.46 (p < 0.001, Model 1), while "feeling lazy and unmotivated" had an even higher OR of 27.73 (p < 0.001, Model 1), strongly associating with reduced exercise participation. In the Exercise Program Aspect/Personal Concerns domain, three barriers showed high ORs: "lack of knowledge about exercise methods" (OR = 23.62, p < 0.001), "concern about pain or injury" (OR = 16.08, p < 0.001), and "fatigue or exhaustion" (OR = 11.13, p < 0.001) in Model 1. These findings highlight significant barriers to exercise participation among older adults.

CONCLUSION: This study highlights the need for targeted interventions to increase exercise opportunities for women and adults over 80. Tailored strategies, including gender-sensitive approaches, improved technology access, and addressing psychological, environmental, and economic factors, may enhance exercise participation.

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**ASSESSING SKELETAL MUSCLE QUALITY IN CHILDREN: A COMPARISON OF ECHO INTENSITY BETWEEN NORMAL-WEIGHT AND OBESE CHILDREN – A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: The global prevalence of childhood and adolescent obesity has increased more than fourfold since 1990, with the coronavirus pandemic further exacerbating this trend (1). A sedentary lifestyle combined with a high-fat diet not only contributes to obesity but also leads to metabolic dysfunction in skeletal muscles (2). Echo intensity (EI), obtained through grayscale analysis, is considered one of the most effective ultrasound measurements for assessing skeletal muscle quality (3). This systematic review and meta-analysis study explored the use of EI as an indicator of muscle quality in both normal-weight (NW) and obese children.

METHODS: The PubMed, Web of Science, and Scopus databases were searched for articles related to muscle morphology assessed by ultrasound in children. The study was conducted in accordance with PRISMA guidelines.

RESULTS: The records identified 186 possible papers after searching for the keywords ((child*) AND (obesity)) AND ((ultrasound) AND ((muscle) AND (quantity OR quality OR thickness OR mass OR size OR strength OR stiffness OR architecture)). After assessing eligibility, only seven articles were found to be eligible. The meta-analysis was based on data from 490 participants aged between 5.0 and 10.4 years. The weighted mean of the EI was 80.5 (SD 3.1) in NW and 105.9 (SD 4.4) in obese children. There was considerable heterogeneity in both analyses. However, the comparison showed a statistically significant difference (p < 0.0001).

CONCLUSION: In conclusion, this study highlights the significant differences in skeletal muscle quality, as measured by EI, between NW and obese children. Despite the observed heterogeneity in the data, which highlights the need for more robust and standardised studies, the findings suggest that ultrasound-derived EI could serve as a valuable tool for assessing muscle quality in children. The statistically significant difference in EI between the two groups suggests that obesity negatively impacts muscle quality, emphasising the need for early interventions to address childhood obesity and its associated metabolic effects.

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**AEROBIC AND RESISTANCE EXERCISE IN CHRONIC KIDNEY DISEASE: A META-ANALYSIS OF RENAL FUNCTION, INFLAMMATION, AND PHYSICAL PERFORMANCE**

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INTRODUCTION: Chronic kidney disease (CKD) is a global public health problem, affecting about 10% of the global population.Ranked as the fourth leading risk factor for global mortality, insufficient physical activity significantly contributes to the onset and progression of CKD.Patients with chronic kidney disease (CKD) often face issues like obesity, high blood sugar, and muscle loss, leading to reduced heart and lung function, muscle and bone deterioration, and decreased daily activity. These problems can worsen CKD progression. Aerobic exercise improves aerobic capacity, while resistance exercise boosts muscle strength. Combining both (ARCE) is gaining attention as a potential treatment for CKD patients. This study

aims to review and analyze randomized controlled trials (RCTs) to assess the combined effects of ARCE on renal function, inflammation, and physical function in CKD patients.

METHODS: PubMed, Embase, Cochrane, Web of Science, and EBSCO were searched for randomized controlled trials (RCTs) investigating the impact of regular ARCE in CKD patients. The study protocol was registered with PROSPERO (CRD42024596379). Review Manager 5 was used for meta-analysis, with effect sizes expressed as standard mean difference (SMD) and 95% confidence intervals (CI). Assessment two investigators independently assessed the risk of bias (ROB) of the included studies according to the Cochrane Risk of Bias Tool.A total of 19 studies (15 RCTs, 4836 patients) were included.

RESULTS: The meta-analysis revealed that ARCE significantly reduced C-reactive protein (CRP) levels (SMD = -0.12, p = 0.03), indicating a notable improvement in systemic inflammation. Additionally, ARCE led to significant reductions in blood glucose (SMD = -0.15, p = 0.01), body mass index (SMD = -0.10, p = 0.05), and waist circumference (SMD = -0.18, p = 0.005), highlighting its benefits for metabolic health and body composition. In terms of physical function, ARCE significantly improved peak oxygen uptake (SMD = 0.25, p = 0.05), 6-minute walk test performance (SMD = 0.82, p < 0.00001), upper limb muscle strength (SMD = 0.30, p = 0.04), lower limb muscle strength (SMD = 0.45, p = 0.0003), and sit-to-stand test ability (SMD = 0.75, p < 0.00001). However, ARCE did not demonstrate significant effects on renal function markers, including glomerular filtration rate (SMD = 0.06, p = 0.46), serum creatinine (SMD = -0.07, p = 0.46), or urine-albumin-creatinine ratio (SMD = -0.06, p = 0.40).

CONCLUSION: In conclusion, regular ARCE significantly improves inflammatory markers, glucose metabolism, body composition, and physical function in CKD patients, despite showing no significant impact on renal function. These findings suggest that ARCE may play a crucial role in delaying disease progression and enhancing quality of life in CKD patients. Furthermore, CRP, as a key inflammatory marker, holds potential as a supplementary indicator for evaluating the therapeutic outcomes of exercise interventions in CKD.

**EFFECTS OF WHEY PROTEIN SUPPLEMENTATION ON PHYSICAL FITNESS AND GLYCATION END-PRODUCTS IN OLDER ADULTS WITH TYPE 2 DIABETES UNDERGOING MUSCLE-RESISTANCE TRAINING**

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INTRODUCTION: This study aims to evaluate the effects of whey protein and maltodextrin supplementation, in conjunction with resistance training (RT), on muscular strength, postural balance, glycaemic control, and the formation of advanced glycation end-products (AGEs) in older adults with type 2 diabetes mellitus (T2DM).

METHODS: This randomized, triple-blind clinical trial included 60 men, aged 65 to 79 years, diagnosed with T2DM. Participants engaged in a RT program twice a week for 12 weeks and were randomly assigned to receive either 20 g of whey protein, 20 g of maltodextrin, or a placebo (flavoured water) immediately after each session. Assessments included isokinetic dynamometry, handgrip strength, the MiniBest test, the Timed Up and Go (TUG) test, the Short Physical Performance Battery (SPPB), skin autofluorescence to measure AGEs, and glycaemic metabolism analysis.

RESULTS: The whey protein group showed significant improvements in quadriceps strength, hamstring strength, and plasma insulin resistance (HOMA-IR). Improvements were seen in MiniBest and TUG tests across all groups. No significant differences were observed in handgrip strength or AGEs levels between groups.

CONCLUSION: Supplementing with whey protein or maltodextrin did not enhance the benefits of RT on muscle strength, balance, or glycaemic control in older adults with T2DM. However, whey protein plus RT significantly reduced insulin resistance, indicating a potential benefit in managing glycaemic control.

**A STUDY ON MENSTRUAL EDUCATION PROGRAMS FOR FEMALE ATHLETES**

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INTRODUCTION: Menstrual education typically begins in elementary school, but many women lack sufficient knowledge and struggle with menstrual-related issues. Research suggests that post-menarche education is often inadequate. Among female athletes, a lack of awareness regarding menstrual irregularities caused by energy deficiency, fatigue fractures, and amenorrhea can result in delayed intervention. Therefore, educating athletes about menstruation and its related challenges is crucial for their health and performance. This study aims to assess the impact of a menstrual education program on female athletes awareness and understanding of menstruation.

METHODS: The study involved seven female athletes (mean age: 19.9±1.1 years) from a university womens judo team. Educational materials were developed under the supervision of an obstetrician-gynecologist, based on prior research and literature on female athletes. The program consisted of two lecture sessions held one month apart, with assessments conducted before each session.

A questionnaire was used to evaluate the following aspects:

- Self-management skills
- Self-efficacy

• Perceptions of menstrual pain (e.g., "Menstrual pain is a natural part of being a woman")

• Understanding of menstruation (scored on a 10-point true/false scale)

RESULTS: The analysis revealed that menstrual knowledge significantly improved between the first (5.7±2.6) and second (7.7±2.2) assessments. However, no significant differences were found in self-management skills (29.1±3.8, 28.7±4.9), self-efficacy (8.4±3.6, 8.7±5.6), or perceptions of menstrual pain (24.9±14.1, 23.9±6.5).

CONCLUSION: The results suggest that menstrual education programs can enhance knowledge about menstruation among female athletes. However, self-management skills and self-efficacy did not show notable improvements. Since self-management is closely linked to self-efficacy, further investigation is needed to determine effective educational strategies.

Previous studies highlight the importance of expert guidance, peer support, and advice from family members in promoting self-management of menstrual health. Given the short duration of this study, Q&A sessions were incorporated to provide immediate support. Future research should adopt a longitudinal approach to assess the long-term effects of menstrual education on athletes health behaviors.

This study demonstrated that a menstrual education program can improve menstrual knowledge among female athletes. However, no significant changes were observed in self-management skills or self-efficacy. To encourage long-term health behavior changes, future research should focus on optimizing the duration, frequency, and content of menstrual education programs. A longitudinal study is also needed to evaluate the program's impact on menstrual symptoms and self-management skills over time.

**EFFECTS OF A SCHOOL-BASED INTERVENTION PROGRAM ON PHYSICAL FITNESS AND BMI IN MEDITERRANEAN CHILDREN**

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INTRODUCTION: Physical fitness and body composition play crucial roles in childrens health and athletic development. This study examined the effects of a school-based intervention program on physical fitness performance and body mass index (BMI) across five Mediterranean countries (Egypt, Lebanon, Italy, Spain, and Portugal) in two age groups (8–10 and 11–14 years). The study aimed to assess improvements in speed, strength, endurance, coordination, and BMI following the intervention and analyze variations based on age and country.

METHODS: A total of 935 children participated (males: 476, females: 459) from the five countries. The intervention program lasted several weeks, and participants underwent assessments for BMI and six physical fitness tests: sprint, standing long jump, jumping sideways, push-ups, sit-ups, and a six-minute endurance run. A three-way repeated measures ANOVA (Time × Age × Country) was conducted to evaluate the interventions effects. A two-way ANOVA (Age × Country) analyzed percentage changes in performance and BMI. Post-hoc pairwise comparisons were performed using the Bonferroni test. Statistical significance was set at $p<0.05$.

RESULTS: The intervention significantly improved physical fitness across most variables ($p<0.001$), with notable differences between countries and age groups. Sprint and endurance performance improved significantly across all countries, with the greatest improvements observed in Lebanon and Portugal ($p<0.05$). Standing long jump and push-up performance showed significant gains in the older age group, particularly in Lebanon and Portugal ($p<0.05$). Jumping sideways and sit-up performance improved in most countries, with Portugal demonstrating the highest improvements ($p<0.05$). BMI significantly decreased in Egypt (11–14 years) but increased in Lebanon and Italy ($p<0.05$). The highest BMI values were recorded in Italy and Spain for the younger age group.

CONCLUSION: The intervention program effectively enhanced physical fitness performance and influenced BMI changes in children, with variations by age and country. These findings highlight the importance of tailored fitness programs that account for regional and developmental differences. Future research should explore the long-term impact of such interventions on BMI and physical fitness and optimize training strategies to maximize benefits for youth health and development.

**VARIABILITY IN IMMUNE BIOMARKER RESPONSE TO ACUTE EXERCISE IN BREAST CANCER PATIENTS**

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INTRODUCTION: Breast cancer (BC) is the most prevalent cancer among women, with approximately 2.3 million new cases diagnosed worldwide each year. Physical activity has the potential to influence circulating immune biomarkers and is crucial in the recovery process. This study aimed to evaluate the immune system mediator profiles in BC patients following acute exercise.

METHODS: Forty-three BC patients (age 35-64) completed VO2 peak test before therapy. Blood samples were collected before (T1) and straight after (T2) VO2 peak test. For each sample IL-6, M-CSF, IL-27, MIG/CXCL9, EGF, and sCD40L level (pg/mL) was measured by MILLIPLEX Human Cytokine/Chemokine/Growth Factor Panel Magnetic Bead Panel, HCYTA-60K (Millipore,Billerica,MA,USA) on a Magpix analyzer (Austin,TX,USA). Two subgroups of BC patients were formed based on the response to an acute exercise: BCI – group with increased post-exercise biomarker concentrations; BCD group with decreased post-exercise biomarker concentrations. Wilcoxon signed-rank test was used for subgroup data analysis. Data are expressed as median (Q1; Q3).

RESULTS: Analysis of all measured biomarkers in both subgroups showed significant effects (P<0.05). The most pronounced inverse effects were observed for IL-6 (BCI-T1: 3.17 (2.27;4.33), BCI-T2: 4.5 (3.43; 5.7) vs BCD-T1: 4.84 (3.34; 8.75); BCD-T2: 3.22 (1.95; 5.20)), sCD40L (BCI-T1: 715 (494;1603), BCI-T2: 996 (690; 2207) vs BCD-T1: 831 (567; 1310), BCD-T2: 601 (432; 932)), M-CSF (BCI-T1: 155 (114.5; 256), BCI-T2: 202 (164.6; 300) vs BCD-T1: 245 (73.9; 294), BCD-T2: 143 (56.1; 228), where biomarker level changed by up to 1.5 times. Still significant changes, but with smaller magnitude, were observed for EGF (BCI-T1: 43.9 (14; 56.6), BCI-T2: 46.8 (22.5; 60.8) vs BCD-T1: 31.8 (20.1; 51.9), BCD-T2: 27.7 (18.0; 46.4)), IL-27 (BCI-T1: IL-27: 1148 (895; 1404), BCI-T2: 1234 (991; 1485) vs BCD-T1: 1121 (741; 1373), BCD-T2: 1093 (723; 1224)) and MIG/CXCL9 (BCI-T1: 2401 (2095; 3549), BCI-T2: 2778 (2461; 3980) vs BCD-T1: 3593 (2618; 5460), BCD-T2: 3244 (2389; 4387)).

CONCLUSION: Acute exercise induced response was observed among all measured immune biomarkers. Furthermore, this response varies significantly among breast cancer patients forming two distinct subgroups. Future studies should account for these individual differences to better tailor exercise interventions for improving immune function during recovery in breast cancer patients.

**IMMUNE (BIOMARKER) ANALYSIS IN THE FORTEE CONSORTIUM: PRESENTATION OF A PROJECT**

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INTRODUCTION: Despite remarkable improvements in survival rate in the last decades, cancer remains the leading cause of death by non-communicable diseases in children in western countries. In addition, cancer and its treatment negatively affect childrens physical capacity, and is linked to a high prevalence of toxicities and side effects as well as physical inactivity—with cancer-related fatigue being a prevalent condition with still unclear etiology. In turn, although exercise training is gaining attention in the context of pediatric oncology, it is not yet part of standard care. Particularly, the level of evidence for the effects of exercise training in childhood cancer patients during intensive cancer treatment is low compared to adult malignancies and more randomized controlled trials (RCT) are needed.

METHODS: In order to expand and synchronize the—still sparse—expertise in pediatric exercise oncology, the European Union-funded FORTEe (Get strong to fight childhood cancer) project has brought together leading experts on pediatric exercise oncology on a European level (6 consortium partners from 8 countries and 9 recruiting centres from 7 countries). We will implement a RCT to evaluate potential effects of an 8-10 week supervised precision exercise training intervention in childhood cancer patients. Supervised exercise training will be provided in the intervention group whereas the control arm will receive usual care. We will recruit ~450 childhood cancer patients aged 4-21 years and requiring chemo and/or radiation therapy—with no exclusion criteria for any type of tumor, and thus with all cancer types represented. In the exercise group, a motivational, playful and personalized exercise training with supervised exercise sessions will take place. Participants of both study groups can take part in an optional exercise program after the intervention phase for the remaining time of their cancer treatment. The following outcomes will be studied: cancer-related fatigue (primary outcome); and a number of secondary outcomes (e.g., health-related quality of life, mental health, physical fitness/performance, physical activity level and behavior, and body composition).

RESULTS: A blood biomarker analysis will be also performed in adolescent and young adult patients suffering from a solid tumor—excluding cancers of the immune system or blood cancer (leukemias and lymphomas). Thus, beside a general analysis of peripheral blood mononuclear cell distribution before and after the exercise intervention, the focus of the biomarker analysis will be natural killer (NK) and regulatory T (Tregs) cells, especially the study of exercise training effects on the cytotoxic activity and DNA-methylation profiles of these cells.

CONCLUSION: We hope that this biomarker analysis subproject will help to gain insight into the potential effects of exercise intervention in children with cancer. This is an important point as the evidence up to date on the effects of exercise in the context of pediatric cancer is mixed and immunotherapy is gaining importance in pediatric oncology.

**EFFECTS OF PHYSICAL EXERCISE ON AUTONOMIC CONTROL IN DIABETIC PATIENTS**

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INTRODUCTION: Chronic hyperglycemia damages body systems, making glucose and cardiovascular management crucial [1]. 50% of diabetic autonomic dysfunction are asymptomatic, increases morbidity, especially via cardiac autonomic neuropathy [2]. Type 2 diabetes mellitus (T2DM) affects both autonomic branches, and physical activity seems to play a role in its management. The study aimed the effect of an exercise program (EP) on autonomic functions in T2DM patients.

METHODS: 21 T2DM patients with no diabetic neuropathy diagnosis were randomly assigned to two groups. The EP group (13: age 59,54±11,79; HbA1c 59,82±19,57; BMI 29,73±5,28); diabetic medication 53,8%; insulin therapy 23%) followed a 12 month exercise program while Control group (8: age 63,75±4,89; HbA1c 65,67±7,23; BMI 32,90±5,38; diabetic medication 12,5%; insulin therapy 0%) maintained a sedentary habits. Heart rate variability (HRV) and heart frequency (HFrest) were assessed at baseline, 6 and 12 months. HRV parameters measure the time between heartbeats providing insights into the autonomic nervous systems balance. The time domain parameters such as MeanRR (average time interval between consecutive heartbeats (R-R intervals) reflecting overall heart rate), SDNN (standard deviation of R-R intervals, indicating overall HRV and autonomic balance), RMSSD (measures short-term HRV and is sensitive to parasympathetic activity). The frequency-domain parameters include LF/HFratio (represent the sympathetic (LF) and parasympathetic (HF) balance). Repeated measures ANOVA was performed along variables, with the significance level set at p<0.05.

RESULTS: SDNN showed a significant difference between groups over time (p=0.008), while other parameters did not. Notably, HRV and HRrest exhibited a positive trend, suggesting improved autonomic nervous function as a result of exercise

CONCLUSION: Exercise program seems to improve cardiovascular autonomic function in adults with TDM2. The SDNN, considered the "gold standard" for a strong prognostic marker for heart disease [3]. In the EP group, SDNN increased compared to the Control group, suggesting that physical exercise has the potential to prevent -or at least delay- the onset of autonomic complications in T2DM.

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**DEVELOPMENT OF THE JAPANESE VERSION OF THE UKK WALK TEST: REFINING $VO_2$MAX PREDICTIVE ACCURACY**

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INTRODUCTION: The UKK Walk Test (UKKWT) is a cardiorespiratory endurance test that estimates maximal oxygen uptake ($VO_2$max) using four parameters: the time required to walk 2 km, heart rate at the end of the walk, body mass index (BMI), and age. Last year, we revised the $VO_2$max prediction equation for Japanese individuals and compared its performance with the original equation proposed by Oja et al. While the coefficient of variation (CV) for the Japanese version (UKK_J2024) showed improvement relative to the original, it remained relatively high, suggesting the need for further refinement. In this study, we investigated whether incorporating additional gait-related variables could enhance $VO_2$max prediction accuracy.

METHODS: Seventy-five healthy Japanese adults (37 men, 38 women; aged 20–65 years) participated in this study. $VO_2$max was measured using a respiratory gas analyzer during uphill treadmill walking. In the UKKWT, $VO_2$max was initially predicted from the four standard parameters. To refine the predictive model, multiple regression analysis using the stepwise method was performed. In the revised model (UKK_J2025), additional independent variables—including mean step count, stride length-to-height ratio, and their changes between the first and second halves of the test—were incorporated based on acceleration data obtained via a heart rate sensor. The predictive performance of the UKK_J2025 model was compared with that of the UKK_J2024 model using the root mean square error (RMSE) and CV.

RESULTS: The mean $VO_2$max measured using the direct gas analysis method was 43.3 ml/kg/min in males and 33.3 ml/kg/min in females. In the UKK_J2024 model, $VO_2$max in males was predicted using 2 km walk time and BMI, yielding a mean of 43.3 ml/kg/min (RMSE: 3.7 ml/kg/min, CV: 8.5%), whereas in females, $VO_2$max was estimated based on 2 km walk time, BMI, and age, with a mean of 33.0 ml/kg/min (RMSE: 4.2 ml/kg/min, CV: 12.6%). Multiple regression analysis for the UKK_J2025 model identified the following predictors of $VO_2$max in males: the magnitude of stride length-to-height ratio changes, mean step count, heart rate at the end of the test, BMI, and age. The revised model yielded a predicted mean $VO_2$max of 44.2 ml/kg/min (RMSE: 3.3 ml/kg/min, CV: 7.6%), demonstrating improved predictive performance compared to UKK_J2024. In females, the selected predictors were mean stride length, mean step count, BMI, and age, resulting in a predicted mean $VO_2$max of 33.4 ml/kg/min (RMSE: 3.8 ml/kg/min, CV: 11.5%), similarly indicating enhanced predictive accuracy.

CONCLUSION: This study successfully improved the predictive performance of $VO_2$max by incorporating gait-related parameters, such as step count and stride indices, into the UKKWT model. However, further refinements in prediction accuracy are necessary to facilitate the broader societal implementation of the UKKWT_J model.

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**THE IMPACT OF COMMUTING HABITS ON PHYSICAL AND MENTAL HEALTH OUTCOMES IN UNIVERSITY MEMBERS (DINAMO-ACTIVE): A PROSPECTIVE, OBSERVATIONAL STUDY**

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INTRODUCTION: Physical activity is a modifiable risk factor but difficult to implement into daily life. The role of the way to work as a potential resource for an active and healthy lifestyle is not certain yet.

METHODS: We evaluated the impact of regularly commuting active (by foot or bicycle) or passive (e.g. private car, public transport) on physical activity characteristics and health-related outcomes in university employees and students. We measured the distance, time and intensity on the way to the university and back home with a wearable activity tracker

over one week. Health-related quality of life (Short Form-36) and productivity (work ability index) were assessed with questionnaires.

RESULTS: From 54 recruited participants, 30 regularly commute active (50% women, age 36.4 yrs) and 24 passive (67% women, age 33.9 yrs). The distance getting to the university was shorter for those who used active (4.7 [2.5; 7.0] km) compared to passive mobility (18.7 [7.5; 29.9] km), as was the time taken (active: 19.2 [14.1; 29.3] min; passive: 49.9 [31.2; 56.4] min (for both $p<0.01$). Heart rate (active 116.0 ± 11.7 bpm, passive 91.5 ± 16.3 bpm, $p<0.01$) was higher whereas moderate to vigorous activity minutes (active 11.7 ± 8.3 min, passive 11.1 ± 8.8 min) were similar when comparing active versus passive commuting. Active commuters had similar sum scores for the physical (active 57.5 [55.8; 58.5] points, passive 57.4 [53.3; 59.3] points) and mental domain (active 50.4 [45.6; 55.8] points, passive 50.9 [43.7; 53.7] points) of health-related quality of life and for the total work ability score (active 42.6 ± 3.7 points, passive 42.1 ± 5.0 points).

CONCLUSION: As expected, active commuters experienced higher levels of physical exertion during their journey to work. However, due to the shorter duration of the journey the time within moderate to vigorous intensity was similar between active and passive commute. This finding might explain the similar scores of health-related quality of live and work ability between groups. Further analyses should reveal whether the mode of passive commuting influences the results, since the use of public transport presumably involves a greater walking distance than driving to work in a private car.

**ASSESSING SLEEP HYGIENE SELF-EFFICACY IN UNIVERSITY ATHLETES**

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INTRODUCTION: Sleep hygiene is linked to better sleep, but many university athletes struggle to adopt optimal sleep habits. Given that self-efficacy predicts health behaviour, we aimed to explore pre-season sleep hygiene self-efficacy and associated sleep characteristics in university athletes.

METHODS: We used the Self Efficacy for Sleep Hygiene Inventory Revised (SESHI-R ) [1] to assess sleep hygiene self-efficacy in university athletes (N=161; 55.7% male; age: 20.6±2.3yr). The SESHI-R provides a global score and factor scores related to specific aspects of sleep hygiene (range 0-100; higher scores=greater self-efficacy). We assessed associations between SESHI-R scores and 1) sleep hygiene using the Athlete Sleep Behaviour Questionnaire (ASBQ) [2], 2) sleep difficulty and quantity/satisfaction using the Athlete Sleep Screening Questionnaire (ASSQ) [3], and 3) sleep regularity using the Sleep Regularity Questionnaire (SRQ) [4]. Differences in SESHI-R scores across sex, academic year, and chronotype (ASSQ) were also explored.

RESULTS: The SESHI-R global score was 64.5±12.1 (range: 21.6-97.0), with the following factor scores for 'Behaviors to Adopt' (69.1±15.0), 'Behaviors to Avoid' (64.6±14.0), and 'Manage Mindset/Environment' (59.5±14.0). Participants averaged 7.6±0.9 hours of sleep/day; 28.4% reported 'somewhat' to 'very dissatisfied' sleep quality. 32.3% reported 'moderate' to 'severe' sleep difficulty and 85.5% had 'poor' sleep hygiene. SESHI-R global score was positively associated with sleep hours ($r=0.451$), SRQ scores ($r=0.388$), and sleep satisfaction ($r=0.292$), but negatively with ASSQ sleep difficulty ($r=-0.570$) and ASBQ sleep hygiene ($r=-0.470$) (all $p<0.001$). SESHI-R scores were not significantly different across sex nor academic year ($p>0.05$). 'Evening' chronotypes had lower global SESHI-R scores than 'morning' chronotypes (56.3±14.1 < 65.5±11.7) ($t(141) =2.91$, $p=0.004$).

CONCLUSION: Overall university athletes, particularly evening chronotypes, are characterized by sub-optimal sleep hygiene self-efficacy. Given the associations between self-efficacy and sleep behaviors/sleep, applying chronotype- and factor-specific confidence-building interventions in pre-season could help improve sleep hygiene and sleep through the competitive season.

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**IMPACT OF STATIN WITHDRAWAL ON SLEEP QUALITY AND FUNCTIONAL CAPACITY**

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INTRODUCTION: Statins are benchmark lipid-lowering drugs, reducing blood cholesterol by controlling its synthesis. There are side effects linked to statin use, notably statin-associated muscle symptoms (SAMS) (Thompson et al., 2016). These symptoms typically include myalgia, stiffness, weakness, fatigue and/or cramps. SAMS can lead to an altered health-related quality of life (Peyrel et al., 2023). Moreover, the potential effects of SAMS on sleep remain poorly documented. The

objective of this exploratory work was to assess if subjective and objective measures of sleep, as well as functional capacity, improve after drug withdrawal in SAMS self-reporters.

METHODS: Patients (5 men, 3 women, 44.8±6.3 yr) in primary cardiovascular prevention were divided into two groups: statin users with (SAMS, n=4) or without self-reported symptoms (No SAMS, n=4). The Epworth Sleepiness Scale (ESS) and the Pittsburgh Sleep Quality Index (PSQI) questionnaire were used to assess subjective daytime sleepiness and sleep quality, respectively. Sleep measurements were recorded objectively for one week using actigraphy. The handgrip strength (FOHG) was measured using a handheld dynamometer, and the Six-Minute Walk Test (6MWT) was used to assess functional capacity. Finally, a 10-point visual analog scale (VAS) evaluated the intensity of SAMS. Measures were taken before and after a 2 month-statin withdrawal. Cohens d-values for pairwise comparisons were used to assess effect sizes (ES) of changes within group over time, and ES were considered as trivial (<0.2), small (0.2–0.5), moderate (0.5–0.8), and large (>0.8).

RESULTS: After statin withdrawal, an improvement of objective sleep quality was observed in the SAMS group (sleep efficiency: +3.8%, ES: 0.33 [small effect]; wake after sleep onset: -15.6%, ES: -0.30 [small effect]; number of awakenings after sleep onset: -12.7%, ES: -0.45 [small effect]), concurrent with a decrease of subjective perception of SAMS intensity (VAS: 4.75 to 2.25, ES: -1.06 [large effect]). A decrease in subjective daytime sleepiness (ESS: 11.3 to 8.3, ES: -0.45 [small effect]) and an increase in subjective sleep quality (PSQI: 7.66 to 6.33, ES: -0.31 [small effect]) were also specifically seen in this group. The No SAMS group did not show any change for the different objective and subjective sleep parameters (ES: -0.08 to 0.15 [trivial effects]). Finally, FOHG increased only in patients with SAMS (left hand, +12.5%, ES: 0.30 [small effect]), while no change was observed for the distance walked at 6MWT.

CONCLUSION: These preliminary data suggest that in patients who self-report SAMS, a 2-month statin withdrawal may increase their sleep quality, as well as functional capacity illustrated by FOHG.

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**IMPORTANCE OF POWER TESTING AND TRAINING IN OLDER WOMEN**

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INTRODUCTION: Gender blindness refers to the lack of consideration of gender as a significant category in addressing a research problem (1). Metabolic and body composition differences between men and women, influenced by hormonal factors, suggest sex differences in the effects of physical exercise despite the aging process (2). When designing and evaluating physical exercise interventions (PEI), it should be essential to analyse the results separately by sex to determine potential differences, also in older adults.

METHODS: One hundred and two over 60 years individuals referred from Primary Care were assigned, according to their fitness, to two types of 8-week PEI: GesmedMarcha (GM; N=53, 37 women; Nordic walking and inspiratory muscle training) and ViuActiu (VA; N=49, 37 women; multicomponent exercise). Body composition, the Short Physical Performance Battery (SPPB) -total score; balance subscale score, 4-meter gait speed (m/s), time in the five-times sit-to-stand test (s)-, and the 200-meter gait speed test (m/s) were assessed. Lower limb power (w) and allometric power (w/m²) were calculated from the 5-STS. Individual absolute deltas (Δ) were considered to compare between sexes using the Student's t-test for independent samples or the Mann-Whitney U test, depending on Shapiro-Wilk normality tests.

RESULTS: Pre-intervention sex differences were observed in both PEI. Men had a lower fat-mass % compared to women [GM: 27.01 (0.92) vs. 35.28 (0.90) %; VA: 32.03 (1.39) vs. 40.35 (0.95)) %], with greater muscle mass (kg). Additionally, men display greater lower limb power [GM: 3.45 (0.20) vs. 3.01 (0.12) w; VA: 2.47 (0.21) vs. 1.95 (0.12) w]. Following the PEI, and within the overall sample, power and allometric power were the only variables that revealed significant sex differences ($p<0.05$) in the magnitude of improvement (i.e. Δ) [Men: 0.71 (0.17) w & 25.74 (4.73) w/m²; Women: 0.31 (0.08) w & 8.82 (2.76) w/m² respectively].

CONCLUSION: Lower limb power, related to rate of force development, is greater in men, as it is influenced by muscle mass and male hormones. Additionally, men show greater improvements in this power following training. Since lower-limb power is crucial for the independence of older adults and avoid falls (3), PEI for older adults should pay special attention to power training and testing in women.

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**STUDY ON THE EFFECTS OF 8-WEEK HIIT TRAINING MODULATING THE HIPPOCAMPAL SIRT1/PGC1A PATHWAY ON HIPPOCAMPAL NEURONAL INJURY AND COGNITIVE DYSFUNCTION IN OBESE RATS**

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INTRODUCTION: This study aimed to investigate the effects of high-intensity interval training (HIIT) on hippocampal neuronal injury and cognitive function in obese rats, providing theoretical evidence for HIIT interventions to improve hippocampal neuronal damage and cognitive dysfunction induced by obesity.

METHODS: Male SD rats were randomly divided into high-fat diet (HFD) and normal diet groups, and fed either a high-fat or normal diet. After 8 weeks, the Lees index (Lee's = body weight (g) ^ (1/3) × 1000 / body length (cm)) was calculated to select obese rats. Obese rats (H group, n=20) and age-matched normal rats (C group, n=20) were further randomly divided into exercise and sedentary subgroups, with 10 rats in each subgroup: control sedentary (CS group, n=10), control exercise (CE group, n=10), high-fat sedentary (HS group, n=10), and high-fat exercise (HE group, n=10). Maximal oxygen uptake (VO2max) testing was conducted to determine the running speed for HIIT. After an adaptation period, all exercise groups underwent 8 weeks of HIIT treadmill training. Behavioral tests were performed in the 9th week, followed by tissue collection for additional analyses.

RESULTS: Compared with the CS group, the CE group showed a decrease in body weight and Lee's index, although the differences were not statistically significant. In contrast, compared with the CS group both the HS and HE groups had significantly increase body weight and Lee's index. The HE group had a significant reduction in body weight and Lee's index compared to the HS group. In the Morris water maze test, the HS group showed a significantly increased escape latency and reduced number of platform crossings. In comparison, both CE and HE groups exhibited significantly reduced escape latencies and increased platform crossings compared to the CS and HS groups. Histological examination using HE and Nissl staining revealed that, compared to the CS group, the hippocampal CA1 neurons in the HS group had significantly fewer cells, with deeper staining, disorganized arrangement, and Nissl body dissolution. In contrast, in the exercise groups (CE and HE), hippocampal CA1 neurons exhibited significantly improved morphology, with increased neuron numbers, clearer cell nuclei, and more organized cellular arrangements. Molecular analysis through quantitative PCR and Western blot showed that both mRNA and protein levels of SIRT1 and PGC1α were reduced in all groups due to obesity. However, exercise, regardless of obesity status, led to significant increases in the mRNA and protein levels of SIRT1 and PGC1α in the hippocampus.

CONCLUSION: An 8-week HIIT training can improve hippocampal neuronal injury and cognitive function in obese rats. The underlying mechanism may involve the modulation of the SIRT1/PGC1α pathway, which helps alleviate pathological neuronal damage and restore cognitive function.

**METHODOLOGICAL CHOICES ON 24-H MOVEMENT BEHAVIOR ASSESSMENT BY ACCELEROMETRY: A SCOPING REVIEW**

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INTRODUCTION: There are no reviews describing current measurement protocols and accelerometer processing decisions that are being used in 24-hour MovBeh studies, across the lifespan. We aim to synthesise information on methods for assessing 24-hour movement behaviours using accelerometry across all age groups

METHODS: PubMed, PsycINFO, SPORTDiscus, and EMBASE were searched until December 2022. Observational or intervention reports describing accelerometry methods in studies on combinations of movement behaviors, with a 24-hour protocol across all ages, were included.

RESULTS: This review included 102 studies. Three studies in toddlers, 15 in preschoolers, 17 in children, 23 in adolescents and 44 in adults and older adults. The Actigraph GT3X was the most commonly used device; the majority of the included reports collected data for seven days, including three weekdays and one weekend day, with at ≥16h/day per 24-hour period for valid data. The criteria for non-wear time varied between ≥20 and ≥90 minutes of consecutive zero counts, depending on the age group. The most common epoch used was 15 or 60 seconds for youth and adults, respectively. The choice of sleep algorithms and SB/PA cut-points, of the included reports, depended on age and the original validation/calibration study. To deal with non-compliant participants, exclusion of non-compliant participants from the analysis was most frequently used. Most studies used diaries/logs to complement the accelerometer data.

CONCLUSION: Accelerometer protocols and methodological decisions varied considerably between reports. Therefore, consensus on methodological decisions is needed to improve precision and comparability between studies, which is challenging given the complexity of the procedures, the number of available brands and types of accelerometers, and the plethora of programming options.

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**AGE- AND SEX-SPECIFIC DIFFERENCES IN FITNESS TESTS OF CYPRIOT SCHOOL-AGED ADOLESCENTS: THE CYFIT STUDY**

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INTRODUCTION: The CyFIT study is a population-based monitoring of physical fitness levels conducted in Cyprus and involves the largest assessment of physical fitness levels in secondary school students. Previous surveillance systems have been developed showcasing the trends of physical fitness in European countries, by providing reference values for children and adolescent populations [1,2,3]. For Cyprus, there have been no earlier reference levels established, while CyFIT creates a sustainable framework for fitness monitoring, offering valuable insights into the physical fitness levels of adolescents. The aim of this study is to highlight age- and sex-specific differences in aspects of physical fitness, in school-aged adolescents in Cyprus.

METHODS: A sample of 16194 school aged-adolescents (50% male, 50% female), from 12 to 17 years old, participated in this study. Participants were secondary school students from 63 (50%) public schools in region of Republic of Cyprus. Participants performed the Eurofit test battery, by trained professionals, which involved in series of 9 tests: Hand movement (HM), sit and reach (SR), standing long jump (SLJ), sit-ups (SU), shuttle run 10 x 5 m (SRM), push-ups (PU), hand grip strength in left (HSL) & right (HSR) hand, and endurance shuttle run (ESR) assessed by the 20-m multistage fitness test. Percentile levels in each test were calculated using descriptive statistics while inferential statistics identified age- and sex-specific differences.

RESULTS: Percentile reference curves were plotted for all physical fitness tests. Females outperformed males only in the SR across all age groups (ES: 0.26-0.72; $p<0.001$). Males outperformed females in all other tests (ES: 0.15-1.89; $p<0.001$), except for HM test at ages 12 and 13, where no significant differences were observed. A significant effect of age on all tests was evident except for PU for females (ES: <0.01-0.37; $p<0.021$ for female; ES: 0.01-0.21; $p<0.001$ for male). Males showed performance increases in PU (13 to 17 reps) and SLJ (149 to 189 cm) from ages 12 to 17, while female performance remained unchanged. Even though handgrip strength increased in both genders from ages 12 to 17 years, the increase in males was 40% vs 9% in females. ESR performance declined in both genders from 12 to 17 years by 14% in males and 27% in females. A two-way ANOVA revealed significant interaction effect between gender and age for all tests (ES: 0.01-0.06; $p<0.001$).

CONCLUSION: This is the first study to assess fitness performance in adolescent population in Cyprus and the trends in age and sex differences are in line with similar studies [1,2,3]. The current results of sex- and age-specific fitness levels for adolescents in Cyprus can be utilized as reference values for health and fitness assessment and monitoring systems.

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**EFFECT OF ACUTE EXERCISE OF DIFERENTS INTESITIES ON ALBUMIN EXCRETION IN OLDER ADULTS**

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INTRODUCTION: Physical exercise has been pointed out as a factor capable of causing microalbuminuria, especially in people with pathologies related to vascular diseases (1). The effect of exercise on albumin excretion has been reported in healthy young adults to be transiently dependent on exercise intensity (2). There are different physiological mechanisms of albumin excretion in relation to the type of exercise, finding that high intensity and short duration can increase albuminuria excretion due to an increase in glomerular hydrostatic pressure. On the other hand, moderate intensity and long duration exercise increases albuminuria due especially to the decrease in tubular protein reabsorption (3). Under normal conditions, albumin is filtered by the glomeruli and proximal tubules which actively reabsorb this protein, these physiological conditions could be altered in older adults (4). The effects of maximal and submaximal exercise on excretion of albumin in older adults (≥65 years) are not well known. The purpose of the study was To evaluate the effect of different intensities of acute exercise on excretion of albumina in elder adults.

METHODS: 20 apparently healthy, sedentary older adults (13 men and 7 women)( 70.1 ± 5.1 years) voluntaries participated in this study. The participants performed 3 exercise tests on a bicycle ergometer: 1 maximal test, where each subject performed 5 minutes warm-up, latter pedaling frequency was 50 rpm, starting with a load of 0.5 Kp and increasing the load by 0.5 kp. every 2 minutes. With a difference of one week between them, 2 submaximal exercise tests were performed at 80% and 60% of the maximal heart rate (HR), after the warm-up they pedaled for 20 minutes continuously at designated heart rate (±2 beats) monitored by a HR transmitter. Urine samples were collected in 4 times: before the test, immediately, 1 and 24 hours after exercise to determine If there is increase the excretion of albumin. Statistical significance was $p < 0.05$

RESULTS: Only in maximal test immediately (of 7.6 ± 2.7 mg/l at 19.0 mg/l, ± 10.7) and 1 hour post exercise (18.6 ± 9.4 mg/l) significant increases in albumin excretion levels was observed. After 24 hours of exercise, any testing did not show microalbuminuria.

CONCLUSION: The exercise of maximal intensity causes increase in the excretion of albumina in apparently healthy older adults, this response is moderate and transient, as described in studies of young adults reporting transient increases in albumin excretion with acute exercise (5). There was no persistent microalbuminuria at 24 hours. Submaximal exercise (80% and 60%), no increased the excretion of albumin in apparently healthy elderly.

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**MENTAL HEALTH AND SLEEP QUALITY IN JAPANESE MENOPAUSAL WOMEN**

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INTRODUCTION: Menopausal symptoms have various adverse effects on health variables, leading to reduction of quality of life (QOL). Both decreased sleep quality and mental health are frequently observed during menopause (Kloss et al., 2014). However, whether impaired mental health with decreased sleep quality is affected by the severity of menopausal symptoms remains unclear. We compared the sleep quality and mental health between women who are aware of menopausal symptoms and healthy young women. In addition, the effect of the severity of menopausal symptoms on sleep quality and mental health were examined in menopausal women.

METHODS: Twenty healthy young women (YM; 20.4 ± 0.6 years, 161.4 ± 5.7 cm, 52.9 ± 5.9 kg) and twenty menopausal women (MW; 49.1 ± 2.6 years, 159.5 ± 5.0 cm, 53.7 ± 7.0 kg) were recruited. Body composition, mental health (CES-D [an indicator of depression], DASS-21 [indicators of depression, stress, anxiety], SF8 [health related QOL]), and subjective sleep score (PSQI) were assessed. Also, the MW group answered subjective questionnaires to assess the severity of menopause symptoms (SMI). In YW group, menstrual cycle was monitored, and all measurements were conducted during early follicular phase.

RESULTS: The scores of CES-D and PSQI were significantly higher in the MW group (CES-D; 11.5 ± 4.5, PSQI; 5.3 ± 1.7, $P<0.05$), compared to the YW group (CES-D; 8.1 ± 3.8, PSQI; 3.9 ± 1.4), indicating that MW group presented impaired mental health and sleep quality. Also, in the DASS-21, the MW group showed significantly higher scores for domains of "depression" (2.9 ± 2.1) and "stress" (3.9 ± 2.8) compared to the YM group (depression; 1.4 ± 1.9, stress; 1.9 ± 1.7, $P<0.05$). Furthermore, the MW group had significantly lower physical summary scores of SF8 (MW; 47.3 ± 5.9, YM; 54.3 ± 3.4, $P<0.05$). The mean SMI score in the MW group was 40 ± 19 points, and considerable number of participants exceeded the cutoff score. When the subjects in the MW group were divided into three groups based on the severity of menopausal symptoms (assessed by SMI), the group with higher SMI scores (61.3 ± 4.1, PSQI; 6.4 ± 2.9) showed significantly lower sleep quality compared with the group with lower SMI scores (22.2 ± 2.6, PSQI; 4.4 ± 2.3, $P<0.05$).

CONCLUSION: The aggravated mental health and sleep quality in MW may be associated with dysfunction of autonomic nervous activity (Maki et al., 2024). These results suggest that both mental health and sleep quality are decreased in menopausal women compared to young women. Moreover, the severity of menopause symptoms appeared to be associated with impaired sleep quality.

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**REFERENCE VALUES FOR THE TRUNK FLEXOR ENDURANCE TEST IN PHYSICAL EDUCATION STUDENTS**

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INTRODUCTION: The trunk flexor endurance test (TFET) has been proposed as a safe alternative to the sit-up test. The trunk inclination angle during TFET has varied from 45 degrees to 60 degrees in previous studies. It is expected that the posture holding time will differ depending on the angle. The clinical significance of the TFET may vary depending on the trunk inclination angle and the subject's characteristics. Despite its potential utility, there is no established standard value for its evaluation. Establishing reference values for TFET is essential for objectively assessing trunk endurance and comparing results across different populations. A standardized evaluation method will enhance the reliability of TFET as a physical fitness test and provide valuable reference data for future studies. Therefore, this study aims to determine reference values of TFET in physical education students and examine the influence of different trunk inclination angles on endurance performance.

METHODS: A total of 378 physical education students (258 men, 114 women) participated in this study. The subjects were divided into 3 groups by trunk inclination angles (45 deg, 50 deg and 55 deg). In the TFET, the subjects took a sitting position so that the whole back is in contact with the tilting table at assigned angle. With the knees flexed at 90 deg and the

hands placed on the chest, the test starts by shifting the tilting table 10 cm backward and the subject should keep the starting posture as long as possible. When subject's back touches the tilting table again, the test ends. The trunk endurance time was recorded. Descriptive statistics, including mean, standard deviation (SD), and standard error of the mean (SEM), were calculated. One-way ANOVA, multiple comparison tests, and t-tests were conducted to determine differences between inclination angles or genders.

RESULTS: The mean value (SD, SEM) of each test (men/women) was 156.0 (121.5, 13.1)/190.2 (84.5, 14.5) sec at 45 deg, 188.0 (83.0, 9.0)/246.0 (125.5, 18.1) sec at 50 deg and 209.1 (116.5, 12.5)/251.8 (144.6, 25.2) sec at 55 deg. A significant main effect of inclination angle was observed in men, with endurance time at 45° being significantly shorter than at 55°. However, no significant effect of inclination angle was observed in women. Additionally, a significant gender difference was found at 50°, where women demonstrated longer endurance times than men.

CONCLUSION: These findings suggest that trunk inclination angle influences endurance performance differently based on gender, highlighting potential physiological or biomechanical differences between men and women in trunk stabilization and endurance. Further research is necessary to explore the underlying mechanisms and practical applications of these results in sports and rehabilitation settings.

**IS THE USE OF ULTRASOUND-DERIVED PREDICTION EQUATIONS FOR PREPUBERTAL CHILDREN USEFUL FOR ESTIMATING REGIONAL SKELETAL MUSCLE AND FAT MASS IN JAPANESE ADOLESCENTS?**

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INTRODUCTION: Accurate estimation of regional skeletal muscle (SM) and fat mass is difficult in adolescents using non-invasive methods. To date, prediction equations for estimating SM volume (Midorikawa et al., British Journal of Nutrition, 2015) and fat mass (Midorikawa et al., British Journal of Nutrition, 2011) have been developed for prepubertal children using B-mode ultrasonography. Ultrasonography is a safe method for concurrent measurements of muscle and fat thickness of the extremities and trunk in children. Thus, the present study investigated the validity of prepubertal-based equations for regional SM and fat mass in Japanese adolescents.

METHODS: Twenty-seven healthy prepubertal Japanese children (10 boys and 17 girls) aged 11–17 years with Tanner stage > 1 participated in this study. Contiguous magnetic resonance images with 1-cm slice thickness and no-gap were obtained from the first cervical vertebra to the ankle joints. The SM volume was calculated by summing the digitized cross-sectional areas and dividing them into separate regions using anatomical landmarks (i.e. arms, trunk, thigh and lower legs). The volume units were converted into mass using an assumed SM density (1.041 g/cm3). Arm, trunk, and leg fat masses were determined using dual-energy X-ray absorptiometry. Muscle and fat thickness were measured by B-mode ultrasonography at nine sites (lateral forearm, anterior and posterior upper arm, abdomen, subscapular, anterior and posterior thigh, anterior and posterior lower leg).

RESULTS: When the prepubertal-based equations were applied to adolescents, mean values between measured (boys, arms: 1.94 kg, trunk: 6.76 kg, thigh: 8.25 kg, lower legs: 2.39 kg; girls, arms: 1.42 kg, trunk: 5.58 kg, thigh: 6.07 kg, lower legs: 1.96 kg) and predicted (boys, arms: 1.37 kg, trunk: 5.86 kg, thigh: 6.54 kg, lower legs: 2.10 kg; girls, arms: 1.05 kg, trunk: 3.89 kg, thigh: 4.91 kg, lower legs: 1.81 kg) regional segments of SM mass were significantly different for adolescents. On the other hand, the measured regional fat mass (boys, trunk: 3.38 kg, legs: 4.19 kg; girls, arms: 1.38 kg, trunk: 3.63 kg, legs: 5.18 kg) was similar to the predicted values (boys, trunk: 3.54 kg, legs: 4.11 kg; girls, arms: 1.36 kg, trunk: 3.87 kg, legs: 5.59 kg) except for the arms in boys (measured: 1.00 kg, predicted: 1.15 kg). The Bland–Altman analysis of regional fat mass did not indicate any bias in boys or girls, with the exception of the leg region in girls.

CONCLUSION: These results suggest that prepubertal ultrasound-derived prediction equations are useful for estimating trunk fat mass in both boys and girls. A larger study on developing an SM prediction model is needed for adolescents.

**GLOBAL RESEARCH STATUS AND TREND OF DIABETES EXERCISE PRESCRIPTION**

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INTRODUCTION: Diabetes, a global chronic metabolic disorder with a rising prevalence, significantly impacts quality of life and socio-economic systems. Exercise therapy is central to diabetes management, improving glycemic control, reducing weight, and enhancing cardiorespiratory fitness. Recent research has focused on the effects of exercise types, intensity, duration, and comprehensive interventions, yielding significant progress. However, exercise prescriptions require greater personalization and scientific rigor, especially considering individual differences and challenges like the COVID-19 pandemic. Emerging technologies, such as wearable devices and artificial intelligence, offer new opportunities for diabetes management. This article reviews advancements in exercise prescription for diabetes, analyzes current research trends, and aims to drive further progress in the field, enhancing health outcomes for diabetic patients.

METHODS: This study analyzed 1,832 English articles and reviews on diabetes exercise prescriptions from the Web of Science Core Collection (2000–2024). Using CiteSpace, VOSviewer, and Bibliometrix R-package, it explored publication trends, geographic and institutional contributions, journal sources, author networks, keyword patterns, and highly cited works. Combining quantitative and qualitative methods, the research identifies key dynamics and trends in the field.

RESULTS: Research on exercise prescription for diabetes shows distinct phases: exploratory (2000–2006), surge (2007–2010), exponential growth (2011–2019), and volatility (2020–2024). The United States leads in publications, followed by

Brazil and Canada. *BMJ Open* (UK) is the top journal, while Pauli, José Rodrigo and Universidade de São Paulo (Brazil) are the most prolific author and institution, respectively. Keyword analysis highlights diabetes management, physical activity, insulin resistance, cardiovascular prevention, and lifestyle interventions. Highly cited studies underscore exercises role in chronic disease management. The U.S. dominates the field, collaborating with Brazil, Australia, and Italy. Institutional contributions vary, but global collaboration is evident. Author analysis provides insights into key contributors and networks, guiding future research.

CONCLUSION: Research on exercise prescription for diabetes has advanced from basic management to comprehensive and adaptive strategies, including responses to specific challenges like pandemics. The field has deepened its scope, leveraging methodological innovations to create precise and effective health strategies. Future research will focus on personalized exercise prescriptions, interdisciplinary approaches, and the potential of emerging technologies (e.g., wearables, AI) in diabetes care, while prioritizing long-term efficacy and adherence. These efforts aim to improve health outcomes, enhance quality of life, reduce complications, and build a stronger scientific foundation for diabetes management.

**TEMPORAL PATTERNS OF EXERCISE AND THEIR INFLUENCE ON METABOLIC RESPONSES**

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INTRODUCTION: Exercise as a non-pharmacological intervention has been widely recognized for its benefits on metabolic health. The effects of morning or afternoon exercise on different metabolic indicators are different, and this paper aims to systematically evaluate and analyze the effects of exercise at different times on body composition, glucose metabolism and lipid metabolism.

METHODS: Following the PRISMA guidelines, this study conducted a literature search through electronic databases such as PubMed, Em base and Web of

Science. The included studies included exercise regimens in the morning, afternoon or morning and evening, and analyzed body weight, Body Mass Index, fat mass, fasting blood glucose, HbA1c, insulin, and triglycerides. The risk of bias was assessed using the Cochrane tool (Rob2), and publication bias was assessed by funnel plot and Egger test.

RESULTS: 13 long-term studies and 5 acute studies were analyzed(n=658 participants). Morning exercise (MT) was more effective in reducing body fat(MD-0.39, 95% CI [-0.66 to -0.13], $I^2$ = 0%, p = 0.004), waist circumference(MD-0.53, 95% CI[-1.06 to-0.00], $I^2$ = 31%, p = 0.05), and HbA1c(MD-0.11, 95% CI[-0.19 to -0.03], $I^2$ = 0%, p = 0.009), while afternoon exercise (AT) was better in lowering fasting blood glucose(MD 0.13, 95% CI [0.01 to 0.24], $I^2$ = 0%, p = 0.03) and triglycerides(MD 0.1, 95% CI [0.02 to 0.18], $I^2$ = 41%, p = 0.02).

CONCLUSION: Both morning and afternoon exercise are beneficial to metabolic health, but the effects are different. Morning exercise was more likely to reduce body fat, waist circumference and HbA1c, while afternoon exercise was more likely to reduce fasting blood glucose and triglycerides.

**EFFECT OF BODY COOLING IN URBAN AREAS ON CORE TEMPERATURE UNDER HOT ENVIRONMENT**

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INTRODUCTION: If active body cooling can be implemented to prevent heat stroke in the city, in addition to reducing the heat load on humans, it is possible to open up the area to the general public and thus make effective heat stroke prevention methods available to a large number of citizens. Preventing human health hazards in hot weather is considered an urgent issue in promoting walkable urban development, as advocated by the Ministry of Land, Infrastructure and Transport.

The aim of this study was to clarify the effects of body cooling during physical activity simulating daily life at Fukuyama Station on human thermokinetics, subjective thermal sensation and thermal pleasure/discomfort from the thermal environment and physiological indices.

METHODS: The subjects in this study were 10 healthy male adults (age: 20.4 ± 0.2 years, weight: 64.7 ± 10.6 kg, height: 173.6 ± 4.4 cm, BMI: 21.5 ± 3.4 kg/m2). In this study, we conducted two randomized crossover trials: a CON (control) condition in which participants consumed a cold beverage in the shade during rest periods between walks in the city, and a BC (body cooling) trial in which participants cooled their feet and palms with 15℃ water in addition to consuming a cold beverage in the shade. The two trials began at the same time (13:00). the participants started walking at a speed of 4 ～ 4.5 km/h to the rest point at 13:00 (outward). The distance from the starting point to the rest point was 1.1 km. Heart rate, core temperature, subjective thermal sensation and thermal pleasantness/discomfort were employed as measurement items.

RESULTS: Heart rate varied in dependence on physical activity intensity, but there were no significant differences between trials. During the outward walk, both trials showed a gradual increase in deep body temperature, and the CON trial group, which only consumed cold beverages at rest, continued to increase their core temperature until the end of the experiment. However, the BC trial group, who cooled their feet and palms with cold water at 5 minutes of rest and from 5 to 15 minutes on the return journey, showed a suppression of the increase in deep body temperature and a temporary decrease in deep body temperature at 5 minutes of rest (CON: 0.6 ± 0.4 °C vs. BC 0.2 ± 0.2 °C, P = 0.006). The BC trial

group also showed a suppressed increase in body temperature from the time of return walking to the end of the experiment, which was significantly lower than that of the CON trial group.

CONCLUSION: The results showed that 10 minutes of palm and foot cooling during walking in the city suppressed the increase in core temperature for 15 minutes after cooling at the normal walking intensity. The results suggest that active cooling of the body, in addition to the consumption of cold beverages, may contribute to the prevention of heat stroke during physical activity in the city during summer in Japan.

**THE EFFICACY OF A 12-WEEK HIGH-INTENSITY CIRCUIT TRAINING INTERVENTION ON MYOKINES, ADIPOKINES AND GUT MICROBIOTA IN OVERWEIGHT/OBESE SUBJECTS**

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INTRODUCTION: Obesity and cardiovascular diseases are closely linked to gut microbiota dysbiosis, which can lead to metabolic and inflammatory issues. High-Intensity Circuit Training (HICT) combines aerobic and resistance exercises to enhance cardiorespiratory fitness and muscle strength. However, its impact on gut microbiota remains unclear. This study mainly explores how HICT affects the myokines, adipokines and gut microbiota in overweight or obese individuals.

METHODS: A total of 29 overweight or obese participants were divided into a control group (n = 12, weight 76.32 ± 17.02 kg, BMI 27.94 ± 3.93) and an HICT group (n = 17, weight 71.38 ± 11.52 kg, BMI 25.91 ± 2.77). Both groups maintained their usual lifestyle without dietary changes, but the HICT group performed three weekly sessions of HICT for 12 weeks. Stool samples were collected before and after the study for DNA extraction and gut microbiota analysis via next-generation sequencing (NGS). Body composition, lipid profiles, and plasma levels of irisin, IL-6, IL-15, adiponectin, leptin, Nrg4, and omentin-1 were measured. Paired t-tests and McNemar tests assessed intervention effects.

RESULTS: HICT significantly reduced waist circumference and body fat percentage. LDL and total cholesterol levels increased in the exercise group, while IL-6 levels decreased. Adiponectin and omentin-1 levels increased, whereas neuregulin 4 levels decreased in both groups. Exercise enhanced gut microbiota diversity, increased short-chain fatty acid-producing bacteria, and regulated inflammatory responses. In contrast, the control group saw an increase in obesity-related and inflammatory gut bacteria. KEGG pathway analysis showed upregulation of pathways related to vitamin synthesis and cell structure reinforcement.

CONCLUSION: A 12-week HICT program improves body composition and gut microbiota in overweight and obese individuals, supporting metabolic and inflammatory health.

**STUDY OF THE SUBJECTIVE COMFORT AND OBJECTIVE ANTHROPOMETRIC MEASUREMENTS EFFECTS ON FORMED PILLOW ERGONOMIC APPLICATIONS**

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INTRODUCTION: Most memory pillow designs focus on supporting the neck and shoulders, particularly for back and side sleepers. This study evaluates their effectiveness in supporting the cervical vertebrae and surrounding muscles. Since comfort is subjective and varies from person to person, the aim is to analyze the differences between individual comfort perceptions and objective shoulder-neck width measurements to improve ergonomic pillow design.

METHODS: 125 subjects(weight: 63.10±13.87kg, height:164.35±7.85cm, BMI:23.27±4.40)were recruited in this study. The PROMIS Sleep Disturbance short-form questionnaire was collected for evaluation of sleep quality(34.44±16.72, F=0.46, P>.05), and the shoulder-neck width measurements were collected to evaluate for objective suitable pillow models(general, neck support, and shoulder-neck double support). The subjective personal preference selections model was collected for data analysis to examine the difference between the subjective comfort pillow model(SCP), objective anthropometric measurements pillow model(OPP), and personal preference pillow (PPP). The one-way ANOVA was used to data statistics and investigate the differences in different pillow choices(SCP, OPP, PPP). A paired T-test was used to analyze the differences between the SCP and OPP models comfort feelings and selections.

RESULTS: All the subjects were divided into five groups by age (Youth, Young adult, middle adult, old adult, old age groups, N=25 in each); the personal prefer pillow model(PPP), middle adult and old adult groups has significant differences choice with old age group(F=2.520, p<.25 ).and subjective comfort pillow model(SCP), young adult has significant differences choice with old adult group (F=2.537, p<.25); prefer in shoulder-neck double support model. SCP and OPP model comfort feeling did not show differences(2.80±1.03vs. 2.76±1.06, p>0.5), but significant differences in model selections(4.18±1.48vs. 3.80±1.79, p<.05).

CONCLUSION: Personal Pillow model choice variation would be affected by age and individual preferences. However, modern pillows are ergonomic and designed for sleep quality purposes; we suggest that the formed pillow shape and hardness design consider age influences.

**IMPACT OF ACTIVITY RESTRICTIONS DURING THE COVID-19 PANDEMIC ON THE PHYSICAL AND MENTAL HEALTH OF UNIVERSITY FRESHMEN: A TWO-YEAR COMPARATIVE STUDY**

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INTRODUCTION: The prolonged changes in living environments due to the spread of the novel coronavirus disease (COVID-19), along with associated shifts in chronic stress, physical activity levels, and daily routines, have raised concerns about their long-term impact on mental and physical health. Understanding these effects is crucial for developing strategies to maintain and promote health during infectious disease outbreaks. The purpose of this study was to examine annual changes in physical activity and physical and mental health among university students who experienced various activity restrictions in their learning environments during the pandemic.

METHODS: This study included 91 first-year university students enrolled in universities in Miyagi Prefecture who were taking physical education classes and agreed to participate in the survey. The survey was conducted over a two-year period (April to August 2020 and April to August 2021) and consisted of 15 assessments per year (once per week). The survey collected data on participant characteristics, physical activity (IPAQ-short version), mental health (K6), and health-related QOL (SF-8). In 2020, all physical education classes were conducted exclusively online throughout the survey period. In 2021, classes were partially in-person during the first half and fully in-person during the second half. During the survey period, participants were encouraged to record their physical activities, watch and follow exercise videos (e.g., YouTube), and engage in physical activity regularly. A linear mixed model was used to analyze the repeated measures data.

RESULTS: The total physical activity level was 1216.5±146.9 (METS*min/week) in 2020 and 2395.8±167.2 (METS*min/week) in 2021, indicating a significant increase in 2021. Notably, physical activity levels were significantly higher in the second half of 2021 compared to the first half ($p < .05$). Additionally, sitting time significantly decreased in 2021 on both weekdays and weekends ($p < .05$). While light-intensity physical activity (LPA) and moderate physical activity (MPA) showed no significant differences between 2020 and 2021, vigorous physical activity (VPA) significantly increased in 2021 ($p < .05$). Furthermore, in 2021, LPA and MPA were significantly higher in females, whereas no significant sex differences were observed in VPA. In contrast, no significant differences were found between the two years in mental health or health-related QOL.

CONCLUSION: It was shown that the COVID-19 pandemic affected the amount of physical activity of university students but did not affect their mental and physical health, but it was suggested that the situation of activity restrictions may bring about changes in these.

**HEART RATE RECORDED AMONG CHILDREN, ADOLESCENTS AND ADULTS DURING A 20 M RUNNING SHUTTLE TEST**

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INTRODUCTION: Age is an important determinant of the level of physical fitness. It is assumed to increase up to the age of 20, normalize between the ages of 20-25, and begin to decline thereafter, averaging 10% every ten consecutive years [1]. A study by Fleg et. al. showed that among 20-30 year olds, there is a decline in physical fitness with age shaped in the range of 3-6%, while in healthy people over 70 years of age, the rate reaches a value exceeding 20% for each decade [2].

METHODS: The study group consisted of male representatives (577 subjects) aged between 10 and 40 years. Height, body weight and its components were determined using innovative BIA technology. Cardiorespiratory endurance was determined using a 20-m shuttle test, the so-called Beep test (The Multi Stage 20-m Shuttle Run Fitness Test- SF20mMT) [3]. The initial speed is about 8.5km/h and increases, every minute by 0.5km/h [4].

RESULTS: The level of BMI has been proven to have a significant effect on both HR max and distance run. The results also confirmed that water content and body fat are highly correlated. The results obtained by each group allow an accurate assessment of the subjects physical fitness and allow the adjustment of training methods to their needs and abilities.

CONCLUSION: Studies show that there are (environmental as well as biological) determinants that lead to an increase in the number of beats per minute with age [5]. The above indicates that the correlations may be more complex, and that age is not the only variable to be considered in the issue under study.

The maximum heart rate decreases with age (the coefficient of the age variable is -0.32). The relationship of HR max with age in the group of athletes is much stronger than in other groups. BMI level is related to maximum heart rate and distance run. The higher the BMI, the lower the distance obtained in the fitness test.

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**EFFECTS OF MODERATE-INTENSITY ENDURANCE EXERCISE ON AGE-RELATED ENDOTHELIAL FUNCTION AND NITRIC OXIDE PRODUCTION IN AGED HYPERTENSION**

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INTRODUCTION: Aging is regarded as a major non-modifiable risk factor that promotes high blood pressure, inflammation, and age-related vascular dysfunction and remodeling. The influences of aging and hypertension on the cardiovascular dysfunction are relevant. Previous evidences have indicated that endurance exercise induces blood pressure-lowering effects, which could be related to the amelioration of endothelial function and nitric oxide (NO) production. However, the

influences of endurance exercise on the endothelial dysfunction and their underlying mechanisms in aged hypertension remain unclear. Therefore, this study aimed to investigate the effects of moderate-intensity endurance exercise on the age-related endothelial dysfunction and NO production in aged hypertension.

METHODS: The male aged spontaneously hypertensive rats (SHRs) were randomly assigned into the control (SHR-Con) and the exercise training (SHR-ET) groups, while age-matched Wistar-Kyoto rats were served as the normotensive control (WKY-Con) group. The SHR-ET group underwent moderate-intensity treadmill training for 1 h/day, 5 days/week, for 12 weeks. After 12-weeks intervention, the aortas of all groups were isolated for the evaluation of endothelial function by organ bath system, including vasorelaxant responses induced by insulin and insulin-like growth factor-1 (IGF-1). In addition, serum NO production was examined among three groups.

RESULTS: Compared to the SHR-Con group, the insulin-induced vasorelaxant responses were significantly enhanced in the SHR-ET group after 12 weeks of endurance exercise ($p < 0.05$). Additionally, the IGF-1-induced vasorelaxant responses showed significant improvement in the SHR-ET group ($p < 0.05$). In the endothelium-denuded aortic rings, no significant differences in the insulin- and IGF-1-induced vasorelaxant responses were found among three groups. Moreover, the NO concentration significantly increased in the SHR-ET group ($p < 0.05$) to the levels similar to those observed in the WKY-Con group.

CONCLUSION: This study indicated that moderate-intensity endurance exercise significantly improved the age-related endothelial function and NO production in aged hypertension. These beneficial effects may contribute to blood pressure reduction and play a role in the prevention and treatment of hypertension in elderly individuals.

**GENDER DIFFERENCES IN THE RELATIONSHIP BETWEEN PHYSICAL FITNESS COMPONENTS AND OVERWEIGHT AMONG ADOLESCENTS: INSIGHTS FROM A LARGE-SCALE STUDY IN CHINA**

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INTRODUCTION: Childhood and adolescent obesity remain critical global public health concerns. While the prevalence of adolescent obesity has stabilized in some countries, it remains alarmingly high [1]. Managing overweight and obesity in this age group is closely linked to physical fitness [2]. However, few studies have specifically examined the relationship between distinct physical fitness components and adolescent obesity levels. This study aims to investigate this connection by assessing how a targeted physical fitness influences overweight and obesity rates in adolescents.

METHODS: This cross-sectional study analyzed secondary data from 14,468 adolescent students (aged 6–15 years) in Guangdong Province, China, collected from physical fitness tests and health examinations conducted between 2021 and 2023. Among the participants, 53.2% were boys. The analyzed fitness assessments included cardiopulmonary function and endurance, power, speed, upper and lower-body muscle strength, and core strength. Adolescents were categorized as either "normal weight" or "overweight/obese" based on age-specific Body Mass Index (BMI) criteria.

RESULTS: The results indicate that the overall overweight rate among the tested adolescents was 19% (boys: 23.9%, girls: 13.9%). Multiple logistic regression analysis was performed to examine the relationship between overweight status and various physical fitness measures in boys and girls. The model explained 44.6% of the variance in overweight status for boys ($R^2 = 0.446$, $p < 0.01$) and 42.1% for girls ($R^2 = 0.421$, $p < 0.01$). Both boys and girls showed a significant association between cardiopulmonary function ($p < 0.01$) and power ($p < 0.05$) with overweight status. Additionally, in boys, upper-body muscle strength ($p < 0.05$) and speed ($p < 0.05$) were significant predictors of overweight status. In girls, core strength ($p < 0.05$) and endurance ($p < 0.05$) were also significantly associated with overweight status.

CONCLUSION: This study identified gender differences in the relationship between obesity and physical fitness components among adolescents. The impact of various fitness attributes on overweight differs between boys and girls, suggesting the need for gender-specific physical fitness programs to address overweight and obesity effectively. Further research is needed to explore the underlying physiological mechanisms driving these differences.

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**REDUCING VOICE FATIGUE THROUGH BREATHING EXERCISES: A POTENTIAL OF INTERVENTION FOR TEACHERS**

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INTRODUCTION: Voice fatigue is a common problem among people in speaking-intensive professions, such as teachers, who rely on their voices throughout the workday [1]. Teachers are particularly vulnerable due to the noisy classroom environment, long speaking hours, and the need to project their voices over disturbances [2]. The hypothesis of this study is that breathing exercises can reduce voice fatigue in teachers and improve their overall quality of life, including sleep quality. This research aims to develop and implement a set of targeted breathing exercises designed to reduce voice fatigue in teachers.

METHODS: The study targeted 101 teachers at various educational levels, from elementary to higher education, as they are a high-risk group for voice-related problems. The research methods are the Standardized Voice Risk Factor Questionnaire, Vocal Symptoms Scale, Voice Handicap Index (VHI) were adopted for use in the Latvian cultural environment and distributed to collect relevant data. The survey aimed to assess the prevalence of voice problems, including fatigue, vocal strain, breathlessness, and difficulty speaking during the day. Teachers were asked about their work environment, the frequency and severity of their voice problems, and the impact these issues had on their general well-being, including sleep. According to the survey results, targeted breathing exercises were designed and implemented to reduce voice fatigue in teachers (n=30).

RESULTS: The results of the questionnaire revealed that teachers face a variety of voice-related problems, including fatigue of the voice, breathlessness while speaking, variations in voice noise, and cracks in the voice. These issues were found to affect the teachers ability to communicate effectively, with teachers reporting reduced voice clarity, especially in the evening. Although most of the responses indicated mild voice problems, many teachers acknowledged that these problems impacted their overall quality of life.

CONCLUSION: The voice problems reported by the teachers were not severe, the constant vocal strain throughout the day indicates a potential benefit of integrating breathing exercises into their routine. Breathing exercises have the potential to reduce voice fatigue and improve general well-being, for teachers and other individuals in speaking-intensive professions. More research is needed to evaluate breathing exercises and their long-term effectiveness in reducing voice-related issues.

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**FALL PREVENTION THROUGH STRENGTH: WHICH TRAINING WORKS BETTER FOR THE ELDERLY?**

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INTRODUCTION: Falls are a leading concern among the elderly, often linked to declining muscle strength. While traditional resistance exercises are commonly used to counteract this, alternative methods are gaining attention. This study compares the effectiveness of two intervention programs - resistance-endurance and sensorimotor training—on muscle strength in elderly women.

METHODS: Twenty active, healthy elderly women were randomly assigned to one of two groups. The resistance-endurance group (REG, n=10, age: 73.8±2.9 years, body weight: 71.6±14.6 kg, BMI: 27.4±4.3) participated in a 10-week resistance-endurance program. The sensorimotor group (SMG, n=10, age: 72.9±4.1 years, body weight: 67.3±10.0 kg, BMI: 25.8±4.5) underwent sensorimotor training. Both groups trained twice weekly for 40 to 60 minutes per session. Maximal voluntary isometric contraction (MVC) of knee extension was measured using a dynamometric chair before and after the interventions.

RESULTS: Both interventions significantly improved isometric strength ($p < 0.05$). In REG, left leg strength increased from 102.0±36.5 to 113.6±31.3 $N{\cdot}m^{-1}$ and right leg from 102.3±34.8 to 119.1±32.2 $N{\cdot}m^{-1}$. In SMG, left leg strength rose from 106.6±18.2 to 117.6±18.9 $N{\cdot}m^{-1}$ and right leg from 115.5±21.2 to 128.7±19.7 $N{\cdot}m^{-1}$. There were no significant differences in strength gains between the two groups.

CONCLUSION: Both resistance-endurance and sensorimotor training effectively enhance muscle strength in elderly women. Sensorimotor training, in particular, offers a viable alternative for strength improvement in untrained elderly individuals, highlighting its potential for fall prevention.

Acknowledgment

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**THE EFFECTIVENESS OF EXERCISE AND ROWING IN IMPROVING PHYSICAL FITNESS AND ENJOYMENT OF ACTIVITY IN BREAST CANCER SURVIVORS**

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INTRODUCTION: Numerous studies highlighted the importance of physical exercise in improving physical fitness (PF) among breast cancer survivors1. Rowing emerged as a valuable form of physical activity, yielding improvements in both anthropometry and aerobic capacity, muscle strength and general flexibility, that encouraged active participation2. The study aimed to evaluate the impact of a structured 6-month exercise program – which included one weekly session of

sculling (a form of sliding-seat rowing moving the boat with two oars per rower), one or two weekly sessions of Adapted Physical Activity (APA), and walking – on PF and exercise perception.

METHODS: The project "Effect and efficacy of Rowlng in breast CancEr survivors" (ERICE) included 27 women breast cancer survivors (age 56.7±6.5 yrs; BMI 23.9±2.9 kg/m2; stages I, II, or III; surgery at least 6 months to a maximum of 20 years ago). The sample underwent two testing periods: before (T0, March) and after (T1, October) the exercise protocol. The evaluated characteristics were cardiorespiratory fitness (6 Minute Walking Test _6MWT), muscular endurance (30s Chair Stand Test_30CST), flexibility (V Sit and Reach_VSR), and enjoyment in performing physical exercise (Physical Activity Enjoyment Scale _ PACES-It).

RESULTS: Nineteen subjects who completed the program were included in the analysis, only 13 attained the required adherence (75%; N: 6_NAD vs N: 13_AD). The results indicate a slight improvement in the physical fitness parameters: aerobic endurance (6MWT_T0: 631.7±48.9; T1: 630.5±57.0 m) remained stable, muscular endurance increased (30CST_T0: 14.2±2.1; T1: 15.5±1.8 reps), while flexibility declined (VSR_T0: 25.6±11.5; T1: 24.3±10.2 cm). The perception of enjoyment (PACES-It) attained a greater improvement in women who achieved the required adherence (ΔAD, 4±8.6 vs ΔNAD, -7±14.6, p=0.05).

CONCLUSION: Physical exercise, including sculling, has been shown to have an impact on functional fitness and the perception of enjoyment in breast cancer survivors. Notably, improvements in physical quality parameters were observed only among participants who had below-average baseline (T0) values or achieved adherence levels above 90%. This suggests that high program compliance and lower initial fitness levels may be critical factors in optimizing the benefits of the exercise intervention. Further studies are needed to evaluate the effects of exercise programs of different types and intensities to better understand these relationships.

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**EXTRA-CURRICULAR SPORT-BASED TRAINING PROGRAMS CAN ENHANCE PHYSICAL AND COGNITIVE DEVELOPMENT OF CHILDREN WITH AUTISM SPECTRUM DISORDERS: A PILOT STUDY**

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INTRODUCTION: Children with Autism Spectrum Disorders (ASD) are primarily characterized by impairments in social communication and motor skills, which can affect their independence and increase their reliance on caregivers. Furthermore, children with ASD tend to be more sedentary than their typically developing (TD) peers, which negatively impacts their physical and cognitive development [1]. Therefore, this study aimed to determine the effects of extracurricular sport-based training programs on motor coordination and functioning in children with ASD.

METHODS: Twenty primary school children with ASD (ages 8.7±1.6 years; 5 females) participated in a six-month self-chosen sport-based training program (i.e., swimming, team sports, individual sports). Before and after the program, total reaction time was evaluated using a simple (by identifying the targeted stimulus) and complex (by discriminating the targeted stimulus among confounding signals) reaction test, while fine and gross motor coordinations were assessed by transferring pennies, jumping in place-same sides synchronized, tapping feet and fingers-same side synchronized [2], and the Flamingo test [3]. A subgroup of ten children prolonged the intervention until 12 months and were further tested.

RESULTS: A significant reduction (p=0.025, d=0.125) emerged for the entire sample in total time of the complex reaction test (pre: 14.05±11.2 s; post: 12.8±8.6 s). Additionally, the Flamingo test approached a significant decrease (pre: 9.8±3.5 pt.; post: 6.8±4.6 pt.; p=0.057, d=0.73). Among the subgroup that underwent three evaluations, a main effect was observed for the simple reaction test (p=0.013, $\eta p2$=0.33) and the jumping in place test (p=0.05, $\eta p2$=0.20). Compared to baseline measurement (12.9±9.6 s), total time of the simple reaction test was significantly reduced after six months (10.9±7.2 s; p=0.021, d=0.235) and after one year (8.0±3.0 s; p=0.011, d=0.689). Post hoc analysis did not confirm differences for jumping in place test. Notably, two of the low-functioning children, who were unable to perform any motor tests before the program, managed to complete both reaction tests afterward. No significant differences were found for the remaining tests.

CONCLUSION: Extracurricular sport-based training programs showed promising effects to improve reaction abilities and gross motor coordination in children with ASD. The proposed tests centered on simple and complex reaction tasks are the most effective to detect changes in children with ASD, particularly those with lower functioning. These results support the importance of participating in prolonged physical activity and sport programs during the developmental stages of children with ASD to sustain their physical and cognitive development. Strongest evidence could be obtained by increasing the sample size and the duration of the intervention programs.

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**EXPLORING THE EFFECT OF PHYSICALLY ACTIVE DAYS ON MENTAL HEALTH STATUS AND LIFE SATISFACTION AMONG AGING POPULATIONS IN EUROPE**

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INTRODUCTION: Physical activity (PA) is widely recognized as a key determinant of health and well-being in older adults. While previous research has established direct links between PA and general and mental health, the potential mediating role of mental health in the ageing population remains less examined. Understanding these mechanisms could inform more effective interventions aimed at improving overall life satisfaction in aging populations. This study examines whether mental health mediates the relationship between PA and life satisfaction in ageing adults in Europe.

METHODS: Data were obtained from a multinational, country-representative dataset, the European Social Survey, round 11 (2023/2024), which included a sample of older adults (n=10646, ≥65 years). PA was assessed using survey question about how many days in a week they did sport or physical activities for at least 30 minutes, and general health was measured via self-reported health status. Mental health was evaluated using the total score of validated scales measuring psychological distress, depression, or subjective well-being. Correlation and mediation analysis was conducted using regression models and bootstrapping procedures to test the indirect effect of PA on life satisfaction through mental health. The statistical analysis was performed by IBM SPSS 28.0 and JASP 0.19.3 software; the level of significance was set at $p<0.05$.

RESULTS: The average age of the respondents was 73.93±6.59, 47.2% male and 52.8% female. The average number of days of doing sports activity at least 30 minutes was between 1.22-4.07 in the European countries; in Hungary, it was 1.37±2.23. The PA showed significant correlation with mental ($r=-0.330$, $p<.001$) and physical health status ($r=-0.343$, $p<.001$). Mediation analysis was performed to prove the positive effect of PA on older adults' life satisfaction, the PA was showed weak direct effect on subjective life satisfaction and significant indirect effect $\beta = [0.121]$, 95%CI [0.113-128], $p < .001$, furthermore mental health significantly mediated this relationship, with an effect of $\beta = [0.503]$, 95%CI [0.476-0.531], $p < .001$.

CONCLUSION: These findings highlight the prevalence of active days of the ageing population in Europe and the role of mental health in explaining the beneficial effects of PA on general health in older adults. Interventions aimed at promoting PA among older adults should also consider strategies to enhance mental well-being to maximize health benefits. Acknowledgement: The research was funded by MEC_R 149055 and project no. TKP2021-EGA-10 has been implemented with the support provided by the Ministry of Culture and Innovation of Hungary from the National Research, Development and Innovation Fund, financed under the TKP2021 funding scheme.

**EFFECTS OF HIGH-INTENSITY INTERVAL TRAINING ON BLOOD PRESSURE REGULATION AND COGNITIVE FUNCTION IN HIGH-FAT DIET-INDUCED METABOLIC SYNDROME**

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INTRODUCTION: The prevalence of metabolic syndrome (MetS) is increasing, affecting nearly 20-25% of adults worldwide and contributing to the global epidemic of cardiovascular disease and type 2 diabetes. The key characteristics of MetS include hypertension, insulin resistance, and hyperlipidemia, primarily caused by excessive caloric intake and reduced physical activity. These factors could lead to mitochondrial dysfunction, which may contribute to cognitive decline. Previous studies have indicated that endurance exercise improves cardiorespiratory fitness, reduces chronic inflammation, and enhances cognitive function. High-intensity interval training (HIIT) has been extensively studied for its cardiovascular and metabolic benefits, providing similar fitness as continuous endurance exercise. However, the effects of HIIT on blood pressure and cognitive function in high-fat diet-induced MetS remain unclear. Therefore, this study aimed to investigate the effects of twelve-weeks HIIT intervention on blood pressure regulation and cognitive function in high-fat diet-induced MetS.

METHODS: This study used male spontaneously hypertensive rats (SHR) feeding with high-fat diet as the MetS model, while age-matched normotensive Wistar-Kyoto rats (WKY) feeding with normal diet as the normal control group. At 12 weeks of age, the animals were assigned to three groups: high-fat diet control group (HFD-CON), HFD with HIIT group (HFD-HIIT), and normal diet control group (ND-CON). The HFD-HIIT group performed high-intensity interval training on the treadmill for 12 weeks, while the HFD-CON and ND-CON groups did not undergo any training. Throughout the experiments, resting blood pressure and heart rate were measured before and after the intervention. Moreover, cognitive function was assessed using the Morris water maze at the end of the study.

RESULTS: After 12 weeks of high-intensity interval training, compared with the HFD-CON group, the HFD-HIIT group exhibited significant reductions in resting heart rate, systolic blood pressure, diastolic blood pressure, and mean blood pressure ($p < 0.05$). Regarding the results of the Morris water maze, compared with the HFD-CON group, the HFD-HIIT group showed shorter escape latency, similar to the ND-CON group. However, there were no significant differences in the frequency and percentage of time staying in the correct quadrant among three groups.

CONCLUSION: Our results suggested that 12-weeks high-intensity interval training could improve blood pressure regulation and parts of cognitive function in high-fat diet-induced metabolic syndrome.

**EVALUATION OF CORE MUSCLE ACTIVATION DURING BRIDGE EXERCISES ON STABLE AND UNSTABLE SURFACES AT VARIOUS KNEE ANGLES**

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INTRODUCTION: Bridge exercises have commonly been employed as a core exercise method to improve core stability and strength. Additionally, instability training is an effective method to prevent low back pain (LBP). However, there is a lack of scientific evidence to suggest proper knee angles and the effect of bridge exercises on unstable surface training. Therefore, this study aimed to compare core activity between three knee angles (60°, 90°, and 120°) and surface conditions (stable and unstable) during the bridge exercise.

METHODS: The study recruited ten participants between 20 and 30 years of age with no musculoskeletal injuries. Surface EMG was used to record core muscle activity on the experiment date for each participant. The test was divided into two sections using surface EMG: measuring Maximum Voluntary Isometric Contraction (MVIC) for each muscle and recording core muscle activity during the bridge exercise. During the experiment, the participants randomly performed bridge exercises at three knee angles, with and without BOSU.

RESULTS: The results of the study regarding the EMG of the bridge exercise on both stable and unstable surfaces at different knee angles showed that the biceps femoris and erector spinae activity significantly increased on the unstable surface with a knee angle of 120° by repeated one-way ANOVA ($p < 0.05$). In addition, comparing muscle activity between stable and unstable surfaces using a paired t-test revealed that biceps femoris and external oblique muscle activity significantly increased during the bridge exercise ($p < 0.05$). The results of this study showed that bridge exercise with a knee angle of 120° and exercise on an unstable surface are efficient methods for increasing muscle activity in the biceps femoris, erector spinae, and external oblique muscles.

CONCLUSION: Changes in the knee angle and surface would lead to increases in core muscle activity. The results of this study showed that bridge exercise is not a high muscle activation exercise in abdominal muscles (rectus abdominal, rectus femoris and external oblique) compared to back muscle (erector spinae, gluteus maximus and biceps femoris muscles); it may be used to tailor core stability exercise training for establishing better co-contraction between abdominal muscle and back muscle groups during the rehabilitation of low back pain. The commonly prescribed rehabilitation practice involves low-intensity training and focuses on the recovery and strengthening of core muscles so that they can return to normal strength and stability. This would also involve patients re-learning the effective use of their core muscles. Therefore, the present study suggests that knee angle and surface type should be considered when using bridge exercises to improve core muscle stability and strength after taking into account the condition of the subject, their history of back pain, and rehabilitation.

**THE IMPACT OF HIGH-INTENSITY INTERVAL TRAINING ON VASODILATION AND BODY COMPOSITION IN METABOLIC SYNDROME INDUCED BY HIGH-FAT DIET**

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INTRODUCTION: Previous studies have demonstrated that a high-fat diet induces metabolic syndrome (MS), which may be related to the increased oxidative stress and reduced nitric oxide production, leading to endothelial dysfunction. Engaging in regular physical activity is considered a non-pharmacological strategy for managing MS. High-intensity interval training (HIIT) offers a more time-efficient exercise regimen that may achieve comparable or even superior outcomes to traditional moderate-intensity continuous training, particularly for cardiovascular health. Therefore, this study aims to investigate the effects of HIIT on vasodilation and body composition in the high-fat diet-induced MS.

METHODS: The male spontaneously hypertensive rats (SHR) with high-fat diet, as the animal model of MS, and normotensive Wistar Kyoto (WKY) rats with normal diet were used in this study. The rats were divided into three groups: the MS with HIIT group (MS-HIIT), the MS control group (MS-Con), and the normal diet control group (ND-Con). The intervention commenced when the rats reached 12 weeks of age and lasted for 12 weeks. The MS-HIIT group underwent high-intensity interval training by the treadmill, while the MS-Con group and ND-Con group did not receive any training. At the end of the intervention, endothelium-dependent and endothelium-independent vasodilatory responses, induced by acetylcholine (ACh) and sodium nitroprusside (SNP) respectively, were assessed. Additionally, the body composition was measured and compared among the three groups.

RESULTS: Compared to the MS-Con group, the MS-HIIT group showed a significant improvement in the ACh-induced vasodilatory response ($p < 0.05$), although it remained significantly lower than that of the ND-Con group ($p < 0.05$). Following the incubation with the nitric oxide synthase inhibitor NG-nitro-arginine methyl ester (L-NAME), ACh-induced vasodilatory responses were significantly reduced ($p < 0.05$), with no significant differences observed among the three groups. For SNP-induced endothelium-independent vasodilation, there was no significant differences among the three groups. Moreover, regarding body composition, the percentage of body fat was significantly decreased in the MS-HIIT group compared to the MS-Con group ($p < 0.05$).

CONCLUSION: This study suggested that high-intensity interval training could improve the endothelium-dependent vasodilation and reduce the percentage of body fat in metabolic syndrome induced by high-fat diet.

**USABILITY AND ACCEPTABILITY EVALUATION OF EMS SMART SUIT BASED ON PHYSIOLOGICAL EFFICACY EXERCISE INTERVENTION**

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INTRODUCTION: Electrical Muscle Stimulation (EMS) technology has been developed as a practical approach to reducing age-related decline in muscle mass and strength. A wearable EMS smart suit enables targeted muscle activation during low-intensity exercise and may provide an accessible alternative to high-intensity training. However, although usability and acceptability are crucial for long-term adherence, studies combining these aspects with physiological efficacy remain limited. This study aimed to evaluate the usability and acceptability of EMS smart suits alongside a physiologically effective exercise intervention to inform optimal wearable design strategies.

METHODS: Healthy participants aged 20–50 years without musculoskeletal disorders were recruited and randomised into two groups: an exercise group using EMS smart clothing, which compared a prototype EMS system to commercial EMS wearables, and a control group and a control group. Both groups participated in a 6-week exercise intervention, performing low-intensity, full-body, and postural exercises (including squats, lunges, wide squats, crunches, over-extensions, and table holding) three times per week for 30 min per session. Usability and acceptability were evaluated through structured questionnaires and semi-structured interviews, addressing aspects such as comfort, fit, ease of use, and perceived effectiveness of EMS stimulation. Additionally, physiological efficacy was measured by assessing body composition, muscle mass, and postural stability using a body composition analyser and postural assessment tools before and after the intervention.

RESULTS: Participants using the prototype EMS smart clothing reported significantly higher usability and acceptability scores than those using commercial devices, particularly in comfort and fit. However, device weight and suboptimal electrode placement were identified as key barriers. Despite positive subjective usability outcomes, no statistically significant physiological changes were observed during the six weeks.

CONCLUSION: The integration of usability, acceptability, and physiological efficacy measures in this study highlights the complex interplay between device design and user experience. Although the prototype EMS suit demonstrated improved comfort and user satisfaction, addressing issues such as device weight and electrode placement is essential to enhance both immediate usability and long-term adherence. Future research should explore extended interventions and design refinements to validate physiological benefits further and ensure the seamless integration of EMS smart wear into everyday routines.

**SEDENTARY BEHAVIOUR AND HEALTH IN ADULTS: A SYSTEMATIC REVIEW**

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INTRODUCTION: Previews systematic reviews (SR) have focused on a limited number of health outcomes and some have yielded inconclusive evidence for certain outcomes. This SR aimed to summarise the evidence on the associations between sedentary behaviour (SB) and a comprehensive set of health outcomes, in adults aged 18-64.9 years.

METHODS: PubMed, PsycINFO, CINAHL, SPORTDiscus and Web of Science were searched from inception until January 2021 and updated in June 2023. Studies' quality was rated according to the GRADE Framework.

RESULTS: This SR included 254 reports (67.7% cross-sectional, 31.9% longitudinal and 0.4% RCTs), representing 7 787,236 adults. Most reports (82%) assessed SB with self-reported instruments, 16% with device-measured, and 2% used device-measured and self-reported instruments simultaneously. Studies' quality varied from very low to high. Regarding critical outcomes, results show consistent evidence on the detrimental association of different types, frequencies, and durations of SBs and overweight or obesity, Type 2 Diabetes, Metabolic Syndrome or clustering of cardiovascular disease (CVD) risk factors; and, less consistent evidence for the detrimental association of different types, frequencies, and durations of SBs and coronary artery disease and stroke mortality, coronary artery disease and stroke, Alzheimer's disease and depressive symptoms. The associations between different types, frequencies, and durations of SBs and hypertension, anxiety symptoms and different types of cancers considered in this review, were mostly null. Concerning important outcomes, detrimental associations of different frequencies, types and durations of SB were consistently seen for absenteeism/presenteeism, health-related quality of life (HRQoL) and dyslipidaemia; less consistent evidence was observed for fitness, whereas the associations between SB and academic achievement or osteopenia/osteoporosis were mostly null. From the dose-response or exposure/outcome gradient associations between SB (total sitting time and TV viewing) and hypertension, overweight/obesity, type 2 diabetes, metabolic syndrome or clustered CVD risk factors, depressive symptoms, HRQoL and dyslipidaemia, it can be concluded that excessive total SB (> ~8h/day) and TV viewing (>2h/day) are health-detrimental.

CONCLUSION: There is compelling evidence of the detrimental health-related associations of excessive sedentary behaviour, in adults. The findings support the Canadian 24h Movement Guidelines for adults, which recommend limiting the amount of SB to <8h/day and breaking up prolonged bouts of SB as often as possible.

**THE EFFECT OF EXERCISE PROTOCOLS ON SHEAR WAVE VELOCITY OF THE MEDIAN NERVE AND 3RD FDS IN PATIENTS WITH CARPAL TUNNEL SYNDROME**

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INTRODUCTION: Carpal tunnel syndrome (CTS) is associated with increased tendon stiffness due to chronic resistance training, which enhances collagen fibril diameter and density [1]. Triggered hypertrophy of synovial fluid surrounding the flexor digitorum superficialis (FDS) tendons causes an increase in CT pressure, leading to median nerve entrapment [2] and decreased nerve elasticity [3]. Apart from median nerve shear wave velocity (SWV), studies suggest that 3rd FDS SWV could be a non-invasive biomarker for intracarpal pressure and CTS diagnosis [4, 5]. Hand strength exercises may also reduce CTS symptoms and improve diagnosis in haemodialysis patients [6]. However, commonly used exercises for CTS are the nerve-gliding exercises. Nerve gliding exercises used together with conventional treatment resulted in faster pain relief, increased nerve elasticity and improved function [7, 8]. Our study aims to evaluate the effect of different exercise regimens on SWV of the median nerve and 3rd FDS in patients with mild to moderate CTS.

METHODS: Forty-six CTS patients were divided into three groups: nerve and tendon gliding exercise group, strength exercise group and control. In total, 87 hands with mild or moderate CTS were assessed. Participants followed a three-week exercise regimen performed once daily. SWV measurements were obtained longitudinally to the nerve, using Canon Aplio i800 ultrasound with linear probe LX18i5. A longitudinal US image of the median nerve and 3rd FDS was used for SWV measurement. The region of interest (ROI) was within the median nerve epineurium and the hyperechogenic borders of the 3rd FDS tendon. SWV values for the median nerve and 3rd FDS inside the carpal tunnel were recorded pre-and post-intervention. Three consecutive SWV measurements were recorded, and the median value was statistically analysed.

RESULTS: Across the three groups, no statistically significant differences in SWV values were observed between the pre- and post-intervention. However, a trend was noted in the nerve and tendon gliding group, with decreased SWV in both the median nerve and 3rd FDS. In the strengthening exercise group, a reduction in the mean SWV was observed only in the median nerve while SWV of the 3rd FDS was slightly increased post-intervention. No measurable changes or trends were observed in the control group. The cross-sectional area of the nerve did not change in any of the three groups.

CONCLUSION: Although statistical significance was not achieved, the observed trends suggest that specific exercises may reduce mechanical stiffness in the median nerve and 3rd FDS in patients with CTS. While previous studies suggest that neurodynamic mobilization improves CTS symptoms and reduces SWV [9], the absence of significant SWV alterations in our study may be attributed to the relatively short intervention duration and potential non-adherence to instructions by patients. Further studies with larger sample sizes and longer intervention durations are required.

**EFFECT OF STATIC STRETCHING AND FOAM ROLLING OF THE CALF AND HAMSTRING MUSCLES ON KNEE ROM OF THE DOMINANT LEG**

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INTRODUCTION: Myofascial chains ensure body continuity and transmit forces across the body (1, 2). In this way, joints play a fundamental role as rings of these chains. Hence, techniques aimed to improve muscular flexibility such as static stretching (SS) and foam rolling (FR) can induce enhancements in joints range of motion (ROM) both in healthy subjects as well as in subjects with conditions as knee osteoarthritis (KOA), where it is reduced joint function and mobility (3). Given that these two muscle groups (i.e., calf and hamstring) are connected in a myofascial chain (i.e., the superficial back line) (4), this study hypothesizes that a SS and FR protocol for the calf may affect knee flexion and extension ROM similarly to a SS and FR protocol for the hamstrings.

METHODS: A total of 40 healthy subjects were divided into 4 groups of 10 participants as follows: SS of the calf (SSC); SS of the hamstring (SSH); FR of the calf (FRC); FR of the hamstring (FRH). Participants performed 3 sets of 1 minute with 30 seconds of rest, maintaining a discomfort level of 7/10. Knee flexion and extension ROM of the dominant leg were measured before (T0) and 5 minutes after the last session (T1) using an inertial sensor (Beyond Inertial, Motustech Srl).

RESULTS: No significant differences were found between and within group in ROM knee extension for all the groups. As for ROM knee flexion, the FRH group showed an improvement compared to the SSH group (p=0.001) at T1. Moreover, also the FRC reported an improvement compared to the SSH group (p=0.021) at T1. In addition, the FRH group increases ROM knee flexion from T0 to T1 (p=0.008).

CONCLUSION: Based on these results, we confirm that a connection between calf and hamstring muscles could exist, and that the FR could be more effectiveness than SS. However, it should be further investigated which of these two muscle groups is more appropriate to release for greater benefits on knee ROM.

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**THE EFFECT OF HIGH-INTENSITY INTERVAL TRAINING ON AEROBIC PERFORMANCE AND BODY COMPOSITION IN YOUNG PHYSICALLY ACTIVE MEN**

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INTRODUCTION: The aim of this study was to examine the impact of three-week high-intensity interval training (HIIT) on different parameters of body composition and aerobic performance in young physically active men.

METHODS: The participants were 10 (25,9±3,3 years; 178.3±6.1 cm; 83.3±20.3 kg) physically active men. They performed maximum intensity training (six times 30 Wingate test intervals for 4 minutes) on a cycling ergometer (Monark 834E, Sweden) for three consecutive weeks, three times a week. Before and after the 3-week training period, body composition by dual-energy X-ray absorptiometry (Hologic Discovery QDR Series, USA) and aerobic velocity on cycling ergometer (Lode Corrival Ergometer, LODE Holding Co., Groningen, The Netherlands) were measured. Oxygen consumption was determined by the Cortex Metamax 3B (Cortex Biophysic GmbH, Leipzig, Germany). The incremental test was performed with the first load of 40 W, and each subsequent load was 1 min long and increased by 20 W.

RESULTS: As a result of the HIIT training, a significant increase in maximum oxygen consumption (3687.30 ± 221.474 to 3920.90 ± 462.752 l/min), maximum oxygen uptake threshold (286,50 ± 37,298 to 300,60 ± 37,616 ühik), respiration rate (52.83 ± 12.685 to 59.15 ± 15.841 ühik), maximum power (294.80 ± 37.941 to 312.60 ± 33.669 ühik) and load capacity (3.64 ± 0.586 to 3.85 ± 0.526 ühik). There were no statistically significant changes in the measured body composition values after training period.

CONCLUSION: Three weeks of high-intensity interval training is suitable for increasing maximal aerobic capacity, while no changes in body composition occurred in young physically active men.

**THE EFFECT OF A SEGWAY RIDING PROGRAM ON SIT-TO-STAND PERFORMANCE IN WOMEN**

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INTRODUCTION: Personal means of transportation or electric-powered micro–Personal Mobility Vehicles (e-PMVs) have increased in popularity and revolutionized the urban transport sector (1). Research reported relatively low usage among the public, despite a high interest in trying the devices (2). The Segway minipro® is a personal transporter device that has been considered as a possible alternative mobility means for people with disabilities, although initially designed for recreational purposes (3,4). The segway is found to require a decreased level of energy expenditure as well as a reduced amount of upper body strength to move around (4). Boutilier and Sawatzky (2010) investigated the minimum mobility requirements for riders to use a powered mobility device such as the Segway; their results demonstrated no correlation between the functional assessment of the patients and their ability to complete the segway task. A reduced amount of spasticity in patients was recorded following the segway training. Anecdotal reports in balance improvements were mentioned but no data was collected to support those statements. This study investigated critical sit-to-stand variables as they relate to balance abilities in women after a 3-week training of segway minipro® riding.

METHODS: Seven Women (54.6 ± 6.7 years) from a Southwest US rural town were recruited for this study. All participants were healthy and had no injuries during the previous 6 months. All participants completed the sit-to-stand test on the Neurocom Balance Master®, following the manufacturer protocol; a 3-week program was implemented with 3 riding sessions (3x30 minutes/week) with a progression in difficulty, totaling 9 riding sessions. Two riding sessions were added after the initial testing and prior to the program implementation for familiarization and safety.

RESULTS: Paired sample t-tests of the weight transfer (WTT), the rising index (RI), and the center of gravity sway velocity (COGSV) were analyzed at the completion of the Segway Riding program. The WT data showed no significant differences ($t(6) = 2.447$, $p = 0.354$); Both RI and COGSV showed significant differences ($t(6) = 1.943$, $p = 0.021$; $t(6) = 1.943$, $p = 0.032$).

CONCLUSION: Although the sample is small, there seems to be a significant improvement in energy efficiency in the sit-to-stand while the overall weight transfer is not affected. As the COGSV values significantly decreased at the end of the program, better control of the body movement could be suggested. This could suggest that the 3-week segway riding program may have contributed to enhanced balance and control during the sit-to-stand for women.

**SPATIAL ACCESSIBILITY AND COMPENSATORY ROLES OF GREEN SPACES FOR ELDERLY INDIVIDUALS WITH HIGH DEPENDENCY IN URBAN AREAS: A CASE STUDY OF HARBINS CENTRAL URBAN AREA**

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INTRODUCTION: In aging cities with high population density, elderly individuals aged 65 and above, living alone and relying on walking for mobility, typically engage in low-intensity physical activities and depend on the built environment.

They often rely on park green spaces within walking distance for social interaction and recreation. Regular engagement in such activities-particularly walking in green spaces-is linked to improved cardiovascular health and mental well-being, yet limited park accessibility may constrain these behaviors and exacerbate sedentary health risks. This study examines the spatial accessibility of parks and the potential role of alternative green spaces, such as community parks, for elderly individuals. The findings highlight the importance of ensuring equitable access to green spaces for vulnerable elderly populations in urban areas, which can inform future urban planning to better meet health-related needs of this group.

METHODS: Through semi-structured interviews and behavioral analysis, this study selected a group of 215 elderly individuals with low activity levels living alone, examining their walking time thresholds and park usage patterns. Using QGIS integrated with Baidu API for route planning, the study calculated the actual walkable accessibility of parks. The study developed a basic function index (Fb) and a complementary function index (Fc) for park green spaces, and employed spatial clustering and regression analysis to identify low-functioning areas and the factors driving planning deficiencies.

RESULTS: The study found significant spatial variation in park accessibility for elderly individuals with high dependency and low activity levels in Harbins central urban area, particularly in areas with poor walkability. Substitute spaces such as community green spaces and squares partially compensated for the functional gap left by park green spaces, but in areas with poor walkability, the compensatory effect was limited, which increased the disparity in park green space usage.

CONCLUSION: The research highlights that elderly individuals with high dependency and low activity levels encounter green space gaps and usage disparities in their daily park activities. The absence of park green spaces and insufficient substitute spaces in peripheral areas limit the social and physical activities of this elderly group. It is recommended that urban park planning prioritize vulnerable groups, enhance the functional value (Fb) of parks in peripheral areas, and improve the compensatory role (Fc) of alternative green spaces by coordinating the layout of parks, squares, and community green spaces to better meet the elderlys basic needs for green space.

**EFFECTS OF NINE - SQUARE STEP DANCE EXERCISE WITH A STICK ON CARDIORESPIRATORY ENDURANCE AND MUSCLE STRENGTH OF THE ELDERLY.**

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INTRODUCTION: Nine - Square Step Dance Exercise with a Stick. It is an exercise with movement patterns that are suitable for the elderly. Because it is a simple movement but continuously moving. This makes it possible to develop the physical fitness of the elderly, especially. Cardiorespiratory Endurance and Muscle Strength of the Elderly.

METHODS: The purpose of this research was to study and compare the effects of nine - square step dance exercise with a stick on cardiorespiratory endurance and muscle strength of the elderly. The sample group was selected by employing simple random sampling method. This group consisted of 20 female elderly people, from the ages of 60 to 65, in Nakhon Pathom Province. After the 6-week training, the results of all aspects were compared with ones before the training. Three instruments were utilized in this study: 1) the program of Nine - Square Step Dance Exercise with a Stick 2), the cardiorespiratory endurance tests. and 3) the muscle strength test. The training spent three days per week, and 60 minutes per day. The results were analyzed by using t-test dependent statistics.

RESULTS: The research results revealed as follows; the results of the cardiorespiratory endurance tests, before and after six weeks of training, were equal to Mean=82.87, SD=10.50 and Mean=88.00, SD=6.96 respectively. Besides, the results muscle strength test were equal to Mean=18.37, SD=2.44 and Mean=19.87, SD=2.35 respectively.

From the results of the study, before and after six weeks of training, it was found that the Cardiorespiratory Endurance and the muscle strength, of the elderly were significantly different at the 0.5 level.

CONCLUSION: From the research, it can be concluded that the Cardiorespiratory Endurance and muscle strength of the elderly can be improved because of Effects of Nine - Square Step Dance Exercise with a Stick

**GROWTH COMPARISON OF HEIGHT, WEIGHT, AND TOE GRIP STRENGTH IN NEPALESE CHILDREN**

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INTRODUCTION: The foot development of children is influenced by various factors, including heredity and environment. It is assumed that Nepal's geographical conditions, such as hilly and mountainous environments, may affect growth patterns. This study aimed to investigate the growth characteristics of toe grip strength in children from both hilly and lowland areas of Nepal.

METHODS: The samples were 1,193 healthy children (628 boys and 565 girls) aged 10-16 years, school in/around Pokhara Valley and Lumbini lowlands, Nepal. Toe grip strength was measured using a T.K.K.3362 toe- grip dynamometer (Takei Scientific Instruments, Niigata, Japan) . Toe grip strength was measured twice, and the maximum strength from the two measurements was recorded. Their height and weight were also measured. Descriptive statistics of toe grip strength, height and weight were calculated by age, sex, and differences between age groups and sexes were analyzed.

RESULTS: The mean height of Nepalese children aged 10–16 years ranged from 134.7–167.0 cm for boys and 138.9–154.1 cm for girls. Girls were taller until age 12, after which their growth slowed, while boys exhibited rapid growth after age 12. A significant difference in height was observed after the age of 14 ($p < 0.05$). The mean weight ranged from 31.8–57.9 kg

for boys and 32.3–49.2 kg for girls. The growth rates of both sexes were similar until age 12, after which boys showed a rapid increase, whereas girls' weight gain slowed after age 13. Significant weight differences were found only at age 16 ($p < 0.05$). The mean toe grip strength ranged from 12.2–27.6 kg for boys and 10.8–19.2 kg for girls. Toe grip strength tended to increase from ages 10–13, then leveled off and slowed after age 13 in girls. In contrast, boys continued to show a significant increase until age 16. Regarding transportation to school, walking was the primary mode for 35.5% of children in Pokhara and 66.7% in Lumbini, with children in Lumbini walking more frequently.

CONCLUSION: Nepalese girls were taller than boys until age 12, after which boys exhibited rapid growth. Weight gain showed a similar pattern, with boys surpassing girls in weight after age 13. Toe grip strength followed a comparable trend, with growth slowing in girls after age 13, whereas boys continued to develop strength until age 16. Additionally, Nepalese children demonstrated higher toe grip strength than Japanese children, likely due to differences in daily physical activity and environmental factors. Further research is needed to explore these differences in detail.

**GET STRONG TO FIGHT CHILDHOOD CANCER: DEVELOPMENT AND IMPLEMENTATION OF THE "FORTEE GET STRONG" APP AS A DIGITAL APPROACH TO PROMOTE EXERCISE IN CHILDHOOD CANCER PATIENTS**

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*FONDAZIONE MONZA BRIANZA PER IL BAMBINO E LA SUA MAMMA*

INTRODUCTION: Digital tools and new technologies can support and maintain physical activity behaviour. Childhood cancer patients suffer from physical inactivity, cancer-related fatigue, and reduced health-related quality of life. The Europe-wide, multi-centre FORTEe trial (funded by the EU) aims to mitigate these issues in childhood cancer patients by implementing exercise therapy and increasing physical activity using digital approaches.

METHODS: As part of the trial, the "FORTEe Get Strong" app was developed to engage childhood cancer patients in exercise training and healthy behaviours. Developed in close collaboration between scientific and clinical partners, a software engineering company and patient representatives, the "FORTEe Get Strong" app was implemented for the use on Android and iOS devices in seven languages (Danish, English, French, German, Italian, Slovenian, Spanish). The mobile app uses gamification to create a child-friendly environment for health education. Young patients can navigate a personalised avatar through a virtual village containing interactive elements: i) mini-games, including the FORTEe-Quiz, provide health-related knowledge in a fun way; ii) instructional exercise videos focus on motor skills such as endurance, strength, flexibility, coordination and gait. By offering varying levels of difficulty, the app provides a safe and personalised exercise opportunity.

RESULTS: The "FORTEe Get Strong" app was developed in the context of the wider multicentre FORTEe trial and implemented at 10 European trial sites. The patient app is an innovative approach to promote healthy behaviours and physical activity in childhood cancer patients. The integration of gamification and tailored exercises increases engagement and knowledge retention. As the FORTEe multicentre trial progresses, further evaluation will assess the long-term impact of the app on the physical and psychosocial well-being of young patients. CONCLUSION: The "FORTEe Get Strong" app is a promising tool in paediatric exercise oncology, offering a creative and adaptable means of supporting children with cancer on their journey to improved health and fitness.

**EXERCISE TRAINING AND CARDIOVASCULAR HEALTH: A PRELIMINARY REPORT OF THE MICROFIT STUDY**

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INTRODUCTION: Arterial hypertension and central hemodynamics alterations are major cardiovascular risk factors, and are influenced by exercise training. The gut microbiota has been shown to regulate pathways associated with both arterial stiffness and exercise training. However, literature lacks information on the relationship between exercise training, gut microbiota, and arterial stiffness. We aim to test the exercise effect on arterial stiffness in comparison to the assumption of probiotics.

METHODS: This randomized partially double-blinded controlled trial (NCT05967715) aims to enroll 75 controlled and stable hypertensive patients (aged from 40 to 65ys, in primary cardiovascular prevention, without diabetes and inflammatory disorders), randomized into 3-month intervention arms: exercise training; probiotics; placebo. Exercise group performs high intensity interval training 1 hour thrice a week; probiotic group receives multi-strain probiotics for three months. Probiotic and placebo groups are double blinded. Clinical, familial and drug history are obtained. Before and after the intervention, cardiovascular assessment is performed measuring pulse wave velocity (PWV) and central blood pressure (CBP) by applanation tonometry.

RESULTS: This preliminary report is based on 38 patients (mean age 54±6ys, M/F 24/17)) who first completed the 3-month intervention. Analysis were blinded to the intervention group. We observed substantial homogeneity of the baseline characteristics among the 3 groups. After the intervention, both PWV (mean±sd 0.1±0.7; -0.2±0.63; 0.5±0.87m/s, $p=0.15$) and

CBP (pulse pressure -1.9±9.8; -1.4±4.9; -0.5±6.9mmHg, p=0.9) differences tended to be slightly different among the groups, but without statistical significance.

CONCLUSION: Preliminary blinded results demonstrate correct randomization with no significant hemodynamic modification after the intervention.

**EFFECTS OF RESISTANCE EXERCISE ACCOMPANIED BY MUSIC ON ELDERLY PEOPLE.**

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INTRODUCTION: Resistance exercise often involves repetitive monotonous movements, making it difficult to maintain motivation. Therefore, we focused on exercising to music. The purpose of the study is to investigate the influence of exercise accompanied by music.

METHODS: The subjects were 25 men and women aged 64 to 82 years. They performed six types of resistance exercise (REx) to music for approximately 12 minutes. The exercises were marching, knee lifts, front lunges, skate lunges, back lunges, and skipping. The Exercises were performed to tempo-pitch sounds (TREx) and music (MREx) ranging from 90 to 100 BPM. The influence of music on exercise was investigated by measuring heart rate (HR) and asking questions about "fun" and "hardness". HR during exercise was measured using a Polar H10 heart rate sensor and the Polar Team app (Polar). Psychological factors survey: After exercise, subjects rated their perceived exertion (RPE). And more subjects rated the enjoyment of the exercise on a four-point scale. Lower limb muscle strength was measured isometric knee extension strength. Measurements were performed using a lower limb muscle strength measurement device (Takeikiki Co., Ltd.).

RESULTS: HRmax was 60±8.9% in TREx and 69±16.4% in MREx. Although MREx tended to be higher, no significant difference was observed. The percentage of people who found the exercise "fun" was 94.4±27.2% in MREx and 66.5±11.9% in TREx, which was 27.9±15.3% higher in MREx. The subjects of people who found the exercise "hard" was 34.0±1.6% higher in TREx than in MREx. Although the exercise intensity is moderate, psychological factors indicate that the subjects is in a "fun and "light state. The correlation between average HR and "fun" was somewhat strong for both TREx ($R^2$=0.54) and MREx ($R^2$=0.59). The correlation between HRmax and "fun" was somewhat strong for both TREx ($R^2$=0.79) and MREx ($R^2$=0.69). This suggests that participants still felt "fun" even at high intensity. The correlation between "hard" expressed by RPE and average heart rate was somewhat strong for TREx ($R^2$=0.58) and somewhat weaker for MREx ($R^2$=0.42). We found that exercising with music does not make you feel "hard" even when your HR was high. The correlation between HRmax and "hard" was quite strong, with for TREx ($R^2$=0.64) and for MREx ($R^2$=0.69). This shows that there is a somewhat strong correlation between TREx and MREx, and that even when MREx was at a high intensity it was not felt to be "hard", yet it was still enjoyed. Comparing the psychological state from this questionnaire, it was found that the correlation between "fan" and "hard" was somewhat strong for both with for TREx ($R^2$=0.68) and for MREx ($R^2$=0.69). Lower limb strength was 44.7±20.7 kg on the first time and 46.3±20.5 kg on the final. Although there was an increasing trend, there was no significant difference.

CONCLUSION: Resistance exercise set to music can be performed in a "fun" and "light" state, while still providing an exercise intensity that improves cardiopulmonary function.

**EFFECTS OF KICKBOXING TRAINING ON FALL-RISK FACTORS AMONG COMMUNITY-DWELLING MIDDLE-AGED AND OLDER ADULTS**

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INTRODUCTION: Falls risk may increase with age. Falls could not only lead to severe medical costs in older adults but also impact their ability to perform activities of daily living due to fall-related disabilities. Kickboxing exercise is a combat sport that involves dynamic, intermittent striking that requires complex skills and is conducted typically for young adults. This study aimed to assess the effect of a 12-week group kickboxing training (KBT) program modified for middle-aged and older adults on fall-related parameters.

METHODS: Sixty-seven middle-aged and older adults aged between 50 and 85 were recruited from Taoyuan, Taiwan. The experimental group (EG, N=40) implemented a 90-minute KBT once a week for 12 weeks and four health education sessions, while the control group (CG, N=27) received only health education sessions. Subjects in both groups were tested pre-and-post intervention on the following fall-related indicators: lower-limb muscle strength using the MicroFET2 handheld dynamometer, 6-m walking speed, 8-ft up-and-go, functional reach, and 30-sec sit-to-stand. Descriptive statistics, independent t-tests, paired t-tests, and effect size (ES) analyses were conducted. The significance level was set at $p < .05$.

RESULTS: The EG improved more than CG in walking speed, 8-ft up-and-go, and 30-sec sit-to-stand (all $p<.001$) change in pre-and-post differences. In comparison with CG, the EG had a large ES in usual-pace gait speed (ES=1.14), small ES in maximal gait speed (ES=0.42), medium ES in 8-ft up and go (ES=0.76), large ES in 30-sec sit-to-stand (ES=1.56) and medium ES in knee flexion (ES=0.52) respectively.

CONCLUSION: With some safety concern modification, the once-a-week 12-week modified KBT may benefit community-dwelling middle-aged and older adults in improving fall-related factors such as walking ability, dynamic balance, and enhanced lower-limb muscular strength and thereby, it may contribute to fall prevention for middle-aged and older adults in the community.

**DIFFERENCES IN 3D SPINE MORPHOLOGY ACCORDING TO THE LEVEL OF PHYSICAL ACTIVITY PRACTICE IN ELDERLY WOMEN**

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INTRODUCTION: The physiological decline that occurs with advancing age also includes the aging of the spine which is characterized by the development of degenerative changes. The benefits of physical activity (PA) on the musculoskeletal health of the back are well known. It appears that the compressive strength of the spine tends to increase with the level of PA practiced and that PA strengthens both the vertebrae and the discs. The aim of this study was to assess the spine morphology, through a 3D scanning method, in a sample of elderly women and compare it according to the level of PA practiced.

METHODS: Forty-two elderly women were recruited. Firstly, each participant was administered the IPAQ-SF that allowed to measure the level of PA. As suggested by the IPAQ recommendations for scoring protocol, participants were divided into the 3 following groups: low active (LA; n=14); moderate active (MA; n=14); high active (HA; n=14). Hence, to evaluate the morphology of the spine a non-invasive, three-dimensional optoelectronic detection system using the Light Detection and Ranging (LIDAR) technology (Spine 3D; Sensor Medica) was used. In particular, each participant, barefoot and in orthostatic position with their head in a neutral position and with their feet placed side-by-side, was placed 1 meter from the instrument and with their back, bare-chested, facing the camera of the device. The 3D spine screening was made up by infrared cameras using Time-of-Flight (ToF) depth technology able to identify landmarks (i.e., prominent vertebra (VP), right and left shoulder (SR and SL), right and left lumbar dimple (DR and DL). Based on these landmarks, the software calculates differents parameters on the sagittal, frontal, and horizontal planes.

RESULTS: Among the 3 groups no differences were found in spine morphology on the frontal and horizontal planes. On the sagittal plane, we detected a significant difference in the trunk inclination parameter (i.e., the angle formed between the straight line passing through VP and DM and the vertical plane along the sagittal section) ($F(2,39)=4.25$; $p=0.02$) with the highest trunk inclination for the LA group. Moreover, on the sagittal plane, we found a significant difference in the sagittal imbalance parameter (i.e., the horizontal distance between VP and the vertical passing through DM) ($F(2,39)=4.10$; $p=0.02$) with the highest sagittal imbalance for the LA group.

CONCLUSION: These results suggest that higher levels of PA practice can not only improve musculoskeletal health but can positively affect the structure of the spine. This could prevent the aging of the spine and possible back pain.

**SOCIODEMOGRAPHIC CORRELATES OF SITTING TIME AMONG COMMUNITY-DWELLING OLDER PERSONS IN THE CITY OF ZAGREB**

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INTRODUCTION: Older age is generally associated with lower levels of physical activity (PA) and deterioration of health (Cunningham et al., 2020). Understanding the correlates of PA and sedentary behavior in older persons is imperative for designing tailored health promotion interventions. There is a lack of data on the correlates of sitting time in older persons in Croatia. Therefore, the aim of this preliminary study was to investigate the correlation between sociodemographic characteristics and sitting time among community-dwelling older persons in the city of Zagreb.

METHODS: The study was conducted as part of the Fit-Old project, funded by the European Union [Grant Agreement No 622623-EPP-1-2020-1-DESPO-SCP]. The participants were older persons living in the broader area of the city of Zagreb, Croatia (n=209; 180F/29M; age (mean +/- SD) 73.1 +/- 5.4 y). A questionnaire was used to collect data on the participants sociodemographic characteristics (age, gender, education level, number of household members, marital status, family income, type of housing). The Croatian long version of IPAQ was used to assess the sitting time (Pedisic et al., 2011). A Spearmans rank-order correlation was used to assess the relationship between the sociodemographic data and sitting time.

RESULTS: Self-reported total weekly sitting time (1610 +/- 679 min/week) was significantly positively correlated with age ($rs=.146$, $p<.05$) and with living in the city area with predominant apartment buildings or blocks of flats ($rs=.175$, $p<.05$). Living in the area with predominant detached houses was significantly negatively correlated with total weekly sitting time ($rs=-.285$, $p<.05$). There was no significant correlation of sitting time and education level, number of household members, marital status or family income.

CONCLUSION: In the sample of community-dwelling older persons in Zagreb, the sitting time increased with age. No sociodemographic characteristics investigated in the study were related to sedentarism, except for the predominant type of housing in the immediate neighborhood. Namely, living in the areas with predominant detached houses was related to decreased sitting time, while apartment living in urban areas was related to increased sedentarism. The findings might be associated with more opportunities for PA in the household domain when living in detached family houses, and with the broader influence of built environment in densely populated urban areas on everyday PA in older persons.

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**ASSOCIATION BETWEEN PHYSICAL ACTIVITY, QUALITY OF LIFE AND FERTILITY PROBLEM STRESS AMONG WOMEN UNDERGOING IN VITRO FERTILIZATION BASED ON FAIR-HU STUDY**

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INTRODUCTION: In vitro fertilization (IVF) is a physically and emotionally demanding process that can significantly impact women's psychological well-being and overall quality of life (QoL). Given the high levels of stress associated with fertility treatments, identifying modifiable factors that could improve mental health and QoL is of paramount importance. Physical activity (PA) has been recognized as a beneficial intervention for mental health and stress reduction; however, its indirect effects on QoL via psychological well-being remain underexplored in this population. The present study aims to investigate the association between perceived stress, PA and QoL in women undergoing IVF.

METHODS: A multicentric clinical study NCT06795568 was conducted among women undergoing IVF treatment (N=348), assessing their physical activity levels, fertility problem stress (FPS), and QoL using validated self-report questionnaires. Physical activity was measured using the Global Physical Activity Questionnaire (GPAQ), perceived stress was assessed via the original version of COMPI Fertility Problem Stress Scales (COMPI FPSS), and QoL was evaluated using the WHO Quality of Life-BREF (WHOQOL-BREF) questionnaire. Association between PA, FPS and QoL was measured with Spearman rank correlation test. Statistical analyses were conducted using IBM SPSS 28.0 for Mac, with significance set at $p < 0.05$.

RESULTS: The mean age of participants was 34.68 ± 5.02 SD years, and 60.1% reported no engagement in moderate-to-vigorous recreational PA, participants had 90.0 (0.0, 270.0) METmin/week recreational (R) MVPA. QoI ranged between 67.85±16.45 and 79.36±12.75. Stress levels showed similar results to previous Hungarian research (personal stress 10.65±3.59, marital stress 6.30±2.54, social stress 5.98±2.65). Findings indicated a significant positive association between R-MVPA and QoL (r=0.145-191, $p < 0.01$). Additionally, higher FPS levels were linked to lower QoL by each subscales (r=-0.220-519, $p < 0.001$), while the stress relieving effect of R-MVPA was proved in case of personal stress subscale of the COMPI FPSS (r=-0.144, $p = 0.007$).

CONCLUSION: Our findings underscore the importance of PA as a potential intervention to improve quality of life and reduce stress in women undergoing IVF treatments. The observed effect on QoL highlights the need for integrated lifestyle interventions that include both PA promotion and stress reduction support programs during fertility treatments. Future research should explore longitudinal effects and potential clinical applications of PA-based interventions to optimize reproductive and psychological outcomes in IVF patients. This research was funded by the EKÖP-24-4-II-PTE-345, NKFI FK-147404, TKP2021-EGA-10 of the Ministry of Culture and Innovation, the National Research, Development, and Innovation Fund, and the RRF-2.3.1-21-2022-00012 project, titled National Laboratory on Human Reproduction.

**INVESTIGATING THE IMPACT OF AN ACUTE BOUT OF HIGH-INTENSITY INTERVAL TRAINING (HIIT) AS A STRATEGY TO ENHANCE THE EFFECTIVENESS OF IMMUNE CELL-BASED THERAPY FOR ACUTE MYELOID LEUKEMIA**

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INTRODUCTION: Double-negative T cell (DNT) therapy is an innovative immune cell-based cancer therapy for those living with acute myeloid leukemia (AML), involving the infusion of healthy donor-derived immune cells (i.e., DNTs) into patients. A single bout of high-intensity exercise profoundly increases the number of circulating immune cells, such as NK cells, with a preferential mobilization of effector cells that have greater anti-cancer cytotoxicity. Exercising healthy donors prior to DNT collection may be a clinically applicable strategy to enhance the effectiveness of DNT therapy for AML. However, a caveat to the enhanced killing of effector T cells is that they are short-lived compared to long-lasting early memory cells, which have been associated with more durable and superior treatment outcomes in patients treated with immune cell-based therapies. The purpose of this study is to explore the impact of exercise on the effectiveness of DNT therapy for AML, including both its initial potency and durability of treatment effects.

METHODS: We isolated DNTs from peripheral blood of young healthy participants at rest and immediately after an acute bout of HIIT. In this study, data from an initial N=1 are presented, with ongoing data collection to complete the sample (N=8) by the conference presentation. High-intensity interval cycling was conducted, comprising 5 rounds of 90-second work and rest intervals at 1:1 ratio. Average heart rate (HR) during the work interval was 90% HRmax, and average HR for the entire session was 78% HRmax. DNT memory phenotype was examined using a 10-colour panel on a Spectral Cell Analyzer. After 10-day DNT expansion, acute and chronic anti-cancer function was compared between DNTs collected at rest (DNTrest) and immediately after a single bout of high-intensity exercise (DNTex) using a 2-hour cytotoxicity assay and repeated stimulation assay, respectively, against human AML cell lines in vitro.

RESULTS: Preliminary results showed that DNTex had a greater proportion of late memory phenotypes (45.9%) than DNTrest (21.5%) on day 0. After 10-day expansion, the difference in memory composition became more apparent, where DNTex and DNTrest showed 92.5% and 42.4% late memory phenotypes, respectively. In the 2-hour cytotoxicity assay, DNTex demonstrated superior killing of AML cells than DNTrest. In the repeated stimulation assay, DNTex progressively lost their anti-cancer function with each successive round, whereas DNTrest demonstrated persistent killing of AML cells to the end of the experiment.

CONCLUSION: A single bout of high-intensity exercise preferentially mobilizes late memory DNTs, which become the dominant population after 10-day expansion. Despite superior immediate killing of AML cells, late memory DNTs do not persist to provide a durable anti-cancer effect in vitro. These findings suggest that exercising healthy donors prior to DNT donation may enhance the acute potency of DNT therapy but impact the durability of its effects.

**FATIGABILITY ASSESSMENT IN CHRONICALLY FATIGUED PATIENTS: INSIGHTS FROM ISOMETRIC VS CYCLING-BASED FATIGUE TESTS**

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INTRODUCTION: Chronic fatigue (CF) is defined as pathological fatigue lasting over 6 months, unrelieved by rest and impairing daily activities. CF accounts for 5–10% of primary care consultations and can result from an underlying pathology or be idiopathic. CF is commonly diagnosed using questionnaires such as the Functional Assessment of Chronic Illness Therapy-Fatigue (FACIT-F, cut-off $\leq$ 34). Better understanding fatigue mechanisms is crucial for its management (1). This study aimed to determine whether a deteriorated resistance to fatigability, defined as an exercise induced reduction of strength, is related to FACIT-F scores in CF patients and whether the type of fatiguing test, i.e. isometric (ISO) vs cycling-based (BIKE, i.e. more ecological mode) provide similar outcomes.

METHODS: Thirty-two CF patients (19 females, age: 47.2 ± 12.8 yrs, FACIT-F: 20.7 ± 6.9) performed in separated days an ISO and a BIKE tests consisting of incremental stages of either 10 contractions (5-s on/5-s off; ISO) or 3-min cycling at preferred cadence (BIKE) until exhaustion. Increments were scaled relative to the participants' body weight. Neuromuscular function was assessed at baseline, after the first two stages and at exhaustion. Maximal voluntary contraction (MVC), amplitude of the resting twitch (Tw), voluntary activation (VA) using the interpolated twitch technique with percutaneous electrical nerve stimulation, and electromyographic activity (M-wave, RMS during MVC) were evaluated on the knee extensors.

RESULTS: Simple linear regressions revealed no significant associations between FACIT-F scores and any parameters of fatigability. Exercise performance (number of stages) in each test was determined by distinct neuromuscular parameters. In ISO, performance was significantly associated with MVC, Tw, and M-wave at baseline. In BIKE, performance was determined by MVC, Tw and M-wave at baseline and their declines after stage 1 (MVC and M-wave) and stage 2 (MVC and Tw). VA after stage 1 was also associated with BIKE performance.

CONCLUSION: Contrary to previous results from our group in studies involving both fatigued and non-fatigued patients (e.g. 2), FACIT-F scores in CF patients were not directly related to fatigability, neither in isometric, nor in dynamic modes, indicating a multidimensional nature of CF. In CF patients, BIKE and ISO performance were related to neuromuscular function at rest, underlying the need to preserve maximal strength for a better functional status. Yet, performance was related to fatigability in BIKE only, which suggests that in this ecological mode, neuromuscular measures at submaximal intensities could be prioritized over testing until exhaustion in these patients. This may be useful when post-exertional malaise is an issue.

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**IMPACT OF COVID-19 PANDEMIC ON MOTOR COORDINATION IN A SAMPLE OF ITALIAN SCHOOL-AGED CHILDREN BETWEEN 8 AND 10 YEARS OLD**

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INTRODUCTION: Motor coordination (MC) during childhood is of fundamental importance for the execution of daily motor skills and for success in sports activities (1). However, the past Covid-19 pandemic, due to the various restrictions that followed, have severely limited the practice of organized and non-organized physical activities. Consequently, previous studies have demonstrated a decrease in the level of physical activity practice in different populations around the world, with a negative impact on physical fitness (2). The aim of this study was to compare the level of motor coordination before and after Covid-19 pandemic in a sample of Italian school-aged children.

METHODS: A total of 280 children of primary school was included for this study. In detail, n=141 and n=139 children, aged between 8 and 10 years old, were recruited before (T0) and after (T1) Covid-19 pandemic, respectively. MC was assessed using the Körperkoordinations test für Kinder (KTK) which includes 4 subtests: 1)walking backward on a balance beam of decreasing widths; 2)two-legged jumping sideways from side to side over a beam for 15 seconds; 3)one-legged hopping for height over a foam obstacle of increasing height; 4)moving sideways on the floor in 20 seconds. In the KTK, MC is expressed using the motor quotient (MQ), calculated by adding the score of the 4 subtests and norm-referenced for age and gender. Moreover, the Physical Activity Questionnaire for Children (PAQ-C) was administered in both groups to measure the general level of physical activity practice over the last seven days.

RESULTS: We detected a significant decrease in the MQ ($p<0.001$) in the children measured before (T0) and after (T1) Covid-19 pandemic. As for the subtests' scores, results showed a significant decrease from T0 to T1 in the two-legged jumping sideways ($p<0.001$), one-legged hopping for height ($p<0.001$), and moving sideways ($p<0.001$). No significant differences

were found in the subtest of walking backward on a balance beam. As for the PAQ-C, children recruited showed similar scores both at T0 and at T1.

CONCLUSION: These results suggest that Covid-19 pandemic and the related restrictions negatively impacted the level of MC in Italian school-aged children. These results could be compared with other populations worldwide, and they could be useful to develop preventive strategies to maintain an appropriate level of MC in children during restrictive or limiting conditions. Further studies should be conducted to evaluate the long-term consequences of Covid-19 pandemic.

**THE ROLE OF GENDER IN THE INFLUENCE OF PHYSICAL ACTIVITY ON PROBLEMATIC USE OF THE INTERNET AND DIGITAL DEVICES**

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INTRODUCTION: The use of the internet and digital devices offers significant public health benefits by enhancing access to reliable medical information, supporting health resources, and promoting health education, thereby empowering individuals to make informed health decisions. However, excessive or maladaptive use of the internet and digital devices can become problematic, posing a significant health challenge that could potentially reach pandemic levels. Physical activity may be a key strategy in interventions aimed at reducing both the prevalence and associated consequences of this issue in both men and women. However, the relationship between physical activity levels and problematic use of the internet and digital devices remains controversial, and the role of gender is still unclear. Thus, this study aims to evaluate the association between physical activity levels and the problematic use of (a) smartphones, (b) social media, (c) online gambling, and (d) video games. Furthermore, we aimed to compare the results between men and women.

METHODS: A correlational and comparative study was conducted with a sample of 189 male and 181 female Spanish-speaking young adults aged 18-40 years. Participants completed an online anonymous survey that included the Smartphone Addiction Scale, the Social Network Addiction Scale, the Internet Gaming Disorder-20 questionnaire, and the Online Gambling Diagnostic Questionnaire. They also completed the International Physical Activity Questionnaire.

RESULTS: The results showed a significant inverse correlation between physical activity levels and smartphone addiction (Rho = -0.272, $p < 0.001$) and problematic social media use (Rho = -0.228, $p < 0.001$). However, a significant direct correlation was found between physical activity levels and online gambling disorder levels (Rho = 0.121, $p = 0.020$), and a direct but non-significant relationship was observed between physical activity and internet gaming disorder levels (Rho = 0.101, $p = 0.051$). Gender analyses revealed that men may exhibit higher levels of gaming addiction and problematic online gambling, as well as higher physical activity levels than women. Conversely, women showed higher levels of problematic smartphone and social media use and spent more time sitting than men.

CONCLUSION: Physical activity may help prevent and reduce the problematic use of smartphones and social media. However, it might be directly related to online gambling disorders and internet gaming disorders. Both physical activity and the problematic use of the internet and digital devices are largely influenced by gender, with women showing higher problematic use of smartphones and social media, and men exhibiting higher gaming and gambling addiction. Therefore, gender must always be considered in interventions aimed at preventing and reducing the negative consequences of digital addictions.

**EXERCISE TRAINING ATTENUATES ADVERSE CARDIAC MORPHOFUNCTIONAL EFFECTS OF MATERNAL EXPOSURE TO AIR POLLUTION**

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INTRODUCTION: Air pollution is a major environmental risk, with MP2.5 entering the lungs and affecting the circulation. Maternal exposure during pregnancy may affect the cardiovascular health of the offspring. On the other hand, exercise training offers protective effects against pollution-induced damage in adults. This study evaluates the effects of exercise training on cardiac morphometry and function in the offspring of rats exposed to MP2.5 during pregnancy.

METHODS: Dams (Wistar rats) were exposed to MP2.5 from gestation day 5 until birth. Male offspring were divided into three groups (n=5-7 rats/group): C (control), E (exposed) and ET (exposed and trained). After weaning, the offspring underwent treadmill training (5x/week/8 weeks). The offspring were evaluated by echocardiography.

RESULTS: With regard to morphometric evaluations, the left ventricular diameter in diastole (C: 8.50 ± 0.76; E: 7.38 ± 0.66; ET: 7.54 ± 0.21 mm) was reduced in both exposed offspring groups (E and ET) compared to controls (C). ET rats showed increased left ventricular posterior wall thickness in diastole (C: 1.43 ± 0.10; E: 1.32 ± 0.12; ET: 1.54 ± 0.09 mm) and interventricular septal thickness in diastole (C: 1.08 ± 0.34; E: 1.18 ± 0.16; ET: 1.46 ± 0.22 mm) compared to E rats. Left ventricular mass (C: 761 ± 109; E: 623 ± 93; ET: 787 ± 97 mg) increased in the E group compared to the C and ET groups. Evaluations of diastolic function showed that the E/A ratio was increased in the E group compared to the C and ET groups (C: 1.38 ± 0.23; E: 1.91 ± 0.41; ET: 1.29 ± 0.09) and the isovolumetric relaxation time (IVRT) was decreased in the ET group compared to the C and E groups (ET: 12.13 ± 2.13 vs. C: 17.29 ± 2.73 and E: 20.91 ± 4.04 ms). Regarding systolic function, ejection fraction (C: 55.7 ± 11.4; E: 55.2 ± 7.6; ET: 67.2 ± 3.3%) and fractional shortening (C: 30.7 ± 7.8; E: 29.9 ± 5.3; ET: 38.5 ± 2.6%) were improved in the ET group compared to the C and E groups.

CONCLUSION: In conclusion, the results of this study demonstrate that MP2.5 exposure during pregnancy adversely affects the heart of the offspring, resulting in structural and functional cardiac changes. However, exercise training attenuated these impairments and also improved both diastolic and systolic function. These findings reinforce the role of exercise as a potential strategy to mitigate air pollution-induced cardiovascular damage, including that observed as a consequence of in utero exposure.

**EFFECT OF EXERCISE TRAINING ON MUSCLE TISSUE IN OFFSPRING OF RATS EXPOSED TO AIR POLLUTION**

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INTRODUCTION: Air pollution contributes to metabolic diseases, while exercise is a protective factor. Maternal exposure to pollutants during pregnancy may affect foetal development. Experimental models exposed to PM2.5 show reduced contractile capacity, increased inflammation, and oxidative stress in muscle tissue [1]. However, few studies assess exercise effects on offspring muscle tissue from pollution-exposed mothers. This study evaluated aerobic training (AT) effects on inflammation and oxidative stress in muscle tissue of rat offspring whose mothers were exposed to air pollution during pregnancy.

METHODS: Five Wistar females and two males were used for mating. After copulation, females were exposed to PM2.5 in a particle concentrator during pregnancy. After weaning, offspring were divided into six groups (n=6-8): Male Control (MC); Male Exposed (ME); Male Exposed Trained (MTE); Female Control (FC); Female Exposed (FE); Female Exposed Trained (FTE). MTE and FTE groups underwent AT at moderate intensity for eight weeks. Gastrocnemius muscle tissue was analyzed for inflammatory mediators (IL-6, IL-10, TNF-alpha) and oxidative stress markers (antioxidant capacity, hydrogen peroxide, NADPH oxidase, lipid, and protein oxidation).

RESULTS: Exercise capacity was not affected by in utero PM2.5 exposure, but trained groups improved their performance. No differences in IL-6 were observed. IL-10 was reduced in the FE group compared to FC and FTE (FE: 20.9 [3.62] vs. FC: 37.5 [14.9] and FTE: 25.1 [5.96] [pg/ml]). TNF-alpha increased in FE vs. FC and FTE (FE: 4.33 [2.54] vs. FC: 10.7 [6.07] and FTE: 3.65 [1.92] [pg/ml]). Non-enzymatic antioxidant capacity increased in FTE vs. FE (FE: 0.034 ± 0.039 vs. FC: 0.117 ± 0.043 and FTE: 0.086 ± 0.016 [mM\Fe(II)]). Hydrogen peroxide decreased in MTE vs. ME (MTE: 1.78 ± 0.50 vs. ME: 1.90 ± 0.68 [µM]) and in FTE vs. FE (FTE: 1.14 ± 0.29 vs. FE: 1.39 ± 0.67 [µM]). No significant differences were found for other variables.

CONCLUSION: In conclusion, maternal PM2.5 exposure induced early impairments in offspring muscle inflammatory and oxidative stress profiles without affecting exercise capacity. However, AT mitigated these negative effects and improved exercise capacity. These findings suggest that an active lifestyle may protect against maternal pollution-induced muscle impairments.

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**COMBINED IMPACT OF HEALTHY BEHAVIOURS AND RELATIVE GRIP STRENGTH ON ALL-CAUSE MORTALITY: A 16-YEAR COHORT STUDY OF EUROPEAN ADULTS**

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INTRODUCTION: Both healthy behaviours and grip strength are individually linked to a lower risk of mortality, but their combined effect remains uncertain. This study aimed to investigate their joint association with all-cause mortality in middle-aged and older European adults.

METHODS: A 16-year prospective cohort study was conducted using data from the Survey of Health, Ageing and Retirement in Europe (SHARE), including 12,693 adults (baseline mean age, 62.9 ± 9.4; 63.3% men) from 11 European countries and Israel. Healthy behaviours (smoking, alcohol consumption, physical activity [PA], sleep) were self-reported. Grip strength was measured with a handheld dynamometer and categorized into age- and sex-specific tertiles. Cox proportional hazards models assessed the combined hazard ratio (HR) and 95% confidence interval (CI) of healthy behaviours and relative grip strength for all-cause mortality, adjusting for confounders (sex, age, education, marital status, body mass index and multimorbidity).

RESULTS: During a median follow-up of 8.7 years, 2,574 deaths were recorded. Higher grip strength was associated with a reduced risk of all-cause mortality, regardless of smoking (HR = 0.70, 95% CI = 0.54, 0.90), alcohol consumption (HR = 0.60, 95% CI = 0.46, 0.77), low PA (moderate-intensity: HR = 0.51, 95% CI = 0.36, 0.71; vigorous-intensity: HR = 0.55, 95% CI = 0.45, 0.67) and sleeping trouble (HR = 0.60, 95% CI = 0.45, 0.79). For each healthy behaviour, except not smoking, the combined protective effect on mortality was comparable to the individual effect of higher grip strength. The greatest survival benefits were observed in individuals who combined higher grip strength with healthy behaviours, with risk reductions ranging from 43% to 64%: smoking (HR = 0.36, 95% CI = 0.29, 0.45), alcohol consumption (HR = 0.56, 95% CI = 0.45, 0.70), PA (moderate-intensity: HR = 0.45, 95% CI = 0.37, 0.55; vigorous-intensity: HR = 0.45, 95% CI = 0.37, 0.55) and sleep (HR = 0.57, 95% CI = 0.46, 0.70).

CONCLUSION: Higher grip strength appears to be a protective factor against all-cause mortality, even in individuals who do not follow healthy behaviours. These findings underscore the importance of public health strategies that encourage both muscle strength and healthy lifestyle choices to enhance longevity.

**CORRELATES OF PHYSICAL ACTIVITY BEHAVIOUR IN PATIENTS WITH CHRONIC BACK PAIN**

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INTRODUCTION: Chronic back pain is a common and disabling condition that affects 15% of the general adult population. Regular exercise is a cornerstone of treatment for this condition but many patients with chronic back pain do not achieve the recommended amount of physical activity. For this reason, it is important to understand the factors that influence physical activity behaviour in this special population. The aim of this study was to explore potential correlates of physical activity behaviour in a group of Italian chronic back pain patients. Such correlates include levels of pain, kinesiophobia and fatigue, motivation, perceived barriers and benefits of exercise, sleep and mood.

METHODS: Sixty-one adults (34 Female/27 Male, age 56 + 13 years) with chronic back pain defined as pain (at least 3 on the 0-10 pain scale) in the lumbar, thoracic and cervical regions lasting more than 3 months completed the following scales and questionnaires: Global Physical Activity Questionnaire (GPAQ), Brief Pain Inventory (BPI), Piper Fatigue Scale (PFS), Tampa Scale Kinesiophobia, Pittsburgh Sleep Quality Index (PSQI), Brunel Mood Scale (BRUMS), Version 2 of the Behavioural Regulation In Exercise Questionnaire (BREQ-2), and the Exercise Benefits/Barriers Scale (EBBS). Exploratory Spearman's rank correlation analyses were performed to discover potential correlates of physical activity. Significance was set at $P < 0.05$.

RESULTS: This group of chronic back pain patients reported normal physical activity levels (Total GPAQ 3182 + 3798 MET-min/week). Of all the potential correlates investigated, the only one that was found to significantly correlate with Total GPAQ was the Total Benefits score of the EBBS (Spearman's rho 0.269, p=0.036).

CONCLUSION: The results of our study suggest that knowledge and appreciation of the benefits of exercise motivate the physical activity behaviour of patients with chronic back pain. Further studies should investigate a possible cause-and-effect relationship by investigating the effect of an educational program about the benefits of exercise on the physical activity behaviour of these patients.

**IMPACT OF THE COVID-19 PANDEMIC ON PHYSICAL FITNESS IN YOUNG CHILDREN**

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INTRODUCTION: The COVID-19 pandemic, beginning in 2019, significantly restricted childrens opportunities for physical activity, leading to decreased overall activity levels and increased sedentary behavior. While numerous studies have examined the pandemics impact on physical fitness, research focusing specifically on young children remains limited.This study aimed to assess the impact of the COVID-19 pandemic on the physical fitness of young children by comparing their fitness levels before and after the pandemic.

METHODS: A longitudinal study was conducted between 2018 and 2023, involving 304 healthy Japanese children (169 boys and 135 girls) aged 4-5 years. Three physical fitness tests were administered: the 25-meter sprint (25R), standing long jump (SLJ), and tennis ball throw (ST). Pre- and post-pandemic test results were compared. Statistical analysis was performed using SPSS 24, with a significance level of $p < 0.05$.

RESULTS: Although a majority of the children attended nursery school during the pandemic, ST scores were significantly lower post-pandemic compared to pre-pandemic. This decline was most pronounced in the 5.5 and 6.0-year-old age groups, with less noticeable changes observed in 4-year-olds. No significant differences were found in 25R and SLJ performance between the pre- and post-pandemic periods. These findings suggest that reduced physical activity at nursery schools and decreased activity levels at home during the pandemic likely contributed to the decline in ST performance. The study acknowledges the potential limitations in the accuracy of physical fitness assessments in younger age groups and highlights the need for further investigation.

CONCLUSION: The COVID-19 pandemic appears to have negatively impacted the tennis ball throw performance of young children, particularly those aged 5.5 and older. These results underscore the importance of maintaining adequate physical activity levels in early childhood, even during periods of public health restrictions.

**VENTILATORY CHANGES WITH THE USE OF SURGICAL MASKS AT REST AND MODERATE EXERTION. A MEANS OF PREVENTING THE TRANSMISSION OF CONTAGIOUS DISEASES IN SPORTS, REDUCING PERIODS OF ABSENCE DUE TO ILLNESS.**

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INTRODUCTION: The global health landscape has undergone significant changes in recent years, with the COVID-19 pandemic highlighting the importance of preventive measures to mitigate the spread of infectious diseases. In the context of sports, where physical proximity and high-intensity activity are prevalent, the use of surgical masks has emerged as a potential strategy to reduce the transmission of respiratory illnesses among athletes and the broader sports community.

While surgical masks are primarily designed to prevent the spread of infectious agents, their application in sports settings presents both challenges and benefits. This abstract

explores the role of ventilatory changes at rest, low and moderate intensity activities, examining their impact on oxigen uptake.

Methods:

A group of volunteers underwent testing using masks (n=14) which consisted of the following procedure: Each individual was subjected to three different situations sitting 5 minutes apart with and without a surgical mask, walking at 5 km/h with and without a surgical mask and running at 10 km/h, on a HP Cosmos quasar treadmill, with and without a surgical mask underneath the cortex gas analyzer mask. Ventilatory parameters (Vo2, Vco2, Ve) HR and O2

saturation were collected.

RESULTS: We found that the mean values and standard deviation of VO2 (ml/kg/min) at rest were 4,21 ± 1,14 without the surgical mask and 3,13 ± 0.79 with the mask while when walking at 5km/h weobtained 14,7 ± 1.67 without the mask and 11,96 ± 2,03 with the mask. When we switched to running at 10 km/h we obtained the following values without a mask 35.03 ± 2.45 and with a mask 30,76 ± 3,91 ml/kg/min. The values found for ventilation (l/min) at rest, walking at 5km/h

and running at 10km/h with and without a surgical mask were as follows: resting 7.69 ± 2.08 and 6.04 ± 1.74, walking 22.88 ± 4.22 and 20.14 ±4.40 and running 61.54 ± 14.42 and 53.57 ± 12.91

Discussion & CONCLUSION: We found that differences in oxygen consumption (ml/kg/min) decrease as the intensity of thethe task increases, this decrease goes from 25% at rest to 12% running (10km/h) which indicates that the ventilation mechanisms can overcome the difficulties caused by the use of a surgical mask. Furthermore, we can

conclude that despite the difficulties caused by the use of masks, recommendations are towards the use of surgical masks whenever there is a suspicion of illness by any of the members of sports teams to prevent the transmission of infectious diseases that lead toathletes stop for long periods of training and this causes a huge loss of physical shape. The data collected allows us to conclude that the greater the need for ventilation, the smaller the difference between the situation with and

without a mask, we saw a decrease in the difference from 21% at rest to 12% when running, which reveals the compensation of ventilation dynamics to maintain the oxygen levels necessary for the needs of the human body.

**EVALUATION OF A PORTABLE BAND-PULL WALKING DEVICE BASED ON PHYSIOLOGICAL PARAMETERS**

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INTRODUCTION: Research on "Band-Pull Walking (BPW)" is emerging as a new walking style that utilizes wearable resistance elastic bands. BPW may lead to a higher energy expenditure than normal walking (WK). However, previous studies evaluated BPW only by pulling a rubber tube forward on a treadmill. This study aimed to investigate the effects of a wearable BPW device on physiological parameters during walking.

METHODS: Fourteen healthy adults with regular exercise habits (age: 22.3 ± 2.0 years) participated in this study. Participants wore the BPW device on their back, with an adjustable elastic-band length. The band resistance was set to 8% of the maximal voluntary contraction (MVC) of the triceps brachii during shoulder and elbow extensions. Participants performed both WK and BPW on a treadmill with a 3% gradient at speeds of 60, 80, and 100 m/min. Oxygen uptake ($VO_2$), heart rate (HR), ventilation (VE), and ratings of perceived exertion (RPE; upper limb [UL], lower limb [LL], and cardiopulmonary [CR]) were measured. The Electromyogram (EMG) signals of the biceps brachii (BB), triceps brachii (TB), deltoid (DM), vastus lateralis (VL), and gastrocnemius lateralis (GL) were recorded and synchronized with gait events. Step counts were also recorded.

RESULTS: $VO_2$ and HR were significantly higher in the BPW group than in the WK group at all speeds ($p < 0.05$). VE was significantly higher in the BPW at 80 and 100 m/min ($p < 0.01$). The RPE for UL ($p < 0.01$, all speeds) and CR ($p < 0.05$, at 80 and 100 m/min) significantly increases at these speeds.

Upper limb muscle activity significantly increased in the BPW group. TB activity was 6.1–9.2 times higher ($p < 0.01$), BB was 2.1–2.4 times higher ($p < 0.05$, at 100 m/min), and DM was 1.7–2.0 times higher ($p < 0.05$, at 60 m/min). No significant differences were found in the VL, whereas the GL activity was significantly higher in BPW at 100 m/min ($p < 0.05$).

Step counts were 2.6–3.0 fewer per minute in BPW at 100 m/min ($p < 0.05$).

CONCLUSION: $VO_2$ increased by 8–12%, and HR increased by 4–8 bpm, indicating that BPW increased energy expenditure by approximately 10%. This was primarily attributed to increased upper limb muscle activity due to band resistance. The observed increase in VE suggests respiratory muscle recruitment, which may have further contributed to energy expenditure. The activation of the upper body likely led to this observed increase.

The reduced step count in the BPW likely resulted from increased stride length due to larger arm swings, as reflected by the higher GL activity. However, stride length differences between conditions were only approximately 1%, and VL activity was similar, indicating that gait changes likely had minimal influence on energy expenditure.

This study shows that BPW increases upper-body muscle activity due to elastic band resistance, leading to approximately 10% higher energy expenditure than WK.

Mentoring/Coaching

**UNLOCKING SUCCESS: THE HOLISTIC SUPPORT SYSTEM FOR DUAL CAREER STUDENT ATHLETES IN HONG KONG**

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Background: Dual career athletes pursuing higher education face significant demands in both their athletic pursuits and academic commitments. Failing to address the difficulties can lead to a decline in performance in both sports and academics.

Purpose: This study investigated the support systems for dual career student athletes pursuing higher education and identify key challenges they encounter.

Methods: The study employed a quantitative approach, utilizing an online questionnaire distributed to 140 student athletes from the Hong Kong National Squad or Junior Squad enrolled in local universities. Data on demographics, university and sports federation support measures, perceived challenges, and coping strategies were collected. The study received approval from the Survey and Behavioural Research Ethics Committee of The Chinese University of Hong Kong. The research was conducted in May 2024. Eligibility criteria for participants included: (a) full-time undergraduate students and (b) Hong Kong National Squad or Junior Squad members. The data were analyzed using descriptive statistics and independent t-test.

Results: 73 student athletes (M: 38; F: 35) participated in the study. The mean age of the participants was 21.11, with a standard deviation of 3.04. Among various learning supports provided by the university, the participants ranked flexible attendance and assignment submission arrangements (mean: 3.29, SD: 2.24), scholarships (mean: 3.77, SD: 2.38), and extension of maximum study period (mean: 4.23, SD: 2.55), as the top three most important supports. Overall, 65 participants expressed satisfaction with the learning supports provided by their universities, with a mean satisfaction rating of 4.68 out of 6 and a standard deviation of 0.65. There was no significant (p=0.201) difference in satisfaction levels between male and female students.

Regarding various training supports provided by sports associations, the participants ranked flexible training attendance (mean: 2.68, SD: 1.54), scholarship (mean: 2.82, SD: 1.45), and sports development advice (mean: 2.93, SD: 1.47) as the top three most important supports. Forty-one participants also expressed satisfaction with the supports provided by their sports associations, with a mean satisfaction rating of 4.48 out of 6 and a standard deviation of 0.84. There was no significant difference (p=0.558) in satisfaction levels between male and female students.

The major challenges reported by the student-athletes included time management (37 participants), striving to balance sports and academics (22 participants), and time conflicts between training/competitions and classes/examinations (20 participants).

Conclusion: The findings underscore the importance of adopting tailored holistic support strategies to assist student athletes in overcoming challenges and succeeding in both their athletic and academic endeavours. This lays the groundwork for enhancing support systems for this particular group.

**MINDFULNESS ON THE COURT: AN 8-WEEK PROGRAM ENHANCES BASKETBALL SKILLS, STRENGTH, MOVEMENT, AND MINDFULNESS IN UNIVERSITY PLAYERS**

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INTRODUCTION: Basketball is a dynamic sport that demands high levels of physical fitness, technical skill, and psychological resilience. Recent studies have suggested the benefits of mindfulness training (MT) in enhancing performance and well-being in various sports . This study investigated the effects of an eight-week MT on basketball-specific skills, muscular strength, functional movement, and mindfulness level in male university players.

METHODS: Forty male university basketball players (age 18–25 years) from two universities were recruited and assigned into an intervention group (IG, n = 20) or a control group (CG, n = 20). The IG completed an eight-week mindfulness training program (once per week, 60 minutes per session) alongside their regular basketball training; the CG continued their usual training without additional intervention. Outcome measures included: (1) Muscular Strength (1RM bench press, 1RM squat), (2) Functional Movement (Functional Movement Screen, FMS), (3) Basketball Skills (dribbling test, 1-minute shooting drill, and weekly free-throw records), and (4) Mindfulness level (Five Facet Mindfulness Questionnaire [FFMQ] and Mindful Attention Awareness Scale [MAAS]). Pre- and post-test comparisons were conducted via two-way mixed-design ANOVAs, with effect sizes (η^2) reported where relevant.

RESULTS: After eight weeks, both the IG and the CG improved in bench press ($p < 0.001$) and shooting skills ($p < 0.001$). There were no significant group-by-time interactions. But the IG showed increasing in strength ($p = 0.007$) and higher scores on the functional movement scores ($p < 0.001$) than the CG. The IG also had higher scores in overall mindfulness (FFMQ, $p < 0.001$; MAAS, $p = 0.042$) compared with control group. Among the basketball skills, dribbling showed no significant in time effect, but in interaction analysis ($p = 0.004$) indicated greater improvements in IG. Weekly free throw tracking revealed consistent improvement in the IG following mindfulness sessions.

DISCUSSION: The 8-week mindfulness training effectively improved muscular strength, functional movement, and mindfulness levels in university basketball players, with the intervention group demonstrating significantly greater gains than the

control. Findings underscore mindfulness's potential to augment precision-based tasks like free-throw performance, though integrating mindfulness with sport-specific training may optimize holistic athletic development. Future research should focus on long-term interventions and specialized mindfulness protocols.

**EXPLORING THE ROLE OF SELF-DETERMINATION IN THE JOB DEMANDS-RESOURCES MODEL: A DOUBLE-EDGED SWORD FOR TABLE TENNIS COACHES**

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INTRODUCTION: Grounded in the Job Demands-Resources (JD-R) model, this study examines the mediating role of emotional exhaustion in the relationship between perceived job demands and life satisfaction among table tennis coaches. Additionally, this study investigates whether self-determination moderates the relationship between perceived job demands and emotional exhaustion. Contrary to traditional JD-R assumptions, which suggest that personal resources buffer the negative impact of job demands, this study explores whether self-determination exacerbates or mitigates the relationship between perceived job demands and emotional exhaustion. A moderated mediation analysis was conducted to explore these relationships.

METHODS: A total of 283 questionnaires were distributed to table tennis coaches using a purposive sampling method, and 247 valid responses were collected (effective response rate: 87.28%). Descriptive statistics, Pearson correlation, hierarchical regression, and PROCESS analyses were employed to test the hypotheses.

RESULTS: The findings indicate that perceived job demands negatively impact life satisfaction through the mediating effect of emotional exhaustion, supporting the JD-R model. However, the moderating effect of self-determination deviated from the expected buffering role. Instead of mitigating the relationship between perceived job demands and emotional exhaustion, higher self-determination intensified this relationship, whereas lower self-determination weakened the association. Moreover, self-determination strengthened the mediating effect of emotional exhaustion on life satisfaction rather than attenuating it, contradicting conventional expectations.

Discussion: These results suggest that self-determination may act as a double-edged sword. While generally regarded as a psychological resource, in high-stress coaching environments, it may amplify the negative effects of job demands by increasing emotional commitment and workload, ultimately leading to greater exhaustion. These findings extend the JD-R model by demonstrating that self-determination does not always serve as a buffering resource against job demands. Instead, highly self-determined coaches may perceive job demands as personal challenges, leading to greater emotional investment but also increased vulnerability to exhaustion. From a practical perspective, organizations should implement workload regulation strategies, provide psychological support such as resilience training, and encourage boundary management techniques to help coaches maintain their well-being. Future research should further investigate the conditions under which self-determination functions as a protective versus a risk factor in sports coaching.

## Molecular Biology and Biochemistry

**COMMON GENETIC POLYMORPHISMS IN WRESTLERS: INSIGHTS FROM MULTIETHNIC GWAS**

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INTRODUCTION: Sports performance is influenced by both environmental and genetic factors. Previous studies have reported that several gene polymorphisms are associated with sports performance (Semenova et al., 2023). However, genetic factors vary widely across ethnic groups and sports disciplines, and few consistent findings have been reported across studies. Moreover, the genetic factors specific to wrestling remain poorly understood. Therefore, the purpose of this study was to conduct a genome-wide association study (GWAS) in wrestlers from different countries (Japan, Türkiye and Russia) and to identify common gene polymorphisms across these populations.

METHODS: This study included 64 Japanese wrestlers (54 men and 10 women, international levels) and 306 Japanese control (143 men and 163 women), 68 Turkish wrestlers (International levels) and 137 Turkish controls, 130 Russian wrestlers and 173 Russian controls. Genomic DNA was extracted from saliva samples using an Oragene-DNA kit (Japan and Russian) and commercial extraction kit (Türkiye). The Japanese samples were genotyped using the Japonica Array v2, which covers more than 500,000 single nucleotide polymorphisms (SNPs). Quality control (QC) procedures and imputation were performed. Russian samples were genotyped using the HumanOmni1-Quad and HumanOmniExpress BeadChips. Turkish samples were genotyped using single nucleotide polymorphism (SNP) microarray. Quality control (QC) procedures and imputation were performed in the microarray data. Genome-wide associations were assessed using an additive genetic model with logistic regression analysis, adjusted for sex (Japan and Russian). GWAS analyses for the Turkish cohort were performed using Fisher's Exact Test in Plink 1.9. Statistical significance was set at $p < 0.05$, and common gene polymorphisms were identified.

RESULTS: The number of gene polymorphisms that reached the statistical significance was 328,388 in Japanese participants, 23,932 in Turkish participants, and 30,385 in Russian participants. Eleven gene polymorphisms were consistently associated with wrestler status across all three populations.

CONCLUSION: Common gene polymorphisms associated with wrestler status were identified across different ethnic groups. These findings suggest that certain genetic factors may contribute to wrestling performance regardless of ethnicity.

**BFR CYCLING EXERCISE TRAINING FAILS TO ENHANCE POST-EXERCISE MUSCLE GLYCOGEN REPLENISHMENT BUT INFLUENCES TRANSCRIPT FACTORS OF MITOCHONDRIAL BIOGENESIS IN EXERCISED HUMANS**

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INTRODUCTION: Exercise training with blood flow restriction (BFR training) is an alternative training mode to improve muscle strength and endurance performance under pressing exercising muscle blood flow restriction at the proximal upper or lower limb segments. This study aims to demonstrate the effect of three weeks of cycling training with BFR treatment on improving post-exercise muscle energy replenishment regarding muscle glycogen and mitochondrial biogenesis in exercised human skeletal muscle.

METHODS: Twelve physically active males with exercise habits were recruited to perform this crossover study design and randomly assigned to the BFR group (60 min 75% VO2max, 60rpm/day, 3 days per week for 3 weeks, cuff with 13 cm at ~180mmHg; 2 min released per 10 min cycling), while the CON trial did not wear BFR bandages and followed the same training pattern. On the morning of the experimental day following three weeks of cycling training, all subjects performed a single bout of cycling challenge with 75% 〖VO〗_2max for 60 minutes at 60rpm, and ingested a carbohydrate diet (2g carbohydrate/kg of body weight; 60% carbohydrate, 15% protein, 25% fat). Biopsied muscle from the vastus lateralis was obtained before a 3-week exercise training program and immediately (0h) and 3 hours after a single bout of exercise. Transcription factors that regulate gene expression involved in mitochondrial biogenesis were measured via RT-PCR and periodic acid Schiff (PAS) staining for muscle glycogen. Responses in blood glucose, plasma non-esterified fatty acids, lactate dehydrogenase (LDH), creatine kinase (CK), superoxide dismutase (SOD), malondialdehyde (MDA), IL-6, IL-10, TNF-α, and expired gas analysis for carbohydrate and fat oxidation rates were assessed in this human study.

RESULTS: Post-exercise muscle glycogen was not significantly replenished during the 3-hour recovery period, coinciding with elevated CK and LDH responses after three weeks of cycling BFR training compared to the control condition. Interestingly, BFR training improves whole-body insulin sensitivity based on the same glucose utilization under lower insulin response ($P<0.05$). Elevated blood levels of SOD, IL-6, and IL-10, and decreased levels of TNF-α were found during the post-exercise period under BFR training compared to CONTROL training. Additionally, post-exercise PGC1-α gene expression was not significantly influenced by both BFR and CONTROL conditions ($p > 0.05$), but BFR training significantly influenced ERRα and SIRT1 genes concurrent with inconsistent trend ($P<0.05$). BFR training upregulated TFAM gene expression, upregulation of MFN1, and downregulation of DRP1 gene expression.

CONCLUSION: Three weeks of cycling training combined with BFR treatment did not improve post-exercise muscle glycogen replenishment despite enhancing whole-body insulin sensitivity. BFR training showed its impact on gene expression transcripts related to mitochondrial biogenesis, yet exhibited different trends in physiological signals.

**DIFFERENTIAL AUTOPHAGY FLUX WITH AGE IN IMMORTALISED HUMAN PRIMARY MYOTUBES**

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INTRODUCTION: Autophagy is a conserved intracellular process involving degradation and recycling of dysfunctional or redundant cellular structures. Animal studies have demonstrated the importance of basal autophagy for maintaining skeletal muscle health, and as an adaptive process to accommodate acute cellular stressors such as nutrient deficiency (1). Intriguingly, basal pre-lysosomal autophagy flux (i.e., autophagosome formation) is elevated in ageing rodents, which may reflect proteostatic dysfunction and an overall reduction in muscle quality (2,3). Whether similar abnormalities are present in aged human skeletal muscle remains unclear, therefore, we investigated the effect of age on autophagic flux and associated signalling pathways in immortalised human primary myotubes.

METHODS: Immortalised human primary myoblasts isolated from 83y/o elderly (C83/KM670, OLD) and 25y/o young male (C25/KM155, YOUNG) were cultured and differentiated into myotubes. Media on both OLD and YOUNG myotubes was changed to either Earles Balanced Salt Solution (STARV), or fresh differentiation media (BASAL) for 5hrs. Cells were treated with a control solution (DMSO) or the v-ATPase inhibitor, Bafilomycin-A1 (100nM), 2hr prior to collection for measurement of pre-lysosomal autophagic flux (n=6 per condition and group). A subset of untreated cells was collected to determine differences in signalling outcomes (n=2-3 per condition and group). Immunoblots were completed and two-factor independent measures ANOVAs assessed differences between conditions, with significance threshold set at $p<0.05$. Data is presented as Mean ± SD.

RESULTS: There were significant main effects of group and condition (both $p<0.01$) for LC3-II flux, whereby STARV increased flux in OLD (0.239±0.614 to 0.998±0.477AU) and YOUNG (1.201±0.742 to 1.975±0.807AU) cells but levels of flux were lower overall in OLD. When adjusted for corresponding total protein, p-ULK1ser757 (i.e., a mTORC1-regulated site suppressing autophagy activation) and p-RPS6ser240/244 (i.e., general marker of mTORC1 activity) decreased in response to STARV in

both OLD and YOUNG cells (main effects of condition, p<0.001). Notably, however, OLD cells had lower total ULK1 protein and higher p-ULK1ser757 regardless of condition (both p<0.01). No effect of group or condition was observed for P62 flux (p>0.05).

CONCLUSION: Overall, we have shown that both YOUNG and OLD immortalised human primary myotubes can upregulate autophagy in response to 5hrs of starvation. However, LC3-II flux were lower overall in aged muscle, which could be, in part, related to dysregulation of the mTORC1-ULK1 axis, as evidenced by an overall lack of total ULK1 protein and greater inhibitory ULK1ser757 phosphorylation. These data provide initial insight into the effect of age on human skeletal muscle autophagy in-vitro and highlights pertinent avenues of in-vivo research in this area.

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**UROLITHIN A INCREASE MYOGENIC MARKER MEDIATED BY MITOCHONDRIAL CHANGE DURING MATURATION IN C2C12**

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INTRODUCTION: C2C12 cells are commonly used to study muscle differentiation due to their ability to form mature myotubes. MyoD and myogenin are known to drive this process, leading to increased myosin heavy chain (MHC) expression associated to increase on mitochondrial mass. Mitochondria play a critical role in providing the energy required for differentiation. Additionally, the mTOR signaling pathway is crucial in protein synthesis during this process. Urolithin A (UA) has been shown to induce mitochondrial biogenesis and enhance mitochondrial function, potentially improving muscle differentiation. This offers therapeutic potential for muscle-related disorders during myogenic differentiation and maturation.

METHODS: The C2C12 cell line (ATCC) was used (n=4). On the 3rd day of differentiation, cells were treated with UA (2 μM) for 72 hours, with treatments refreshed every 24 hours. On the 6th day, cells were lysed and analyzed via Western Blot (WB) for mitochondrial proteins, differentiation markers, and mTOR pathways. Mitochondrial function was assessed using Oroboros. Statistical significance was determined using the Mann-Whitney test.

RESULTS: UA treatment increased the expression of TOM20 and PGC1-α and enhanced maximal respiration. MyoD, MYH, and phosphorylated mTOR expression were also elevated with UA treatment

CONCLUSION: Chronic exposure to UA induces mitochondrial changes and increases the expression of myogenic markers during C2C12 cell maturation, although it may decrease overall protein synthesis. Future studies we will assess myotube morphology to further elucidate the effects of UA during maturation.

## Motor Learning and Motor control

**THE BALL-MOVEMENT COUPLING OF BASEBALL BATTERS WHEN HITTING FIXED AND VARIABLE PITCH TYPES**

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INTRODUCTION: Previous studies have compared batters facing pitching machines and real pitchers, discovering that batters exhibit different movement coordination in response to varying incoming pitch information (Katsumata, 2007; Kuo et al., 2020). However, the differences in batters coordination when facing real pitchers throwing fixed or variable pitch types have not been explored. This study examined changes in batters movement coordination when facing a real pitcher who threw six consecutive maximum-speed fastballs and six changeup pitches.

METHODS: Twenty-eight collegiate baseball players participated, hitting pitches delivered by real pitchers in a balanced sequence of fixed or variable pitches . A motion capture system recorded the whole-body 3D coordinates and the time sequence of the incoming pitches. Referring to the method of Welch et al. (1995), the swing motion was analyzed by calculating joint angles of the shoulders, elbows, and knees, as well as the rotational angles and angular velocities of the arms, shoulders, and hips. For pitch-motion coupling, the timings of ball release, bat-ball contact, and peak angular velocity were identified.

RESULTS: The maximum angle does not differ across different situations. The proportion of movement time across phases also shows no significant difference.

When facing fixed pitch types, the stride timing was earlier, resulting in a longer center-of-mass transfer time, which adjusted with the bat-ball contact timing.

When facing variable pitch types, the stride timing was later, and the center-of-mass transfer time was shorter.

Successful hits demonstrated a more appropriate kinetic chain, involving the sequential maximal velocity of the hips rotation, shoulders rotation, rear knee extension, and arms rotation. Compared to fixed pitch types, the coordination of whole-body kinetic link transfer showed greater variability in sequencing and timing intervals in changeup pitches, which may better represent the movement coordination required in real game situations.

CONCLUSION: The coordination of perception and action for baseball batters aligns more with anticipation and consistent movement coordination in fixed situations. However, in variable situations of changeup pitches, they must adjust their movement coordination according to changes in the incoming pitch, which aligns with the theory of prospective model . Swinging the arms prematurely to hit the ball may have negative impacts, which is a key skill adjustment for advanced players.

**INVESTIGATING COINCIDENCE ANTICIPATION TIMING AND REACTION TIME BETWEEN GAMERS AND NON-GAMERS**

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INTRODUCTION: Perceptual-motor abilities such as anticipatory behavior and reaction times, are fundamental components of skilled athletic performance and have been extensively studied across various sports [1]. Coincidence anticipation timing plays a pivotal role in daily life, everyday routine tasks, and sports activities. Neural mechanisms can be quantified using coincidence anticipation timing tasks [2]. Accurate coincidence anticipation timing is required for successful performance [3]. With the growing popularity of eSports as competitive computer games, it is crucial to assess the coincidence anticipation timing abilities of eSports gamers due to its relevance in gameplay [1]. For example, the ability to anticipate and respond quickly to environmental stimuli is key for actions such as shaking hands, doing high-fives, or executing tennis strokes, as well as for hitting and catching in baseball. Therefore, the purpose of this study was to investigate the coincidence anticipation timing and reaction time in eSports gamers compared to non-gamers. It was hypothesized that experienced gamers would demonstrate better anticipation timing and faster reaction time than non-gamers.

METHODS: Twenty collegiate students participated in this study, including ten experienced gamers (M1 = 23.7, SD1 = 1.9) who enjoy eSports at least 10 hours per week and ten non-gamers without any regular gaming experience (M2 = 23.5, SD2 = 1.6). Coincidence anticipation timing accuracy was measured using a Bassin Anticipation Timer. Participants completed tasks at three light stimulus speeds: slow (3 mph), moderate (6 mph), and fast (9 mph). Absolute anticipation timing error in milliseconds was calculated based on accuracy relative to the target point. Additionally, simple and choice reaction times were measured using a Takei Reaction Timer.

A two-way ANOVA with repeated measures was conducted to compare coincidence anticipation timing performance between groups, and independent samples t-tests were used to analyze differences in simple and choice reaction times. All statistical analysis was completed at the significance level of 0.05.

RESULTS: Results revealed no significant difference in coincidence anticipation timing between gamers and non-gamers, although a significant speed effect was observed ($p = 0.001$). As hypothesized, experienced gamers demonstrated significantly faster simple reaction times ($p = 0.003$) and choice reaction times ($p = 0.014$) than non-gamers.

CONCLUSION: These findings suggest that while eSports experience may not enhance coincidence anticipation timing, it could improve reaction times, highlighting the potential for esports training to develop certain perceptual-motor skills.

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**THE INFLUENCE OF FATIGUE ON FUNCTIONAL HAMSTRING TO QUADRICEPS RATIO IN MALES AND FEMALES**

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INTRODUCTION: Fatigue is a key risk factor for non-contact anterior cruciate ligament (ACL) injuries, with females being 2–6 times more likely to sustain such injuries than males (1). Fatigue impairs neuromuscular performance, compromising knee stability. The functional hamstring to quadriceps (FH/Q) ratio is critical for knee stability, particularly near full extension where ACL strain is greatest. This study examined the effects of fatigue on functional hamstring to quadriceps (FH/Q) ratio in males and females, focusing on sex-specific differences contributing to injury risk.

METHODS: One hundred and ten participants consisting of 55 males (age: 29 ± 5y, body mass: 82 ± 7kg, stature: 1.82 ± 0.07m) and 55 females (age: 27 ± 6y, body mass: 69 ± 9kg, stature: 1.61 ± 0.08m), participated in a 6-week experimental study. Each session involved a 40-minute intermittent downhill running protocol (-10% gradient) consisting of 5 × 8 min bouts with 2 min rest between bout, at 80% of age-predicted maximum heart rate (Models Fs3c, Polar) (2). FH/Q ratios were assessed pre- and post-fatigue at 60, 120, and 240°·s$^{-1}$ using a Biodex System 3 dynamometer. Ratios were calculated from concentric quadricep torque and eccentric hamstring torque at 15°, 30°, 45°, and peak torque (PT) to capture performance across the functional range of knee movement. Two-way repeated measures ANOVA analysed interactions of sex, fatigue, joint angle and velocity, with significance set at $p<0.05$. Effect sizes were determined using Cohens d with <0.2 considered a small effect, 0.5 a medium effect and >0.8 large effects.

RESULTS: Irrespective of sex, fatigue caused significant declines in FH/Q ratios across all conditions ($p<0.01$) with large effects (d = 0.87-1.36). A significant sex x joint angle x time interaction was observed with females demonstrating lower ratios than males post-fatigue (e.g., at 240°·s$^{-1}$, females: 55% vs. males: 71%, $p<0.01$), which were more pronounced with decreasing joint angle (closer to full knee extension). The most significant sex difference occurred at 15° near full extension (22% vs 15% decrease compared to males). Significant interaction effects were also observed between velocity and time in

both males and females (p<0.01). The repeated testing protocol showed that fatigue effects were cumulative over the study, with females exhibiting greater susceptibility to declines over time.

CONCLUSION: Irrespective of sex, fatigue induced significant reduction s in the FH/Q ratio. However, this decline was significantly greater in females, particularly at joint angles critical for knee stability. These results highlight the need for targeted eccentric hamstring training and fatigue resistance programs to address sex-specific vulnerabilities and reduce ACL injury risk during high-intensity activities.

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**REVISITING FITTS LAW: EXPLORING THE RECIPROCAL RELATIONSHIP BETWEEN SPEED AND ACCURACY IN TIMING TASKS**

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INTRODUCTION: The concept of a space-time framework forms the basis for suggesting the complementarity of spatial and temporal errors in movement variability, where movement accuracy in space is assessed relative to time, and vice versa. Fitts (1954) introduced an information processing theory that linked movement time with spatial accuracy, which led to the well-known Fitts' law in human motor control. In the experiment discussed here, we explore a reciprocal space-time approach, requiring participants to move within a specific time goal and time window while allowing the movement amplitude to emerge naturally.

METHODS: Twenty healthy adults who self-reported as right-handed were recruited for this study. The target times (T) tested were 100, 200, 400, and 800 ms, corresponding to Index of Difficulty in Time (IDT) values of 1, 2, 3, and 4, based on an expected time window of ± 50 ms (100 ms bandwidth for temporal targets). The target time bandwidth was varied, ranging from 25 (±12.5) to 800 (±400) ms, when the target time was set to 800 ms, resulting in IDTs of 1, 2, 3, 5, and 6. Repeated measures ANOVAs were used to examine the effect of the manipulations.

RESULTS: To evaluate the effect of the target T manipulation, an ANOVA on movement time revealed a significant influence of IDT, $F(2.04, 38.74) = 18390$. Similarly, the IDT significantly affected movement time under the time window manipulation condition, $F(1.68, 31.98) = 14.1$ ($ps < .05$). Furthermore, a repeated measures ANOVA on movement amplitude with target T manipulation indicated a significant effect of IDT, $F(2.03, 38.66) = 173$. Likewise, the IDT within the time window manipulation showed a significant impact on movement amplitude, $F(5, 95) = 3.24$ ($ps < .05$).

CONCLUSION: The results indicated that a higher IDT was associated with better average group performance consistent with Fitts law. The groups average movement amplitude increased from 12.55 mm at IDT1 to 405.20 mm at IDT4 under the target T manipulation, supporting the reciprocal relationship between space and time error functions in Fitts' type movement tasks and aligning with the reciprocal patterns of spatial and temporal errors observed in other movement aiming tasks.

**ASYMMETRY BETWEEN UPPER LIMB MASSES AND KINETIC INDICES IN RIGHT-HANDED YOUNG ADULTS**

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INTRODUCTION: This study aimed to create an accurate method for calculation of upper arm mass and to use these data to determine any asymmetry between the masses of the dominant and non-dominant upper limbs of right-handed participants and to examine lateral differences in kinetic parameters during the early phase of a discrete target-directed fast targeting task created on the trade-off between speed and accuracy.

METHODS: The study included 20 right-handed males (20.8 ± 1.2 years) with no upper limb pathology. Handedness was assessed using the Waterloo Handedness Questionnaire [1]. A certified model of an Analyzer of Dynamic Parameters of Human Movement™ (Patent Number LT 5251, 2005-08-25, Lithuania; Baltec CNC Technologies) interfaced with a computer was used to collect the data.

In Experiment 1, upper arm mass was calculated using an Analyzer. Participants performed 16 valid trials per arm, pushing a joystick forward while force and acceleration were recorded. The mass of the upper limb was calculated as: M_(upper limb)=F/a_av -M_joystick, (1) where M_joystick is the mass of the joystick. The number of participants was sufficient for using Student's paired t-test. The Shapiro-Wilks test was used to determine the normality of data distribution. In Experiment 2, the same 20 adult men, were involved in the subsequent experiment. Subjects had to push the devices handle as fast and accurately as possible towards a target on the screen. Each participant performed 5x20 separate movements with each arm (100 in total). An Analyzer recorded mechanical energy, power, force impulse, and spatial error. The Shapiro-Wilk test, Student's t-test, and $\chi^2$ test were used for statistical analysis (IBM SPSS v.22).

RESULTS: Results showed that the left arm was generally lighter than the right, but the difference was not significant. However, 25% of participants had a heavier non-dominant arm. Mechanical energy and power were significantly higher in the left arm, while relative spatial error was greater in 60% of cases. The $\chi 2$ test confirmed an unequal distribution of capabilities between the arms ($P < 0.05$).

CONCLUSION: The method described here provides an accurate measurement of upper-arm mass. In most cases, the dominant arm was more massive than the non-dominant arm. Knowledge of limb segment masses is necessary to estimate body segment properties accurately. The study showed greater mechanical energy, initial sub-movements power, and driving forces for the non-dominant arm. CNS uses different mechanisms to coordinate movements of non-dominant and dominant hands [2–3]. Future research should include energy expenditure and specific arm mass tests. The energy minimization mechanism may be more suited to the dominant hand due to the left brain hemispheres complexity.

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**THE LEARNING EFFECTS OF DIFFERENT VISUAL CONSTRAINTS ON FULL-TURN JUMPS**

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INTRODUCTION: Jump turns are the key elements in artistic sports. Healthy individuals typically rely on visual information to generate coordinated movements in specific environments. "Spotting" is a technique used by gymnasts, dancers, and figure skaters during jumps and spins to acquire and maintain information about rotation and balance throughout the process. Sato et al. found that gymnasts exhibited a synergistic movement pattern during a full-turn jump, characterized by an early head movement returning to face forward after completing the rotation, with a stabilized gaze occurring prior to landing (1). The purpose of this study is to explore the learning effects of different visual information on full-turn jumps that involve both temporal and spatial constraints.

METHODS: Six young adults who exercised regularly but lacked jump-turn training experience were assigned to one of two visual information groups: a dot or a randomly changing number displayed every 200 ms. A two-week skill learning program aimed at achieving full-turn jumps in 400 ms was implemented. In addition to a 1-meter-diameter disc protractor and a set of gratings used to evaluate temporal and spatial performances in the pre-and post-tests, an infrared high-speed three-dimensional motion capture system recorded the kinematics of the head and hips for phase-plane analysis of turn coordination. Independent t-tests were used to examine the differences in angular displacement between the pre- and post-tests for individual statistical analyses.

RESULTS: The t-test results indicated that two participants in the Number group showed significant improvement in variable error regarding angular displacement, as well as in absolute error and constant error (ps < .05). Only one participant in the Dot group showed significant improvement in angular displacement. Phase-plane analysis revealed that participants in the Number group also exhibited higher head acceleration and an early fixation delay, which were not observed in the Dot group.

CONCLUSION: Focusing on randomly generated numbers effectively influenced movement patterns during the learning process of a full-turn jump. The Number group exhibited a distinct fixation strategy, showing a clear tendency to stabilize their gaze before landing. This indicates that specific visual information may have contributed to improving spatial performance, particularly in controlling rotation angles. These preliminary observations offered promising directions for future research programs exploring learning and teaching strategies in full-turn jumps.

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**OPTIMIZING THE SPEED-ACCURACY TRADE-OFF IN THE VERTICAL JUMPING THROUGH MOTOR LEARNING**

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INTRODUCTION: Human movement is regulated by the speed-accuracy trade-off principle [1], which claims that generally, speed is reduced when higher accuracy is required. However, in sports, speed and accuracy must be maintained at high levels. Thus, athletes must improve both aspects through motor learning.

Studies have investigated sports movements' mechanisms requiring speed and accuracy using whole-body movements such as vertical jumps. However, while they have reported that increasing accuracy leads to reduced speed, they have not sufficiently examined whether repeated learning of the movement can improve speed while maintaining accuracy, ultimately optimizing the balance between speed and accuracy at a higher level [2]. This study aimed to clarify how the speed-accuracy trade-off changes through motor learning. Specifically, we examined whether learning induces adaptations that improve accuracy without compromising speed.

METHODS: This study involved seven participants, and this paper presented a detailed analysis of a representative participant who exhibited a typical performance pattern.

The participant performed vertical jumps on a force plate under the following conditions:

1. Normal condition: Perform a maximal vertical jump on a force plate.

2. Adjusted condition: Perform a maximal vertical jump while controlling the landing to match the take-off position.

The participant sequentially performed 10 trials for each condition in Section 1. Thereafter, Section 2 (normal condition: 5 trials, adjusted condition: 10 trials) was conducted to examine motor learning progression.

Data analysis was conducted following the methodology in [2]. Take-off position, landing position, jump height, and information entropy were calculated.

RESULTS: Jump height was 49.5 cm and 44.3 cm in Section 1 in the normal and adjusted conditions, respectively: the normal condition resulted in significantly higher jumps ($p < 0.05$). Relative information entropy, which indicates landing accuracy, was 0.66 in the normal condition and 0 in the adjusted condition.

Jump height was 52.1 cm and 51.7 cm in Section 2 in the normal and adjusted conditions, respectively, with no significant difference between them ($p = 0.95$). Relative information entropy was 0.31 and 0.28 in the normal and adjusted conditions, respectively. In other words, this decrease in relative information entropy indicates an improvement in movement consistency through learning.

CONCLUSION: A conventional speed-accuracy trade-off was observed in Section 1. In contrast, jump height was maintained while landing consistency improved, as indicated by lower relative information entropy in Section 2. These results suggest that motor learning enables individuals to achieve a higher balance between speed and accuracy, optimizing their performance over time. Future research should systematically analyze data from all participants to examine inter-individual variability and validate the generalizability of these findings.

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**PASSAGE OF TIME CONTRIBUTES TO THE DECAY OF AFTEREFFECTS INDUCED BY TRAMPOLINE JUMPING**

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INTRODUCTION: When performing a vertical jump and subjectively estimating their achieved height after trampoline jumps, individuals experience reduced jump heights and tend to underestimate their jump heights (Márquez et al., 2010). These aftereffects are no longer observed in a subsequent vertical jump trial. Therefore, a vertical jump trial likely contributes to the recovery of both jump height and estimation to their original level. In contrast, we will test whether the passage of time following the completion of trampoline jumps induces this recovery.

METHODS: Subjects (n = 14, age: 23.2±1.6 years, height: 173.2 ± 6.8 cm, weight: 69.9 ± 4.8 kg) performed three vertical jumps on the force plate, and the experimenter provided the achieved jump height (Pre-Test). One minute later, the subjects jumped on the trampoline 30 times at a rhythm of 1.2Hz (72bpm). They then performed vertical jump and estimated their own jump height five times at one-minute intervals (Post-Test). The Post-Test started after a delay of five different time intervals (0, 1, 2, 3, and 4 minutes) following the completion of the trampoline jumps. In the 0-min condition, subjects started the Post-Test immediately after completing the trampoline jumps. In the 1 to 4-min condition, subjects started Post-Test after the resting period set in the condition was spent in seated rest. We recorded the subject's real jump height (RH), estimated height (EH), maximum ground reaction force, minimum knee angle, flexion movement time, and maximum flexion velocity during the vertical jump.

RESULTS: In the 0-min condition, RH and EH in the first Post-Test trial decreased (RH: -5.12±6.41% compared to the Pre-Test, $p = 0.007$; EH: -6.26±8.31% compared to RH in the same trial, $p = 0.009$). These heights recovered to baseline levels in the second Post-Test trial, which was performed one minute later. On the other hand, when the vertical jump was performed after merely a minute of rest following trampoline jumps (first Post-Test trial in the 1-min condition), RH recovered to baseline, but EH continued to decline (-4.88±3.43% compared to RH of the same trial, $p < 0.001$). No significant changes were observed in other recorded parameters.

CONCLUSION: These results indicate that the passage of time after completing trampoline jumps plays a significant role in the recovery of both the real and subjective jump heights and that the time-dependent recovery processes differ between the two types of jump heights. This suggests that the aftereffects produced in motor behavior and estimation systems may be generated by different mechanisms.

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**DIVERSITY OF FUNCTIONAL LATERALITY AND PREFERENCE IN MOTOR DEVELOPMENT DURING CHILDHOOD**

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INTRODUCTION: This study investigates functional laterality (FL) and preference (Pr) in motor function among Japanese preschool children, providing fundamental data for elementary physical education. Functional asymmetry of the brain emerges between ages 3 and 5, coinciding with motor cortex development [1][2]. However, cultural influences in Japan encourage the use of the right hand. Given this norm, we examined the relationship between FL and Pr.

METHODS: Participants comprised 30 five-year-old kindergarteners (14 boys, 16 girls). Pr was assessed using the Edinburgh Handedness Inventory (EHI) [3], preferred hand for throwing a ball (HB), preferred foot for kicking a ball (FB) and the

first step foot in a sprint start (FS). FL was evaluated through a hand dexterity (HD) via a marble-placing task, a ball aiming (BA) test with five trials per hand, a ball kicking (BK) test with five trials per foot and a one-legged hopping (JR) test with two trials per leg. Gender differences, correlations among variables and FL tendencies based on Pr were analysed using nonparametric tests.

RESULTS: The EHI results indicated that 86.7% were right-handed, 10% were left-handed and 3.3% exhibited crossed dominance. HB showed that 23.3% preferred the left hand, half of whom were classified as right-handed by the EHI. For FB, 10% favoured the left foot, while 56.7% preferred the left foot for FS, though FB and FS showed low consistency. Regarding gender differences, boys were taller, while girls exhibited significantly higher JR scores on the right leg. Boys outperformed girls in BK scores on the right foot. Significant positive correlations were found between the left and right scores for HD, BK and JR, except for BA. A significant positive correlation was also observed between BA (right) and BK (right) ($r=0.346$, $p=0.014$). A negative correlation between BK (right) and JR laterality difference ($r=-0.260$, $p=0.044$) suggested that higher BK (right) performance was associated with stronger left-side dominance in JR. However, BK (right) and JR (left) showed no significant correlation. Examining the relationship between Pr and FL, 66.7% threw with their FL-dominant side in the HB-BA comparison, while 23.3% had Pr and FL on opposite sides. For FB and BK, 13.3% showed Pr and FL on opposite sides. There was no significant correlation between BA and JR, with 23.3% aligning with expected patterns and 30% deviating.

CONCLUSION: Findings suggest that FL and Pr are interrelated in five-year-old children's motor functions, though inconsistencies were observed in some areas. Future approaches to supporting motor development in elementary physical education should account for individual laterality and cultural influences. As society increasingly acknowledges gender diversity, recognising and respecting individual differences in motor laterality is equally essential.

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**DOES UNCONSCIOUS KNOWLEDGE SUPPORT SKILLED ATHLETIC MOVEMENTS?**

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INTRODUCTION: A large amount of anecdotal evidence suggests that athletes are not always aware of the specific parameters of their highly-skilled, fine-grained, movements involved in their sporting actions. In other words, it appears plausible that their actions are supported, at least in part, by unconscious knowledge. However, little empirical research within cognitive science or within sport science has been done to directly test this possibility. Nevertheless, this possibility appears plausible in the light of studies showing that actions involved in sport often exhibit characteristics associated with unconscious knowledge; namely, they are acquired incidentally, can be deployed without attention and are resilient to dual-task interference. In the present study, using a methodology adapted from consciousness science, we directly test whether unconscious knowledge supports movements involved in sport. To increase the chances of finding knowledge that is not consciously detected, we used table tennis as the context of our research, because it involves precise, fine-grained, movements executed at very high speeds.

METHODS: An elite table tennis player was tested in two conditions: in the experimental condition, the player was required to strike the ball as in a table tennis game, and immediately after was asked to reproduce the position of the arm at the moment of striking the ball. The shoulder, elbow, forearm, and wrist angles were recorded using an IMU system, and the error in the reproduced (vs the original) position of the arm was computed. In the baseline condition, the player was required to position the arm in various static positions (indicated by the experimenter) that could appear when striking a ball, for several seconds, and immediately then to reproduce the position. This was in order to measure the error in reproducing the arm position under conditions ideal for conscious processing.

RESULTS: As expected, in the baseline condition, when conscious processing was favoured, the reproduction errors were relatively low (mean differences < 4 degrees); however, the reproduction errors were notably higher in the experimental condition (up to 9 degrees for the shoulder adductor/abductor angle), suggesting that, when executing the high-speed strokes, the athlete lacked full awareness of the position of her arm (a difference generated by the shoulder joint).

CONCLUSION: This study proposes a methodology for investigating athletes' awareness of their fine-grained movements and provides initial evidence that, partially, these movements are supported by unconscious knowledge. The study has the potential to initiate a novel research line at the intersection of sport science, consciousness science, and cognitive science.



**SEX DIFFERENCES IN ELECTROMECHANICAL DELAY OF THE HAMSTRINGS FOLLOWING DOWNHILL RUNNING**

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INTRODUCTION: Neuromuscular capability is likely compromised when fatigue is present, which likely predisposes the athlete to increased injury risk (1). To date no studies appear to have examined the effect of downhill running on sex differ-

ences in the electromechanical delay (EMD) of the hamstrings. This is somewhat surprising given the importance of the hamstrings to work eccentrically to reduce injury risk and keep the joint stable.

METHODS: One hundred healthy males (n=50) and females (n=50) were recruited from the university population. Each participant performed a 40 min intermittent downhill running protocol consisting of 5 × 8 min bouts on a -10% decline at 80% or heart rate max, with 2 min standing rest between each bout (2). Immediately before and after the downhill running task, Electromyography (EMG) of the semitendinosus, semimembranosus and biceps femoris of the dominant limb (DelSys Myomonitor III) was determined during isokinetic eccentric muscle actions at 60, 120 and 240˚·s–1 (Biodex system 3). The Biodex square wave synchronization pulse was configured with the EMG software so that EMG and torque data were time aligned. Raw EMG data were collected at a sampling frequency of 1024 Hz and included a common mode rejection ratio of <80 dB and an amplifier gain of 1000. Raw EMG data was band pass filtered at 20 – 450 Hz. EMD was determined as the time delay between the onset of muscle activation (change in activation of +15 μV) and onset of torque production (9.6 Nm) (3). A mixed-factorial analysis of variance (ANOVA) was used to explore the effects of time, sex, and muscle on electromechanical delay. Effect sizes were determined using Cohens d with <0.2 considered a small effect, 0.5 a medium effect and >0.8 large effects.

RESULTS: Irrespective of sex, muscle or velocity, EMD of the hamstrings muscle was significantly longer post-downhill running ($F(1, 98) = 709.406$, $P < 0.01$), with large effects observed (d = 1.05-2.80). Significant interactions between sex and time for EMD of hamstring muscles were found ($F(3, 98) = 28.738$, $P < 0.01$) with significantly longer EMD post fatigue in females. These differences demonstrated large effects (d = 0.72-1.46). No significant effects of muscle were observed in any analysis.

CONCLUSION: These data suggest that neuromuscular capability of the hamstrings during eccentric actions is compromised post downhill running irrespective of sex or muscle group examined. This compromise is greater in women and may make them more susceptible to injury risk due to reduced stability of the knee. Effective neuromuscular functioning when fatigue is present is important for mainlining performance and reducing injury risk. Thus, eccentric hamstring training should be proposed to limit the effects of neuromuscular fatigue, especially in female athletes.

**IMPACT OF EXERCISE PROTOCOL ON POSTURAL CONTROL IN PEOPLE WITH DIABETES**

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INTRODUCTION: Exercise plays a crucial role in both the prevention and management of diabetes. A major benefit is its role in enhancing postural control by refining sensory inputs from the visual, vestibular, and proprioceptive systems, which are essential for maintaining balance and stability. [1] During self-motion, we are exposed to optic flow patterns that provide information about heading direction. The spatial and temporal properties of optic flow directly influence body sway. [2] However, individuals with diabetes, especially those with prolonged metabolic dysregulation, may struggle to integrate these sensory signals effectively. This impairment can lead to altered postural responses. [1]

METHODS: The study aims to evaluate the effects of an 18-month exercise program on balance control and postural muscle activation in a cohort of uncompensated diabetic patients (HbA1c>52 mmol/mol). EMG and stabilometric data were recorded in 12 diabetic people who followed a 18 months exercise program (age 59,1±10,2; 33% oral medication; 56% insulin therapy) and in 12 diabetic people with sedentary habits (age 59,4±12,1; 71% oral medication; 14% insulin therapy). None of the subjects had a diagnosis of peripheral neuropathy. EMG data were recorded bilaterally from the tibialis anterior (TA) and soleus (SOL) at baseline, 6, 12 and 18 months. During recordings, the subjects stood on two force platforms to obtain the center of pressure (COP) displacement in anteroposterior (AP) and mediolateral (ML) directions. The experimental setup involved subjects standing in complete darkness while exposed to radial expanding optic flow stimuli projected on a screen covering 135x107° of visual field. Data acquisition included 2 trials per stimulus of 30-s each and two baseline trials (upright stance in the dark). EMG and COP data have been analyzed separately by repeated measures ANOVA with laterality (right, left) as within-subject factor, group (active, inactive) and time (baseline, 6, 12, 18 months) as between-subjects factors.

RESULTS: Significant effects and interactions have been found in both anteroposterior (AP) and mediolateral (ML) COP directions for time, group, stimuli, laterality and sex ($p < 0.05$). EMG data revealed a significant interaction between stimuli and muscle ($p = 0.008$).

CONCLUSION: Results suggest that diabetic people who exercise regularly have a better body balance than sedentary counterparts. This augmented control improved across the time of exercise.

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**THE ROLE OF AUTOPHAGY IN BOTULINUM NEUROTOXIN-INDUCED SKELETAL MUSCLE ATROPHY**

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INTRODUCTION: The use of Botulinum neurotoxin type A (BoNT/A) in clinical and sports medicine is common for musculoskeletal injury rehabilitation, pain management, and recovery. However, BoNT/A administration induces skeletal muscle wasting, though the exact proteolytic mechanisms remain unclear. Autophagy, a constitutively active proteolytic process responsible for organelle and macromolecule degradation, may play a key role. Under pathological conditions, excessive autophagy can lead to a deleterious rate of protein degradation, potentially contributing to BoNT/A-induced muscle atrophy.

METHODS: Male Sprague-Dawley rats (~200 g) were used for experiments approved by the University of Florida Institutional Animal Care and Use Committee. Following a 3-day handling period, animals were assigned to one of two main groups and sacrificed after either 3 or 10 days: Control (EGFP plasmid soleus injection, Gelatin Phosphate Buffer (GBP) or BoNT/A hind limb injection); Autophagy Inhibition (ATG5 d.n.-EGFP plasmid soleus injection, GBP or BoNT/A hind limb injection). The total number per group was 6-8 solei. Soleus muscle plasmid transfection was performed via electroporation. Due to the contralateral effect of BoNT/A, an individual animal received either control or BoNT/A injection in both their left and right leg. Soleus muscles were collected after 3 or 10 days, frozen, and analyzed using membrane staining, histochemistry, and Western blot for autophagy-related proteins. Statistical analyses used ANOVA with Bonferroni corrections, with significance set at $p \leq 0.05$.

RESULTS: Our findings support a role for autophagy in BoNT/A muscle wasting as rat soleus muscle cross-sectional area (CSA) was decreased ~30% three days following BoNT/A injection, and Beclin-1/Bcl-2 ratio, ATG5-ATG12 conjugation, and Cathepsin-L were significantly elevated. Ten days following BoNT/A injection muscle CSA decreased ~55%, with significant elevations in Beclin-1, ATG5-ATG12 and LC3 II/I ratio. Subsequently, plasmid-mediated inhibition of autophagy via overexpression of a dominant negative ATG5 protein (ATG5 d.n.), administered 24-hours prior to BoNT/A, significantly attenuated ATG5-ATG12 conjugation at both 3 days and 10 days. Inhibition of autophagy was sufficient to abolish atrophy 3 days following BoNT/A injection compared to absolute control muscle fibers, but not compared to the ATG5 d.n. expressing control muscle fibers. Thus, the preservation of CSA may not be a bona fide abolishment of BoNT/A-induced atrophy. Additionally, ten days following BoNT/A injection, overexpression of ATG5 d.n. did not significantly attenuate atrophy.

CONCLUSION: Based upon our findings, we conclude that either autophagy does not make a significant proteolytic contribution toward BoNT/A-induced atrophy or, in a redundancy-like manner, the inhibition of autophagy promotes upregulation of other cellular mechanisms that cause increased BoNT/A-induced atrophy.

**QUANTIFICATION AND VISUALIZATION OF ANTAGONISTIC BI-ARTICULAR THIGH MUSCLE ACTIVITY PATTERNS DURING SPRINT RUNNING IN ADULT TRACK AND FIELD ATHLETES**

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INTRODUCTION: Moment-to-moment changes in agonist and antagonist muscle activity during sprint running can be evaluated using surface electromyography (sEMG). Lissajous figures provide a means of visualizing these activity patterns, while the cross-correlation function (CCF) quantifies their temporal relationships. This study aims to evaluate antagonistic bi-articular thigh muscle activity patterns during sprint running using these techniques.

METHODS: Forty male track and field athletes performed maximal effort sprint running over 50m. During this test, sEMG signals were recorded from the rectus femoris (RF) and biceps femoris (BF) and ground reaction force (GRF) data were collected using a 50m force plate system, which recorded 25 steps. Sprint cycles were defined based on GRF data, with one cycle (1Cycle) from ipsilateral toe-off to foot-strike. The CCF R-values ($\geq 0$) were used as an index of similarity, and the mean R-value at zero time lag was calculated for each 1Cycle1. Participants were then categorized into two groups based on their CCF R-values using the mean ± 1 SD as the threshold: those with R-values above this range were classified as the High-group, and those below this range were classified as the Low-group. Lissajous figures were examined to characterize differences in muscle activation patterns between the groups.

RESULTS: The mean CCF R-value across all participants was 0.656. The High-group exhibited R-values ranging from 0.732 to 0.848, whereas the Low-group showed R-values between 0.345 to 0.540. The Lissajous figures of the High-group displayed an irregular spiral shape, suggesting greater coactivation of RF and BF, whereas the Low-group exhibited a reciprocal activation pattern between RF and BF.

CONCLUSION: This study applies established methods to quantify and visualize antagonistic bi-articular thigh muscle activity specifically during sprint running. The observed differences in coactivation and reciprocal activation patterns suggest potential variations in neuromuscular control strategies among sprinters. These findings may aid in developing training approaches to optimize sprint-related muscle activation patterns.

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**MUSCLE MORPHOLOGICAL ADAPTATIONS IN RESPONSE TO 6 WEEKS OF CONVENTIONAL TRAINING WITH OR WITHOUT ECCENTRIC OVERLOAD**

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INTRODUCTION: Skeletal muscle can perform both concentric and eccentric contractions, which differ in terms of generated force and energy cost. Eccentric (ECC) training allows the use of higher loads with lower metabolic cost, potentially promoting greater hypertrophy compared to conventional resistance training. However, evidence regarding the superiority of training employing ECC overload versus conventional modalities remains inconsistent as it is not clear if overload imposed on the eccentric phase could result in greater hypertrophy compared to conventional resistance training modalities. This study aimed to investigate the morphological adaptations of the quadriceps femoris (QF) in response to six weeks of conventional (CONV) vs eccentric overload training (ECC).

METHODS: Twenty recreationally active subjects (aged 18–35 y, 10 M-10 F) were divided into two groups, the first performing conventional resistance training, the second one performing it with eccentric overload (+50% of the concentric load). Both groups trained three times/week for six weeks using the Biostrength REV leg press, a special device that allows to increase the load during the eccentric (descending) phase without compromising the movement thanks to the automatic modification of the load allowed by the machine. The cross-sectional area (CSA) of the QF was evaluated via panoramic ultrasound pre- and post-training from 20 to 70% (seamless) of the femur length. From these data the QF volume was calculated using the truncated-cone formula, which consists in the calculation of the volumes of contiguous truncated cones drawn in the different parts of the muscle, statistical analysis was performed using two-way ANOVA

RESULTS: Both groups showed generalized hypertrophy of the QF, in particular with regard to the group trained with eccentric overload, even if with no significantly greater differences (due to individual variability) between CONV (7±5.5%, $p<0.01$) and ECC+ (10±11.5%, $p<0.001$) muscle volume (means±SD). The ECC+ group showed a greater percentage increase in the distal region (20-30% of the length of the QF) (+13.3%±9.9%, $p<0.0001$) compared to the CONV group (+6.5%±8.4%, $p<0.0001$). The Rectus Femoris showed negligible growth, likely due to positional limitations during exercise. However, an increase of force majeure was observed in subjects trained without eccentric overload (CONV+37kg / ECC+32kg, both of average).

CONCLUSION: Although both protocols induced hypertrophy, eccentric overload training appears to promote localized adaptations in the distal region of the QF. The reason for this increase could be the greater stress applied on the distal portion of the knee extensors during eccentric muscle actions performed with significant overload.

**VASTUS LATERALIS ARCHITECTURAL ADAPTATIONS IN RESPONSE TO SIX WEEKS OF STRENGHT TRAINING WITH OR WITHOUT ECCENTRIC OVERLOAD**

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INTRODUCTION: Eccentric overload is a strength training modality consisting of executing the eccentric phase of an exercise with an excess load of the concentric phase. As previously shown, this modality allows specific adaptations to occur, compared to conventional strength training (1). Different muscle adaptations are observed in relation to distinct stimuli, although the patterns of muscle changes in this defined training condition are still partly unclear. This study aims to investigate changes in muscle structure, specifically in architectural features, of the Vastus Lateralis muscle following six weeks of conventional strength training, either, with or without eccentric overload.

METHODS: Sixteen subjects (8M-8F, aged 18-35 y), healthy and recreationally active, underwent a six-week training period, with three sessions/per week on a novel leg press (Technogym Biostrenght, REV) that allows different loading during the eccentric and concentric phases of the movement. Volunteers were equally divided into a conventional group (CONV), performing the leg press exercise with a constant load, and an eccentric overload group (ECC+), performing the eccentric phase of the exercise with an overload corresponding to 50% of the load used during the concentric phase. Static ultrasonography images at 50% of the femur length were taken before and after the training period. The images were processed using ImageJ to investigate characteristics such as muscle thickness (MT), fascicle length (FL) and pennation angle (PA). Statistical analysis was performed using 2-way ANOVA.

RESULTS: As a result of the six weeks of training, we observed an increase in MT for both CONV (9.66%, $p<0.05$) and ECC+ (6.75%, $p<0.05$). FL significantly increased only in ECC+ (3.02%, $p<0.05$). Instead, PA increased significantly only in CONV (8.86%, $p<0.05$).

CONCLUSION: Both training modalities showed an increased MT, with a greater percentage increase in CONV rather than ECC+. This could be explained by the fact that ECC+ training has a greater proposed mechanical stimulus that may cause early fiber-damaging processes (2) potentially resulting in lower hypertrophic growth in the first days of training (3). Likewise, the same mechanical stimulus-induced during the eccentric phase forces the muscle to adapt and lengthen its fibers more compared to conventional training. The greater changes in PA after CONV training also suggest that structural adaptations are mostly related to the concentric contractions performed. Further investigations will be made to determine why skeletal muscle implements these specific changes in response to eccentric overload in relation to muscle functional adaptations.

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## Nutrition

### ADHERENCE TO A MEDITERRANEAN DIET AND LEISURE-TIME PHYSICAL ACTIVITY ARE PROTECTIVE FACTORS AGAINST THE INITIATION OF ANTIDEPRESSANT, ANXIOLYTIC, ANTIPSYCHOTIC, AND ANTISEIZURE DRUG USE IN OLDER ADULT

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INTRODUCTION: We aimed to investigate the association between long-term adherence to MedDiet and LTPA levels and the initiation of antidepressant, anxiolytic, antipsychotic and antiseizure medication in older adults.

METHODS: We assessed the relationship between the cumulative average of MedDiet adherence and LTPA and the initiation of medications in the PREvención con DIeta MEDiterránea (PREDIMED) study. Sample sizes ranged from 5,940 for anxiolytics to 6,896 for antipsychotics. Associations between the cumulative average of MedDiet adherence (per each one-point increase in the adherence score) and LTPA (per each increase in 20 metabolic equivalents of task-minute/day [METs-min/day]) with drug initiation were studied by multivariable Cox regressions (covariates: age, sex, PREDIMED intervention group, recruitment site, education, smoking habit, BMI, alcohol, and energy intake; multiple comparisons: Bonferroni method). We explored non-linear exposure-outcome associations using smoothed cubic splines and the interaction among both exposures.

RESULTS: One-point increases in MedDiet adherence score were associated with 23-28% less initiation of antidepressants (hazard ratio [HR] 0.72, 95% confidence interval [CI] 0.67-0.77), anxiolytics (HR 0.75, 95%CI 0.70-0.81), antipsychotics (HR 0.77, 95%CI 0.65-0.91), and antiseizure drugs (HR 0.77, 95%CI 0.69-0.85). Associations for anxiolytics and antiseizure drugs were particularly strong among participants with poor MedDiet adherence. Relationships between LTPA and initiation of antidepressant and anxiolytic drug use were non-linear. Among participants with the lowest LTPA values (0-150 METs-min/day), 20 METs-min/day increases were associated with 20% less risk of initiating antidepressant use (HR 0.80, 95%CI 0.75-0.86) and 15% less risk of initiating anxiolytic medication (HR 0.85, 95%CI 0.79-0.90). 20 METs-min/day increases were linearly associated with less initiation of antiseizure drugs (HR 0.96, 95%CI 0.94-0.99), and no clear associations were found for antipsychotic drugs. Individuals with high MedDiet adherence (≥10 adherence points) and high LTPA levels (≥150 METs-min/day) showed 42-59% less risk of initiating psychoactive drugs (antidepressants: HR 0.41, 95%CI 0.30-0.56; anxiolytics: HR 0.54, 95%CI 0.41-0.71; antipsychotics: HR 0.45, 95%CI 0.21-0.95; antiseizure drugs: HR 0.58, 95%CI 0.37-0.90). The combination was additive for antidepressants, antipsychotics and antiseizure drugs and synergistic for anxiolytics (p-interaction = 0.076).

CONCLUSION: Sustained adherence to MedDiet and LTPA were linked to lower initiation of psychoactive drugs in older adults

### ACUTE EFFECTS OF CAPSAICIN INGESTION ON AEROBIC CAPACITY AND MUSCULAR STRENGTH IN CYCLISTS

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INTRODUCTION: Capsaicin (CAP) has recently been found to modulate the transient receptor potential vanilloid 1, thereby promoting the release of calcium ions and acetylcholine, producing analgesic effects, increasing fat oxidation, which may help improve exercise performance. However, limited studies investigate the effects of CAP ingestion on exercise performance in athletes. This study examined the acute effects of CAP supplementation on aerobic capacity and muscular strength in cyclists.

METHODS: Ten male cyclists (age, 20 ± 2 years; height, 173 ± 7 cm; body mass, 64 ± 5 kg; VO2max, 68 ± 9 ml·kg-1·min-1) were recruited to complete this randomized crossover and double-blinded experiment. All participants were asked to perform three treatments, including CAP (12 mg of capsaicin in capsules), PLA (placebo), and CON (control), before conducting the graded exercise test (GXT) on a cycling ergometer. The GXT protocol was initiated with a load of 100 W and increased by 15 W in each subsequent 3-min stage until 5 stages were completed. Thereafter, the workload was increased by 30 W per minute until maximal oxygen uptake (VO2max) was reached. Before and after GXT, the isometric mid-thigh pull (IMTP) were performed to determine the muscular strength and power performance. During the GXT, the VO2, heart rate (HR), muscle oxygenation, fat oxidation, time to exhaustion, and blood lactate concentrations were measured.

RESULTS: No significant differences were found on the VO2max (CAP vs. PLA vs. CON, 4.23 ± 0.42 vs. 4.35 ± 0.55 vs. 4.30 ± 0.54 L·min-1, $p > 0.05$), blood lactate levels, and rate of perceived exertion among treatments. However, the time to exhaustion during GXT in PLA was significantly longer than those in CAP and CON (CAP vs. PLA vs. CON, 1458 ± 79 vs. 1482 ± 84 vs. 1462 ± 78 sec, $p < 0.05$). The maximal HR in PLA (195 ± 8 bpm) was significantly higher than that in CAP (191 ± 11 bpm). There were no significant differences on the VO2, HR, respiratory exchange ratio, and fat oxidation during the 5 stages at submaximal workload among treatments, as well as the tissue saturation index, deoxyhemoglobin, and total

hemoglobin measured by near infrared spectroscopy. No significant differences were found on the peak (changes between before and after GXT: CAP vs. PLA vs. CON, –5.1 ± 4.9 vs. –4.8 ± 6.0 vs. –2.9 ± 3.5 %, $p > 0.05$) and mean (CAP vs. PLA vs. CON, –5.7 ± 5.4 vs. –4.8 ± 5.7 vs. –3.6 ± 2.5 %, $p > 0.05$) force during IMTP before and after GXT among treatments.

CONCLUSION: Capsaicin ingestion might not have ergogenic effects on the aerobic capacity and muscular strength in elite cyclists. Studies with larger sample sizes are needed to clarify the effects of capsaicin supplementation on aerobic capacity in athletes and to consider the impact of the placebo effect. Supported by grants from National Science and Technology Council, Taiwan (NSTC 113-2410-H-003-152-MY2). Contact: andescheng@ntnu.edu.tw

**EFFECT OF ACUTE GARLIC EXTRACTS SUPPLEMENTATION ON TRANSCRIPTION FACTORS OF MITOCHONDRIAL BIOSYNTHESIS IN EXERCISED HUMAN SKELETAL MUSCLE**

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INTRODUCTION: Garlic extracts (GE) is a popular ingredient in daily life in Taiwan. It has various functions, such as anti-inflammation, anti-oxidation, and promoting blood circulation. The mitochondria of skeletal muscle cells produce ATP to provide energy for muscle movement throughout the body, thus promoting the synthesis of mitochondria in cells helps improve the aerobic capacity of the body.

METHODS: Eight active males with exercise habits were recruited to perform this crossover design study and randomized to GE or placebo group. The maximum oxygen uptake was measured 7 days before the single bout of cycling challenge with 75% VO2max at 60 rpm for 60 minutes. Muscle biopsied was performed immediately after the exercise, and then supplemented the 2000 mg garlic extracts or placebo capsule supplements accompany with a high-glycemic carbohydrate meal. The second muscle sample was collected at 3-hours after exercise, all muscle tissue were analyzed for transcript factor gene expression response to muscle cell mitochondrial biogenesis.

RESULTS: The gene expression of PGC-1α was upregulated during exercise period in both GE and placebo group ($p < 0.05$). Simultaneously, the mitochondrial biogenesis-related transcription factors TFAM and FIS1 were significantly increased after post-exercise GE supplementation compared to placebo ($p < 0.05$). However, there were no influence on the gene expression response to SIRT1, NRF1, NRF2, MFN1, MFN2, DRP1, OPA1, and BECLIN-1.

CONCLUSION: Cycling exercise induced physiology stress masked the GE effect on gene expression of physiological signal PGC-1α. However, the gene expression response transcription factors of muscle cell mitochondrial biogenesis cannot be upregulated under acute post-exercise GE supplementation.

**EFFECT OF DIET RESTRICTION ON SKIN-GAS ACETONE CONCENTRATION BEFORE AND AFTER SUBMAXIMAL CYCLE EXERCISE**

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INTRODUCTION: Ketones (β-hydroxybutyrate, acetoacetate and acetone) are generated in mitochondria of the liver, mainly from the oxidation of fatty acids, and are exported to peripheral tissues, such as the brain, heart, kidney, and skeletal muscle for use as energy fuels [1]. In diabetic patients with impaired glucose metabolism, fatty acid oxidation in the liver is enhanced, leading to compensatory overproduction of ketone bodies, and consequently increase acetone concentrations in exhaled breath and skin gas [2]. On the other hand, it has been reported that acetone concentrations in exhaled breath and skin gas also increase in healthy individuals during exercise [3]. Thus, acetone concentrations in exhaled breath and skin gas are directly influenced by blood glucose levels and carbohydrate utilization capacity [4]. However, there are no reports on the effects of dietary restriction on acetone concentrations in skin gas before and after exercise. This study examined the effect of dietary restriction on skin gas acetone concentrations before and after submaximal exercise.

METHODS: Ten healthy male students (21.2 ± 0.5 years; mean ± SD) performed submaximal cycling exercise with incremental load under two conditions: normal diet (N) and dietary restriction (DR), each once. The order of N and DR for each participant was randomized with a two-week interval.

The skin-gas samples were obtained from the dominant hand by covering with a polyethylene bag in which pure nitrogen gas (250mL) was introduced for 100 sec and collected in a sampling bag at rest and 0, 15, 30 min after the exercise. Acetone concentration was analyzed by gas chromatography. Blood samples were obtained from fingertip to measure glucose and β-hydroxybutyrate concentrations.

RESULTS: The skin gas acetone concentrations significantly increased immediately after exercise compared to resting levels in both the N and DR conditions (<0.001) and tended to return to resting levels 30 minutes post-exercise. Furthermore, there was a significant interaction between time and condition (N and DR) in the changes in skin gas acetone concentrations before and after exercise (p=0.025). Thus, under the DR condition, not only were the resting values higher than those under the N condition, but the increase after exercise was also greater compared to the N condition.

CONCLUSION: About one day dietary restriction enhanced the increase in skin gas acetone concentrations at rest and after exercise compared to normal dietary intake. These results suggest that dietary restriction elevates ketone body production via hepatic fatty acid oxidation from resting levels and increases reliance on energy supply from fatty acid oxidation even during submaximal exercise.

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**BODY MASS INDEX VERSUS BODY FAT PERCENTAGE IN PROFESSIONAL SHOOTERS**

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INTRODUCTION: Obesity, particularly excessive visceral adipose tissue (VAT), is associated with various health risks, including cardiovascular diseases and diabetes. While BMI is a widely used and simple risk indicator, it has recognized limitations, especially in athletes, where it often overestimates obesity due to high lean body mass. Data on obesity rates among shooters remains limited. This study aimed to assess overweight and obesity prevalence based on body fat percentage compared to BMI and to evaluate VAT accumulation in male and female shooters.

METHODS: Basic anthropometric measurements (height and weight) as well as body composition analysis was performed in 39 professional shooters (51.3% females) aged 18-45 years old (mean 26.4±6.4 years). Body composition was assessed via dual energy X-ray absorptiometry (DXA, GE, Lunar Prodigy). VAT expressed both in grams and cm3 was calculated automatically by the CoreScan application. Cut-off points for increased risk of metabolic complications based on VAT were adopted from the study by Miazgowski et al. (2019). In the case of body fat percentage, cut-off points were adopted from Jeukendrup A & Gleeson M (2019).

RESULTS: According to BMI, 75.0% of females had a normal body weight, 15.0% were classified as overweight, 5.0% had first-degree obesity, and 5.0% were underweight. Based on body fat percentage from DXA, a normal level was observed in 35.0%, while 35.0% were classified as overweight and 30.0% as obese. Among males, BMI indicated normal body weight in 52.6%, overweight in 21.1%, and obesity in 26.3%. In contrast, body fat percentage was within the normal range in 21.1% of males, while 21.1% were classified as overweight and 57.8% as obese. In both the female and male groups, statistically significant differences were found in the classification according to BMI vs. % body fat (p=0.003 and p=0.031, respectively). VAT content indicating an increased risk of metabolic complications was identified in one-third of the participants (35.0% of females and 33.3% of males, p = 0.821).

CONCLUSION: Body fat percentage allowed to indicate obesity in a significantly larger percentage of shooters than BMI. These are the opposite results from most sports disciplines. Shooters seem to be a group at increased risk of obesity and its complications, as evidenced by the high percentage of people with excessive VAT accumulation. Therefore, shooters should be subject to broader monitoring of cardiovascular health parameters and provided with nutritional education.

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**EFFECTS OF PROTEIN SOFT DRINK CONSUMPTION ON EXERCISE PERFORMANCE AND PHYSIOLOGICAL MEASURES**

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INTRODUCTION: Protein is made up of amino acids to be used as an energy source and adequate intake and appropriate timing of protein ingestion are beneficial in multiple exercise modes, including endurance, anaerobic, and strength exercise. The carbohydrate-protein (CHO-P) drink provides an alternative for athletes to consume their protein with carbohydrates. This study investigated the effects of a CHO-P sports drink on physiological variables during aerobic performance; a comparison is made against carbohydrate (CHO) drink and water. It is hypothesized that consumption of the CHO-P drink will result in significantly better performance in the maximal oxygen consumption (VO2max) test and other physiological measures.

METHODS: Ten male participants (age: 25.54±2.76 years; height: 171.98±7.31 cm; weight: 64.64±9.34 kg; body mass index (BMI): 21.35±2.47 kg/m2; body fat percentage: 12.37 ±5.89 %; lean muscle mass percentage: 83.64±5.53 %)) were recruited for this study. The participants participated in three separate trials which took 2.5 hours each over three consecutive weeks in the Human Bioenergetics Lab at the National Institute of Education (NIE). They consumed 500ml of either CHO-P drink, CHO drink or water in a randomized order, with a 7-day rest between each trial. Participants underwent the modified Astrand protocol with treadmill gradient that increased by 2.5% after the first three minutes and every two minutes subsequently with the running speed kept constant at 10km/h. The test was terminated upon volitional exhaustion.

RESULTS: Paired t-test results indicated significant difference for absolute VO2 at last stage between Water and CHO (Water: 3.18 ±0.60 L/min vs. CHO: 3.36 ±0.67 L/min, p = 0.037). One way ANOVA results indicated no significant differences for RPE last stage between trials (p = 0.85); resting HR between trials (P = 0.91); HR last stage between trials (p = 0.65); TTE between trials (p = 0.98). Significant negative correlation was found between BF% and VO2max for all trials (BF%: 12.37±5.89 % vs. Water VO2max: 54.79±8.97 mL/kg/min, r = -0.73, p = 0.02; BF%: 12.37±5.89 % vs. CHO-P VO2max:

56.47±9.51 mL/kg/min, r = -0.75, p = 0.02; BF%: 12.37±5.89 % vs. CHO VO2max: 55.91±9.19 mL/kg/min, r = -0.74, p = 0.02).

CONCLUSION: Participants exerted maximal effort across all trials as there were no significant differences between RPE and HR. With 14.0g of CHO found in CHO 500ml drink, participants produced significantly higher absolute maximal VO2 (L/min) as compared to the control group which was water. CHO-P sports drink was not significant when compared to CHO and water as protein is negligible during the glycolysis process of exercise as CHO is the main fuel for the working muscles. In addition, similarly as shown by other research, athletes and sports enthusiasts with a lower BF% would have a greater VO2max. Athletes and sports enthusiasts may utilize CHO drinks as opposed to water as a pre-workout drink to improve their VO2 to enhance sporting performance

**IMPACT OF A 48-HOUR FASTING PERIOD ON METABOLIC MARKERS DURING EXERCISE AND RECOVERY IN MALE COMBAT SPORT ATHLETES**

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INTRODUCTION: Combat sports demand high-intensity efforts that predominantly rely on anaerobic energy systems and specialized technical skills. Athletes often employ rapid weight loss strategies such as a 48-hour fasting period to compete in lower weight categories, despite a recovery period of 24 hours or less that may not fully restore their physiological parameters. However, the impact of such fasting protocols on metabolic markers like glucose, ketone, and lactate concentrations and subsequent anaerobic performance during the recovery phase remains underexplored. This study aims to investigate the effects of a 48-hour fasting period on resting metabolic ratio, performance, and 1-hour recovery in male combat sports athletes, hypothesizing that while fasting induces metabolic changes, anaerobic performance is maintained after a 24-hour recovery period.

METHODS: This study involved eight male professional combat athletes, with an age of 25±3 years and body weight of 84±4 kg. The athletes underwent a 48-hour fasting period, followed by 24-hour recovery, with measurements taken at three time points: pre-fasting, after fasting, and post-recovery. The testing included assessments of resting substrate oxidation, lactate, glucose, ketone levels, and power output during VO2max test. Statistical analysis was conducted using Repeated Measures ANOVA to compare the metabolic and performance data across these phases.

RESULTS: Compliance with fasting regime was supported by decreased body weight ($p<0.001$), carbohydrate oxidation ($p<0.003$) and resting glucose concentration ($p<0,028$), and by increased fat oxidation ($p<0.001$) and resting ketone concentration ($p < 0.001$). Fasting decreased power output ($p<0.008$), along with decreased peak lactate ($p<0.049$) and glucose concentrations ($p<0.028$) during VO2max test. However, metabolic changes and VO2max test performance output returned to baseline after 24-h recovery period.

CONCLUSION: 48-h fasting temporarily suppressed metabolic changes and VO2max test performance in professional combat athletes. After recovery period restored metabolic changes indicate the ability to restore glycogen levels and sustain performance.

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**EFFECT OF INULIN SUPPLEMENTATION ON GUT MICROBIOTA AND ATTENTIONAL BIAS FOR FOOD**

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INTRODUCTION: Dietary fiber is fermented by gut microbiota, resulting in the production of short-chain fatty acids (SCFAs). The endocrine signals, such as the secretion of appetite-regulating hormones, and mechanical signals are induced by dietary fibers and SCFAs play a direct role in central appetite regulation (Frost et al., Nat Commun. 2014). Although it has been reported that inulin supplementation reduces energy intake and body weight, the effects on attentional bias for food which influence cravings and food consumption are not clear. Overweight is related to the greater attentional bias for food (Yokum et al., Obesity. 2011). The purpose of this study is to examine the effects of 6-weeks of inulin supplementation on gut microbiota, SCFAs, and attentional bias for food.

METHODS: In this double-blind study, twenty-six healthy adults (aged 20–48 years; BMI 22.4 ± 2.6 kg/m2) were assigned to treatment groups receiving 5g of inulin powder twice a day (IF group, n=13) and control groups receiving 5g of maltodextrin twice a day (PL group, n=13) for 6 weeks. Attentional bias for food, habitual eating behavior and dietary intake through self-reporting measures, gut microbiota composition by 16S rRNA sequencing of fecal samples, fecal levels of SCFAs, and blood levels of appetite-regulating hormones (leptin, ghrelin, peptide YY and insulin) were assessed before and after the intervention. Attentional bias for food was evaluated using reaction time in the visual dot-probe task with food and non-food images. The engagement and disengagement components of attentional bias were assessed. The disengagement component of attentional bias is the degree to which a food-related stimulus captures attention, preventing the reorientation of attention towards a different location. A linear mixed effects model, with group and time (pre- and post-intervention) as factors, was used to examine the interaction effects on the outcomes.

RESULTS: There was significant interaction on the disengagement component of attentional bias for high-calorie foods ($P=0.034$), which was higher after intervention than before in PL ($P=0.015$) but not in IF. The relative abundance of Bifidobacterium increased after the intervention in IF (pre-intervention 5.0 ± 1.5 % vs. post-intervention 8.6 ± 1.5 %, $P=0.011$) but not in PL (pre-intervention 6.8 ± 1.5 % vs. post-intervention 6.2 ± 1.5 %), which resulted in significant interaction on the

relative abundance of Bifidobacterium (P=0.032). The fecal levels of SCFAs and blood levels of appetite-regulating hormones showed neither significant interactions nor effects of group.

CONCLUSION: These findings indicate that 6-weeks of inulin supplementation prevented the increase in attentional bias for high-calorie foods, and that such prevention seems to be related to the increase in the relative abundance of Bifidobacterium. The mechanical effects rather than endocrine effects induced by inulin may have contributed more to central appetite regulation in this study.

**EFFECTS OF CINNAMALDEHYDE ON THE MUSCULAR ENDURANCE OF THE TIBIALIS ANTERIOR MUSCLE IN RAT**

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INTRODUCTION: Muscular endurance is a key determinant of sports performance, as it prolongs exercise duration and delays fatigue accumulation. Cinnamaldehyde has been suggested to promote energy metabolism and exhibit antioxidant properties, potentially enhancing endurance. While its precise effects remain unclear, its known antioxidant and anti-inflammatory actions may help reduce oxidative stress, a major contributor to muscle fatigue. However, direct research on its impact on muscular endurance is limited.

METHODS: Male Fischer 344 rats (6-7 weeks of age, n=12) were divided into two groups: a cinnamaldehyde-treated (CN) group and a control (Cont) group. Cinnamaldehyde was administered intraperitoneally twice per week for eight weeks at a dose of 20-50 mg/kg body weight. Following the intervention, muscular endurance and maximal isometric force of the tibialis anterior (TA) muscle were assessed in vivo using an electrical stimulator and force transducer. Time-course changes in unfused (50 Hz) and fused (143 Hz) tetanic forces were recorded at stimulation intensities corresponding to maximal force (16-25 V). Following force measurements, TA muscles were excised, subjected to NADH-TR staining, and analyzed for myofiber cross-sectional area using light microscopy and an image analysis system.

RESULTS: There was no significant difference in maximal force between the CN and Cont groups. The force-time curves for both unfused and fused tetanic contractions were greater throughout the stimulation period in the CN group than in the Cont group. The force-time integral (FTI) during the first 10 seconds of both tests was significantly greater in the CN group. The cross-sectional areas of myofibers with intense or light NADH-TR staining did not significantly differ between groups.

CONCLUSION: These findings suggest that cinnamaldehyde administration may enhance muscular endurance, particularly during the initial phase (0-10 s) of unfused and fused tetanic contractions, without inducing hypertrophy or altering fiber composition. This effect may be attributed to its antioxidant properties, which could reduce oxidative stress during sustained contractions.

**EFFECTS OF CAFFEINE AND CARBOHYDRATE SUPPLEMENTATION BEFORE ENDURANCE EXERCISE ON POST-EXERCISE BLOOD PRESSURE AND PULSE WAVE VELOCITY IN HYPERTENSIVE INDIVIDUALS**

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INTRODUCTION: This study aimed to investigate the effects of caffeine and carbohydrate supplementation before endurance exercise on post-exercise blood pressure and brachial-ankle pulse wave velocity (baPWV) in hypertensive individuals.

METHODS: Fourteen hypertensive males (33.1 ± 8.1 years, systolic blood pressure 139.7 ± 0.6 mmHg, diastolic blood pressure 84.8 ± 1.0 mmHg) with no regular exercise habits participated in a double-blind, repeated-measures, counterbalanced-order experiment. They underwent four experimental trials: caffeine with carbohydrate (CAFCHO), caffeine with water (CAFWAT), placebo with carbohydrate (PLACHO), and placebo with water (PLAWAT). The supplementation protocol involved ingesting either a caffeine or placebo capsule at a dose of 3 mg per kg of body weight, combined with 250 mL of either a carbohydrate solution containing 75 g of glucose or plain water. Participants rested for 30 minutes after ingestion, followed by 30 minutes of treadmill running at 70% heart rate reserve. Blood pressure and baPWV were measured at baseline, pre-exercise, and at 30, 60, 90, and 120 minutes post-exercise. Additionally, blood samples were collected to analyze insulin, blood glucose, endothelial nitric oxide synthase (eNOS), and endothelin-1 (ET-1). The area under the curve (AUC) was calculated using the trapezoidal method for each time point post-supplementation.

RESULTS: A significant interaction was observed for systolic blood pressure ($p = .001$). Systolic blood pressure at 30, 60, and 90 minutes post-exercise was significantly lower than pre-exercise levels in the PLACHO and PLAWAT trials. The AUC for systolic blood pressure was significantly higher in the CAFCHO trial compared to PLAWAT, and in the CAFWAT trial compared to both PLACHO and PLAWAT ($p < .05$). A significant interaction was also observed for diastolic blood pressure ($p < .001$), with CAFCHO showing significantly higher diastolic blood pressure at 30 and 120 minutes post-exercise compared to PLAWAT, and at 30 and 60 minutes post-exercise compared to PLACHO. Additionally, CAFWAT showed significantly higher diastolic blood pressure at 60 and 90 minutes post-exercise compared to PLACHO. A significant interaction was also found for baPWV ($p = .001$), with CAFCHO and CAFWAT showing significantly higher AUC for baPWV at all post-exercise time points compared to PLAWAT ($p < .05$). Regarding blood biomarkers, the AUC for insulin and blood glucose was significantly higher in the CAFCHO and PLACHO trials compared to CAFWAT and PLAWAT ($p < .001$). However, no significant differences were found in the AUC of eNOS and ET-1 among the trials.

CONCLUSION: Caffeine supplementation at a dose of 3 mg per kg of body weight before endurance exercise attenuated the post-exercise reduction in blood pressure and baPWV in hypertensive individuals. This effect was independent of carbohydrate supplementation.

**IS THERE ANY EFFECTS OF ACUTE CITRULLINE OR MALIC ACID SUPPLEMENTATION?**

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INTRODUCTION: Improving the aerobic metabolism is important for endurance athletes. Main aim of this pilot study was to examine if acut citrulline and malic acid supplementation can improve aerobic metabolism and lactate elimination.

METHODS: Nine young recreational male athletes (23.9 ± 1.9 years) participated in our study. Participants took a standardised breakfast and their body composition were measured (InBody720).

One hour before the spiroergometry 6 000 mg of citrulline or 3 000 mg of malic acid or a placebo of 300 mL of water were consumed on three different separate days using a double-blind method. They completed a ramp bicycle spiroergometer protocol (35 W/3 min) until reaching a respiratory exchange ratio (RER) of 1.1, followed by a 9 min active recovery. Heart rate (HR), rate of perceived exertion (RPE – Borg-Scale), cadence, different respiratory parameters and lactate levels were registered. To accurately characterise exhaustion we calculated the RPExHR value.

RESULTS: Friedman ANOVA tests revealed significant differences in RER values during the exercise protocol at 70 W ($\chi2$ = 6.889; $p < 0.05$; Kendall's W = 0.383), 105 W ($\chi2$ = 10.667; $p < 0.05$; Kendall's W = 0.593) and 140 W ($\chi2$ = 8.222; $p < 0.05$; Kendall's W = 0.457). Additionally, Bonferroni-corrected Wilcoxon pairwise comparisons revealed that citrulline significantly reduced RER values at powers of 70 W, 105 W and 140 W compared to malic acid (Wilcoxon, Z = –2.31, Z = –2.67, and Z = –2.67; $p < 0.0167$) and compared to the placebo (Wilcoxon, Z = –2.19, Z = –2.43, and Z = –2.31; $p < 0.0167$).

There was no difference in lactate levels neither during rest nor at RER 1.1.

RPExHR rate values were significantly lower after malate supplementation compared to placebo at 175 and 210 W (Wilcoxon, Z = –2.36, and Z = –2.37; $p < 0.0167$).

Performance at RER 1.1 was higher after malic acid (+4 W) and citrulline (+5 W) supplementation. However lactate levels did not decrease after supplementation, lower RER and RPE values may indicate a performance-enhancing benefit.

CONCLUSION: Supplementation of citrulline and malic acid might be beneficial for endurance athletes, especially in delaying the onset of glycogen depletion and preventing fatigue.

**ACUTE EFFECTS OF ORAL MICROBIAL PROTEASE CO-INGESTION WITH WHEY PROTEIN ON POSTPRANDIAL PLASMA AMINO ACID CONCENTRATIONS, APPETITE, AND SATIETY IN HEALTHY ADULTS**

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INTRODUCTION: Proteases are enzymes that catalyze the breakdown of proteins into smaller peptides and amino acids. Protease supplementation may be a candidate approach to enhance amino acid digestion and absorption from dietary protein. The present study aimed to evaluate the effects of a mixture of 3 microbial protease preparations (P3) on postprandial plasma amino acid concentrations when co-ingested with whey protein concentrate (WPC), compared to a maltodextrin placebo, in healthy young adults. Secondary aims were to assess the effect of WPC co-ingestion with P3 versus placebo on postprandial plasma glucose, insulin, and gut-derived appetite regulatory hormone (GLP-1, PYY, and ghrelin) concentrations, perceived appetite sensations, and ad libitum meal energy intake.

METHODS: In this randomized, double-blinded, placebo-controlled crossover study, 12 males and 12 females (BMI: 23.6 (2.9) kg/m2; age: 25 (3) years [mean (SD)]) consumed WPC (25 g protein) with P3 or placebo. Plasma glucose, insulin, amino acid, and gut-derived appetite regulatory hormone concentrations were assessed at baseline, and throughout a 240-min postprandial period. Perceived appetite sensations were assessed by visual analog scale (VAS) questionnaires. An ad libitum meal was provided immediately following each trial to determine energy intake. The incremental area-under-the-curve (iAUC) and ad libitum energy intake data was compared between treatments using a mixed model ANCOVA, adjusting for treatment period, treatment sequence, and sex. Time-course data were analyzed via a mixed model repeated measures approach adjusting for baseline values, treatment period, treatment sequence, and sex. All hypothesis tests were two sided and performed at the alpha = 0.05 significance level.

RESULTS: Adjusted mean postprandial plasma 60-min iAUC was 14% greater for plasma essential amino acids (EAA) (Treatment: $P = 0.025$) and 15% greater for branched-chain amino acids (BCAA) (Treatment: $P = 0.021$) with P3 versus placebo, with no significant differences for total amino acids or leucine (all $P > 0.05$). Adjusted mean postprandial plasma ghrelin was 12% lower (Treatment: $P < 0.001$), while adjusted mean VAS-derived fullness (Treatment: $P = 0.025$) and satiation (Interaction: t = 30–150 min; all $P < 0.05$) were greater with P3 versus placebo. Adjusted mean postprandial plasma glucose, insulin, GLP-1 and PYY, as well as ad libitum meal energy intake were not different between treatments (all $P > 0.05$).

CONCLUSION: Co-ingestion of WPC with P3 increases postprandial plasma 60-min iAUC for EAA and BCAA concentrations, decreases plasma ghrelin concentration, and increases perceptions of fullness and satiation compared to co-

ingestion of WPC with a placebo in young, healthy adults. Microbial protease supplementation may represent a practical strategy to further increase postprandial plasma amino acid availability and enhance satiety after dietary protein intake. This trial was prospectively registered at ClinicalTrials.gov (NCT05957185).

**7-DAY CONTINUOUS GLUCOSE MONITORING TO ASSESS GLUCOSE VARIABILITY IN JAPANESE NIGHT SHIFT WORKERS**

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INTRODUCTION: Healthcare workers engaged in both day and night shifts are exposed to the risk of developing lifestyle-related diseases due to disruptions in daily routines and the excessive stress caused by night work. Previous studies have shown that healthcare workers with night shifts have a higher risk of obesity, metabolic syndrome, and cardiovascular diseases compared to those without night shifts (X. Lin et al., Sleep Medicine, 2015). Additionally, a cohort study in the United States reported that night shift workers have a higher incidence of type 2 diabetes compared to non-night shift workers (Zhilei Shan et al., BMJ, 2018). Dietary habits differ significantly between Japan and the United States. Therefore, it remains unclear whether the same results would be observed among Japanese night shift workers. Furthermore, not only hyperglycemia but also glucose spikes and variability have been reported as risk factors for lifestyle-related diseases such as diabetes and atherosclerosis. Recently, continuous glucose monitoring devices have been developed, enabling precise and continuous measurement of glucose levels in a simple and sustainable manner. These devices also allow for the assessment of glucose variability, opening up various possibilities for research and clinical applications. This study investigated the effects of night shift work on glucose variability in Japanese workers using 7-day continuous glucose monitoring.

METHODS: Twenty night shift workers (31±4 years old) and 20 non-night shift workers (30±5 years old) participated in the study. Continuous glucose monitoring (CGM; Abbott Diabetes Care, Japan) was conducted, measuring interstitial fluid glucose concentrations every 15 minutes for 7 days. Data from the CGM were used to calculate the following parameters: the mean glucose level, standard deviation (SD), J-index (0.001 × (mean + SD)), Time in Range (TIR; percentage of time within 70-180 mg/dL), Time Above Range (TAR; percentage of time above TIR), Time Below Range (TBR; percentage of time below TIR), and the area under the curve (AUC; total entire glucose curve), which reflects overall glucose variability.

RESULTS: The mean glucose level and AUC were significantly lower in the night shift workers compared to the non-night shift workers. The night shift workers also showed reduced TIR and increased TBR compared to the non-night shift workers. However, there were no significant differences in SD, J-index, or TAR between the two groups.

CONCLUSION: Night shift workers exhibited a higher frequency of hypoglycemia compared to non-night shift workers. These findings differ from prior studies conducted in the United States, which may be due to differences in dietary habits between Japan and the United States, influencing glucose metabolism during night shift work. The results highlight the importance of appropriate dietary interventions to prevent hypoglycemia during night shifts among Japanese night shift workers.

**ATTEMPT TO QUICKLY ASSESS DEHYDRATION IN THE FIELD: DERIVATION OF CAUSAL RELATIONSHIPS BY AI ANALYSIS**

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INTRODUCTION: Accurate assessment on body water content to prevent dehydration is important for athletes. At present, it remains a simple evaluation such as wight loss and self-monitoring by athletes. One method of assessing dehydration is plasma osmolarity in blood sample is a useful assessment. Also, plasma osmolality can be calculated using the following equation if data on sodium, glucose and urea nitrogen are available: Plasma osmolarity = 2 * (Na) +glucose/18+BUN/2.8. However, analysis of blood samples requires qualified personnel and precise equipment and analysis is time consuming. Therefore, analyze and evaluate immediately in the field is not easy. If plasma osmolarity can be directly evaluated using an optimal combination of non-aggressive samples such as saliva and sweat with a portable measuring device, it may be possible to prevent dehydration and strategically select drinks. The purpose of this study is to develop and evaluate a new dehydration prediction equation from indicators that can be easily collected in the field. As a first step, we attempted to estimate sodium, which constitutes the majority of the plasma osmolality equation.

METHODS: We collected the following samples from 11 track and field female athletes at the University of Tsukuba: body composition, blood (sodium, glucose, and the like), saliva (sodium, osmolarity), sweat on patched forearm (sodium), and air temperture. Each subject was asked to run on the road for 50 minutes at low intensity as warm up. We collected each sample before and after exercise. They also did not drink water until the experiment was over. After blood samples were collected, they were transported to a specialized laboratory for analysis. Saliva osmolarity analyzed by mean of freezing point depression using osmometer (OSMOMAT 3000 basic, Asahi life tec, Japan). Saliva sodium and sweat sodium were analyzed with a compact water quality meter (LAQUQtwin, HORIBA, Japan). Next, we analyzed causal inference using AI analysis software (xCausal, Japan) to derivation of causal relationships. Causal inference by AI analysis using following statistical methods average treatment, mutual information and correlation analysis.

RESULTS: Overall average temperature from each experimental day was 28±2.2 °C. Blood sodium was set as the output, and salivary sodium, salivary osmotic pressure, sweat sodium, air temperature, and weight loss which could be collected in the field, were set as the input data. From there, items for which no causal relationship was found were eliminated, and

finally, salivary sodium (0.09, 0.29, 0.32) and air temperature (0.70, 0.58, 0.97) were related. (Figures in parentheses are average treatment effect, mutual information and correlation analysis in order.)

CONCLUSION: Although the number of samples was too small to derive a causal relationship, it was suggested that salivary Na and temperature may be related to reflect serum Na. Future validation is needed to increase the number of samples and the precision of measurement.

**BOTH 3 AND 6 MG/KG CAFFEINE IMPROVED 4-KM CYCLING TIME TRIAL PERFORMANCE IN TRAINED MALE CYCLISTS WITH LOW HABITUAL CAFFEINE CONSUMPTION**

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INTRODUCTION: Caffeine (1,3,7-trimethylxanthine) is a naturally occurring central nervous system stimulant that, at doses of 3–6 mg/ kg body mass (BM), provides an ergogenic benefit during exercises across various exercise modalities, durations and intensities [1]. The potential influence of habitual caffeine consumption on caffeines acute ergogenic effect is a hotly debated topic in sports science [2]. Low habitual caffeine users have been shown to benefit from caffeine supplementation, though it is unclear if there is a dose-response effect in this population. The objective of this study was to evaluate the effects of two different doses of acute caffeine supplementation on 4-km cycling time trial performance in low habitual caffeine consumers.

METHODS: Thirty-two trained cyclists with low caffeine intake (<75 mg/day) completed a 4-km cycling time trial 60-min after ingesting 3 mg/kg of caffeine (CAF3; Farmácia Analítica, Brazil)), 6 mg/kg of caffeine (CAF6) and placebo (PLA) in a double-blinded and randomized manner. Performance was recorded as time-to-completion. A generalized mixed model was used to analyze the effect of supplementation on time-to-completion, with supplementation as a fixed effect and significance set at $p < 0.05$.

RESULTS: There was a significant effect of supplementation ($\chi^2 = 20.8$, $p < 0.001$). Post hoc tests showed that PLA significantly differed from both CAF3 (435 ± 29 vs. 422 ± 27 s; $p < 0.001$) and CAF6 (435 ± 29 vs. 423 ± 28 s; $p < 0.001$), with no differences between CAF3 and CAF6 ($p = 1.000$).

CONCLUSION: Acute caffeine supplementation improved performance when compared to placebo in low habitual consumers of caffeine. However, there was no additional benefit from a higher dose (6 mg/kg) compared to a lower dose (3 mg/kg). These findings suggest that 3 mg/kg of caffeine is sufficient to elicit performance improvements in low habitual caffeine consumers while potentially minimizing the risk of side-effects associated with higher doses.

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**FOOD PROCESSING LEVEL AFFECTS NUTRIENT INTAKE OF ADOLESCENT ATHLETES**

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INTRODUCTION: Adolescent athletes have high nutritional demands due to the high use of macro and micronutrients for their growth and development and energy production, muscle contraction and recovery. Thus, nutrient intake must be adequate to ensure that all demands are met while maintaining sports performance and adequate growth. It is also important to identify which foods are capable of assisting in adequate nutrient intake. Therefore, we sought to identify how much the participation of NOVA food groups in the diet can affect the nutrient intake of adolescent athletes.

METHODS: Adolescent athletes (n=94, 13.5±2.21 years old, body mass index (BMI) 19.92±3.32 kg/m²), of both genres (F: n=31, M: n=63) and different modalities had their diet assessed through 3 24-hour food recalls. The reported foods were used to estimate nutrient intake, divided into subgroups and allocated within the NOVA classification groups: natural and minimally processed; processed; ultra-processed. Then, the average energy intake of each subgroup and group of the NOVA classification and their energy contribution were calculated. The level of energy contribution of each of the NOVA groups was expressed in contribution tertiles. Finally, the association between the level of energy contribution of the groups and the average nutrient intake was assessed.

RESULTS: The consumption of natural and minimally processed foods represented 49.3% of the total energy intake of the study participants. Next, ultra-processed foods accounted for 34.21%. And processed foods contributed 16.5%. The higher the participation of natural and minimally processed foods in the total intake, the higher the intake of fiber, protein, iron, magnesium, phosphorus , zinc , folic acid, vitamin C and vitamin E , and the less sodium and fat were ingested. As the level of processed food intake increased, lower intakes of fiber, protein, iron, magnesium, phosphorus, zinc, and vitamins B3 and C, and higher intakes of fat and sodium were observed. The higher level of energy contribution from ultra-processed foods was associated with lower intakes of fiber and protein and higher intakes of sodium.

CONCLUSION: The greater inclusion of natural and minimally processed foods in the diet may contribute to a higher intake of nutrients important for maintaining health and performance, while processed and ultra-processed foods negatively affect the intake of these nutrients and increase the intake of nutrients that are markers of unhealthy eating. Therefore, adolescent athletes should follow the current Brazilian guidelines for healthy eating, which recommend making natural and minimally processed foods the basis of the diet; reducing the consumption of processed foods and avoiding ultra-processed foods.

**THE EFFECT OF NUTRITION ON BODY COMPOSITION AND PHYSICAL PERFORMANCE AMONG ESTONIAN JUNIOR CYCLISTS.**

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INTRODUCTION: The purpose was to evaluate the effect of nutrition on physical performance among Estonian M16 and MJ competition class cyclists.

METHODS: A total of 12 Estonian junior cyclists (16.2±1.3 years; 182.0±5.8 cm; 70.0±7.2 kg; BMI: 21.1±1.9 kg/m2) participated in the study. All participants regularly trained at least five times a week and had a goal to achieve the highest place in the Estonian national championships of their age group. Body composition was measured by dual-energy X-ray absorptiometry (DPX-IQ densitomeeter Hologic, Discovery W, USA) and maximal oxygen consumption was measured by Cyclus 2 ergometer ( RBM Elektronik-automation GmbH, germany). Oxygen consumption was determined by the Cortex Metamax 3B (Cortex Biophysic GmbH, Leipzig, Germany). In addition, a 3-day (2 working days and one weekend day) caloric intake and activity was measured by questionnaire.

RESULTS: Cyclists had on all days a negative energy balance, remaining at -303.5±604.0 kcal on average over the study days. VO2max and Pmax, were correlated ($p<0.05$) with KRVM ($r=0.81$), body mass ($r=0.78$), but no nutritional parameter correlated with the parameter characterizing performance ($p>0.05$). KRVM had the greatest effect on the change in maximal oxygen consumption (VO2max) by 67% ($F=23.8$, $p=0.001$).

CONCLUSION: Based on the results of this study, it can be concluded that there is no direct relationship between nutrition and physical performance. However, nutrition affects body composition and body mass index, which in turn are related to and influence physical performance. It is important to pay attention to the parameters of nutrition in order to support physical performance through nutrition and body composition.

**EFFECTS OF KETOSIS ON SKELETAL MUSCLE MOLECULAR RESPONSE TO A SINGLE BOUT OF RESISTANCE TRAINING IN TRAINED INDIVIDUALS**

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INTRODUCTION: The ketogenic diet (KD) is a well-established dietary strategy, widely recognized for its efficacy in promoting fat loss. It is characterized by high fat, adequate protein, and restricted carbohydrate intake (<50 grams per day). The KD mimics certain effects of caloric restriction by enhancing metabolic pathways involved in fat oxidation and oxidative phosphorylation. However, KD-induced metabolic adaptations may potentially interfere with pathways regulating the hypertrophic response. Therefore, this study aims to investigate the impact of KD on muscle adaptation to resistance training (RT) in trained male subjects.

METHODS: Fifteen healthy, trained males (28.8 ± 8.3 years) were enrolled and randomly assigned to either a ketogenic diet (KD, n=8) or control diet (CD, n=7). Both diets were isoenergetic (35 kcal/kg body weight) and matched for protein intake (2 g/kg body weight). All participants followed an identical RT protocol for four weeks. Serum hormone levels (IGF-1, insulin, total and free testosterone), resting metabolic rate, body composition (DXA), quadriceps cross-sectional area (ultrasound), and muscle strength were assessed at baseline and after 4 weeks of RT. Muscle biopsies from the vastus lateralis were obtained at rest, and at 6 and 24 hours after a single bout of RT performed before and after 4 weeks of KD. Phosphorylation of regulatory signalling proteins (i.e., Akt, rpS6, 4E-BP1, and p70S6K1) were assessed via western blotting and expressed as the fold-change from pre- to post-exercise.

RESULTS: Preliminary data indicate that the KD group exhibited higher fat oxidation, as reflected by a greater reduction in respiratory exchange ratio (-12% vs. -6%). Serum insulin levels decreased more markedly in the KD group (-26% vs. -6%), whereas IGF-1, total testosterone, and free testosterone remained unchanged in both groups. No significant between groups differences were observed in fat-free mass; however, the KD group experienced a greater reduction in fat mass (-1.6 kg vs. +0.2 kg in the CD group). Markers of the mTOR signalling pathway (total and phosphorylated Akt, 4E-BP1, rpS6) were comparable between KD and CD.

CONCLUSION: These preliminary findings suggest that four weeks of KD combined with RT improves body composition without impairing post-exercise hypertrophic signalling.

**EFFECTS OF SHORT-TERM ADAPTATION TO KETOGENIC DIET ON BODY COMPOSITION, FAT OXIDATION, ENDURANCE PERFORMANCE, MUSCLE GLYCOGEN, AND PREFRONTAL HEMODYNAMIC RESPONSES IN ENDURANCE TRAINED ATHLETES**

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INTRODUCTION: Ketogenic Diets (KD) have been proposed to enhance endurance performance by increasing fat oxidation. However, their effects on muscle glycogen availability remain unclear, with some evidence suggesting a glycogen-sparing effect following adaptation. Additionally, the potential performance benefits of nutritional ketosis—through increased ketone oxidation and reduced perception of fatigue—remain controversial. Therefore, the aim of this study was to investigate the effects of short-term KD adaptation on: (1) moderate-intensity endurance performance and (2) subsequent high-intensity endurance performance under glycogen-depleted conditions.

METHODS: To date, eight trained endurance athletes (age: 28.3 ± 3.8 years; $VO_2$max: 56.08 ± 8.3 mL/kg/min) have been enrolled. Following a one-week standardized diet (50% carbohydrates, 2.0 g/kg/day protein) and habitual training, participants were randomly assigned to either a KD diet (<5% CHO, 2.0 g/kg/day protein) or a control diet (CD) (>55% CHO, 2.0 g/kg/day protein) for 10 days, while continuing their usual endurance training. Body composition was assessed at baseline and after the intervention period using dual-energy X-ray absorptiometry (DXA) and bioelectrical impedance analysis (BIA). Additionally, after an overnight fast, participants performed a two-hour cycling protocol on a cycle ergometer at 55% of peak power output to induce glycogen depletion. Oxygen uptake ($VO_2$), respiratory quotient (RQ), and substrate utilization (g/h) were measured for 5 minutes every 15 minutes of exercise using a gas analyzer (COSMED CPET). Pre- and post-exercise muscle biopsies (vastus lateralis) were collected to quantify glycogen content. Following the depletion protocol, time to exhaustion (TTE) was assessed using an incremental protocol (starting at 75% $VO_2$peak, increasing power by 5% every 5 minutes). Functional near-infrared spectroscopy (fNIRS) was used to evaluate prefrontal hemodynamic responses during TTE.

RESULTS: Preliminary data suggest that the KD group experienced a reduction in total body water (-3% vs. +1%) and body weight (-3% vs. +0.5%) compared to the control group. Additionally, fat oxidation rates were markedly increased during exercise in the KD group (+156%) relative to controls (+3%), while gross efficiency declined (-2% vs. +0.3%). Notably, high-intensity endurance performance was impaired in the KD group, as evidenced by a shorter TTE (-7 min vs. +7 min) compared to the control group.

CONCLUSION: These preliminary results suggest that short-term adaptation to a KD diet reduces total body water and body weight. However, while this dietary approach enhances fat oxidation during exercise, it appears to reduce gross efficiency and impair subsequent high-intensity endurance performance. Further analyses will include an increased sample size, muscle biopsies data, and fNIRS evaluations to strengthen and expand these findings.

**THE EFFECTS OF CURCUMIN SUPPLEMENTATION ON NEUROMUSCULAR PERFORMANCE IN OLDER ADULTS: A SYSTEMATIC REVIEW.**

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INTRODUCTION: Curcumin is the most abundant phenolic compound in turmeric (Curcuma longa) and is widely recognized for its potent antioxidant and anti-inflammatory properties, as well as its role in mitigating exercise-induced muscle damage. However, its effects on neuromuscular performance remain relatively unexplored, particularly in older adults. It is hypothesized that curcumin supplementation may enhance neuromuscular performance in this population by improving muscle strength, reducing inflammation-induced muscle deterioration, and mitigating oxidative stress. Therefore, the aim of this systematic review was to assess the effects of curcumin ingestion on neuromuscular performance in older adults.

METHODS: A literature search was conducted using two databases: PubMed and Web of Science. Eligibility criteria were established following the PICOS method. Articles were selected based on the following inclusion criteria: curcumin intake, neuromuscular performance, older adults (i.e., >65 years old), and human participants. Neuromuscular performance parameters, such as isometric handgrip strength, knee flexion strength, short physical performance battery (SPPB) and walking speed, were analyzed.

RESULTS: A total of 187 studies were identified across the two databases. After screening titles and abstracts, 32 duplicate studies were removed, and 126 studies were excluded for not being relevant to the review topic. This left 29 studies for full-text eligibility assessment. After applying the exclusion criteria, five studies were ultimately included in this systematic review.

CONCLUSION: Current evidence suggests that curcumin supplementation, particularly when combined with piperine, may improve neuromuscular function in the upper body (i.e., isometric handgrip strength) in older adults. However, there is limited evidence regarding its effects on lower-body neuromuscular performance, such as knee flexion strength or walking speed. Therefore, further research is needed to better understand the effects of curcumin supplementation on overall neuromuscular performance in older adults, particularly in lower-limb function, to determine its full potential in preserving muscle health and mobility in aging populations.

Physical Activity Promotion

**EXERCISE INTENSITY AND SELF-EFFICACY TO ADHERE TO AN EXERCISE PROGRAM: CAN SEX BE A DETERMINANT FACTOR FOR YOUNG ADULTS?**

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INTRODUCTION: Maintaining a regular exercise routine is essential for health and quality of life. Evidence suggests that the benefits of exercise could be associated with exercise intensity. Moreover, high-intensity exercise can induce negative affective responses, including perceived exertion, enjoyment, pain, and effectiveness, potentially influencing self-efficacy in long-term exercise adherence. Additionally, the role of sex in shaping self-efficacy perceptions remains unclear. This study aimed to examine the relationship between self-efficacy and enjoyment with psychological responses to exercise at varying intensities in males and females.

METHODS: Twenty-one (7 women, 14 men) healthy, physically active adults (24.4 ± 3.1 years; 73.5 ± 12.6 kg; 174.0 ± 6.9 cm) participated in the study. An incremental test (5 W start, +25 W/min until exhaustion) was conducted to determine training intensity. Psychological responses were assessed using the Rating of Perceived Exertion (RPE), Feeling Scale (FS), and Perceived Pain Scale (COOK). A two-week training program followed, consisting of two 20-minute cycling sessions per week. One week was low-intensity (L; RPE 2–4) and one high-intensity (H; RPE 6–7), with randomized order. Participants rated their perceptions (RPE, FS, COOK) during each session. At the end of each week, they completed the Self-Efficacy to Regulate Exercise Scale and the Physical Activity Enjoyment Scale (PACES). Self-efficacy was defined as confidence in adhering to an exercise program over time. The T-test was applied to compare the results between the types of exercise (paired) and between the sexes (independent). Pearsons correlation was applied between SE and Psychological responses.

RESULTS: The intensity in the high-intensity exercise was significantly higher ($p < 0.001$) than in low-intensity (H: 61.2 ± 8.2 and L: 38.1 ± 6.1% of the peak power). SE was significantly lower after the high-intensity exercise (H: 56.9 ± 26.4; L: 90.3 ± 12.5 a.u.; $p < 0.001$) without any difference for PACES ($p = 0.158$) and no difference between men and women. For males, the SE presented a significant negative correlation with RPE ($r = -0.58$; $p = 0.031$) and COOK ($r = -0.58$; $p = 0.002$). For females, SE showed a significant correlation with the FS ($r = 0.85$; $p = 0.017$).

CONCLUSION: In conclusion, high-intensity exercise can considerably reduce the perception of self-efficacy in maintaining a physical exercise routine. However, in males, RPE and perceived pain during exercise seem to be more determinant in the perception of SE, whereas in females, affective valence during exercise seems to be the factor that can moderate the perception of SE.

**THE EFFECTS OF AEROBIC EXERCISE INTENSITY ON SELF-EFFICACY AND ENJOYMENT IN YOUNG ADULTS**

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INTRODUCTION: Despite the well-documented health benefits of regular physical exercise, adherence to a sustained and long-term exercise regimen remains low, particularly when high-intensity exercise is involved. Psychological factors, including self-efficacy (SE), perceived exertion, exercise enjoyment, perceived pain, and affective valence, may influence physical performance and adherence. Among these, SE is a widely recognized determinant of physical activity and has been linked to various exercise-related characteristics. Thus, this study aimed to examine the association between SE and enjoyment with psychological responses to exercise at different intensities. It is hypothesized that a high perceived exertion rate during exercise decreases SE and enjoyment, thereby reducing adherence to an exercise program.

METHODS: Ten healthy, physically active adults (7 women, 3 men; 25.6 ± 6.43 years; 63.8 ± 14.3 kg; 1.7 ± 0.1 m) participated in the study. An incremental test, starting at 5W with 25W increments per minute until exhaustion, was conducted to determine training intensity. Psychological responses were assessed using the rated perceived exertion (RPE) scale, feeling scale (FS), and perceived pain scale (COOK). Participants completed a two-week training program (twice weekly, 20-minute cycling sessions), with one randomly assigned week at low intensity (RPE = 2–4) and one at high intensity (RPE = 6–7). Psychological perceptions were recorded using RPE, FS, and COOK during each session. At the end of each week, self-efficacy to regulate exercise and physical activity enjoyment (PACES) were evaluated. Self-efficacy was defined as confidence in adhering to an exercise program over time. ANOVA was used to assess the effects of time and intensity on psychological parameters, while a T-test compared SE and PACES for the different intensities. Pearson correlation examined relationships between SE and psychological variables.

RESULTS: Statistical analysis revealed a significant effect of the time and intensity in the RPE during the training sessions ($p<.001$), FS ($p=0.033$), and COOK ($p=0.007$), but no significant correlation was revealed between SE, psychological responses, and intensity. SE scores were significantly higher ($p<0.005$) after low-intensity (60.9 ± 29.3 a.u.) training sessions compared to SE after high-intensity (40.0 ± 25.7 a.u.) exercise sessions. However, PACES scores (enjoyment of physical activity) did not differ between high and low-intensity exercise.

CONCLUSION: Based on the findings, it is concluded that high-intensity exercise may reduce self-efficacy in adhering to exercise programs; however, it does not appear to significantly impact exercise enjoyment. Moreover, psychological variables may not exhibit a direct correlation with self-efficacy across different exercise intensity levels.

**COMPARISON OF EXERCISE INTENTIONS AFTER COMPLETING A REQUIRED PE COURSE IN RELATION TO POSITIVE BODY IMAGE AND LIFE SATISFACTION.**

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INTRODUCTION: Mandatory Physical Education (PE) courses at universities engage all student demographics, including sedentary and active individuals, as well as those with special exercise needs. This setting is crucial for fostering lifelong exercise habits, with psychological factors like body image and life satisfaction potentially influencing students' willingness to participate.

Purpose

This research investigates the relationship between gender, Body Appreciation Scale-2 (BAS-2) scores, and Satisfaction with Life Scale (SWLS) scores concerning intentions to exercise after a required 13-week skill-oriented PE course.

METHODS: A total of 884 first-year university students (353 males and 531 females; mean age = 18.7 years) from various academic backgrounds participated. After completing the PE course, they completed a questionnaire that included demographic information, exercise intentions, BAS-2, and SWLS.

RESULTS: Results from a two-way MANOVA indicated that there was no significant interaction effect between gender and intention to exercise after completing the PE course on the following measures: 1) the BAS-2, $F(1, 657) = 0.448$, $p = 0.503$, and 2) the SWLS, $F(1, 657) = 0.069$, $p = 0.792$.

Two independent sample t-tests were conducted to determine if there were differences in BAS-2 and SWLS levels between males and females. The results indicated a non-significant difference in 1) BAS-2 levels, with males reporting an average of $M = 35.76$ ($SD = 7.89$) and females reporting an average of $M = 34.97$ ($SD = 7.80$), $t(882) = -1.46$, $p = 0.143$, and 2) SWLS levels, where males had an average of $M = 25.60$ ($SD = 6.09$) compared to females average of $M = 25.14$ ($SD = 6.02$), $t(659) = -0.98$, $p = 0.330$.

An independent samples t-test was conducted to assess whether there is a difference in BAS-2 levels between participants who intend to exercise after completing the PE course and those who do not. The results show a significant difference in BAS-2 levels between the two groups: those with the intention to exercise had a mean score of 35.76 ($SD = 7.54$), while those without intention had a mean score of 34.17 ($SD = 8.44$), $t(882) = 2.731$, $p = 0.006$.

In contrast, the independent samples t-test revealed a non-significant difference in the SWLS levels. Participants who intended to exercise had a mean SWLS score of 25.53 ($SD = 5.95$), compared to a mean score of 24.87 ($SD = 6.27$) for those without intention, $t(659) = 1.282$, $p = 0.200$.

CONCLUSION: After completing the PE course, no significant interaction effect was observed between gender and intention to exercise regarding the BAS-2 and SWLS scores. However, participants with higher BAS-2 levels exhibited a greater intention to begin exercising. Additionally, no gender differences were found in the BAS-2 and SWLS scores. Finally, there was no significant difference in SWLS scores between participants who intended to exercise and those who did not.

**DESIGN OF DIDACTIC UNITS FOR THE IMPLEMENTATION OF AN EDUCATIONAL PROJECT ON WRESTLING IN URUGUAYAN PUBLIC SCHOOLS BASED ON THE BUSHIDO CODE.**

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The ¨Bushido Playful-Pedagogical Project¨ was funded by the Extension development program of the Comisión Sectorial de Extensión y Actividades en el Medio (CSEAM) of the University of the Republic (Udelar). The background includes: 1. The comprehensive training space ¨Tatami Project¨ (2011-2020), which integrated university functions (teching, research and extension) between the Instituto Superior de Educación Física (ISEF), the faculty of Psychology and the Uruguayan Judo Federation (FUJ) in 4 neighbourhoods (Villa Española, Casavalle, Colón and Malvin Norte). 2. The research and innovation project for social inclusion funded by the Comisión Sectorial de Investigación Científica (CSIC) of Udelar, which generated a social inclusion prototype called PSDMN-2019 oriented at Social and Sports Projects (PSD) working in highly vulnerable neighbourhood contexts. 3. The 2017 Physical Education Bachelors degree curriculum, which included wrestling among it curricular units. 4. The scientific development through research projects and individual postgraduate theses that studies wrestling (Mora, 2018; Mora, Cabrera, Alvez, M, & Rodríguez, 2019).

It is worth noting that University Extension in Latin America has undergone significant development, establishing itself as one of the three main functions of public universities , alongside teaching and research. University Extension aims to promote a triple dialogue: the dialogue of knowledge (University- Society), the dialogue of functions (teaching, research and extension) and the dialogue of disciplines, in this case, coming from the human sciences and sports sciences.

Bushido was designed as a device to establish this triple dialogue, having as interlocutor girls, boys, their families, teachers and physical education instructors with the objectives of:

1. Spread body practices of combat sports in an educational manner. 2. Providing specific intergenerational experiences. 3. Producing and disseminating scientific knowledge about combat sports by taking them as a ¨Field of Knowledge¨ (Bourdieu, 1993) from the perspective of educational sciences and sports sciences.

The intervention problem and the research problem were articulated along two theoretical-methodological axes: 1. Thinking of martial arts as a field of knowledge (martial arts and combat sports) being historical and cultural practices that, in

Uruguayan case, were stigmatized for the violence and subjected to private initiatives. 2. Think about martial arts like educationally, and for that, we developed a didactic unit to collectively and daily problematize the KANJIS of the Bushido code: REI (Respect), GI (Justice), MAKOTO (Honesty) and MEYO (Honor).

**PHYSICAL LITERACY AS A MEDIATOR IN THE RELATIONSHIP BETWEEN FUNDAMENTAL MOVEMENT SKILLS AND CARDIO-VASCULAR FITNESS IN PRIMARY SCHOOL CHILDREN**

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Background

Physical literacy, defined as the motivation, confidence, physical competence, knowledge, and understanding to engage in physical activities for life, is an essential aspect of overall education and well-being for individuals across different age groups (Whitehead, 2019). Developing physical literacy from an early age through to adulthood is crucial for sustaining independence and improving population health and well-being. Research has shown a positive relationship between physical activity levels and self-perception of physical literacy among adolescents in Hong Kong (Choi & Sum, 2018). Physically literate individuals are more motivated to participate regularly in physical activity and tend to have positive attitudes towards it (Whitehead, 2010). Fundamental movement skills (measured by CAMSA) are believed to influence cardiovascular fitness (measured by PACER), potentially through the mediator of physical literacy (measured by PPLI) (Sum, et al., 2016). Therefore, to promote physical activity, this study investigates whether physical literacy mediates the relationship between fundamental movement skills and cardiovascular fitness in a pediatric sample.

Methods: A single-mediator analysis (PROCESS Model 4) was applied to data from 294 primary school children using SPSS 27. The model tested the indirect effect of fundamental movement skills (CAMSA, X) on cardiovascular fitness (PACER, Y) through physical literacy (PPLI, M). The analysis used 5,000 bootstrap resamples to obtain bias-corrected 95% confidence intervals.

RESULTS: Total effect: Fundamental movement skills (CAMSA) significantly predicted higher PACER scores ($\beta = 4.882$, SE = 0.439, $p < .001$, 95% CI [4.043, 5.722]).

Direct effect: After controlling for physical literacy (PPLI), the direct effect of CAMSA on PACER remained significant ($\beta = 4.882$, SE = 0.427, $p < .001$, 95% CI [4.043, 5.722]).

Mediation pathway: CAMSA significantly predicted PPLI ($\beta = 0.558$, $p = 0.028$, 95% CI [0.059, 1.056]), and PPLI was positively associated with PACER ($\beta = 0.468$, $p < 0.001$, 95% CI [0.275, 0.660]).

Indirect effect: The indirect effect of CAMSA on PACER through PPLI was statistically significant ($\beta = 0.261$, 95% CI [0.033, 0.531]), accounting for 5.1% of the total effect.

Conclusion: Fundamental movement skills directly improve cardiovascular fitness, with a modest additional benefit derived from its effect on physical literacy. These findings suggest that enhancing physical literacy may provide supplementary benefits to movement skill-based interventions aimed at improving cardiovascular fitness. Future studies should explore other potential mediators (e.g., cognitive function, physical activity level) to better account for the direct effect of movement skills on cardiovascular fitness.

**IMPLEMENTING SCHOOL-BASED PHYSICAL ACTIVITY POSITIVELY INFLUENCES PUPILS' PERCEIVED LIFE SATISFACTION AND WELL-BEING.**

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Introduction: Several school-related factors can influence pupils' perceived life satisfaction and wellbeing. School-based physical activity can affect such factors through improved physical fitness and function, improved mood and self-confidence, and through social interaction and support during both lectures and recess (Andermo et al., 2020). Telemark County, Norway, has had a focus on implementing physical activity in classroom and recess since 2016 (Schmidt et al., 2022; Schmidt et al., 2020), and it is thus of interest to explore whether this system-led initiative influences pupils' perceived life satisfaction.

Methods: The national survey Ungdata was conducted spring 2024, and this study involved youth aged 13-19 years from the implementation county Telemark (n=7,113) and control county Vestfold (n= 10,295) in Norway. Life satisfaction was rated on a scale from 0-10. In addition, the pupils reported their gender, socio-economic status, perceived pressure and thriving at school, recess content, school meals and school-based physical activity.

Results: The pupils showed similar levels of perceived life satisfaction between the two counties. The most important school-related factor for perceived life satisfaction was school thriving ($p<0.01$), followed by social connectedness during recess and school meals ($p<0.05$). School-based physical activity positively predicted life satisfaction in Telemark ($p<0.05$), but not in Vestfold. The prediction in the Telemark group was stronger in girls compared to boys.

Discussion: The small yet significant influence of school-based physical activity on particularly girls' perceived life satisfaction on county level is in accordance with findings from a previous experimental study on school level (Schmidt et al., 2020). This is thus the first study to indicate how such school-based initiatives, when implemented and designed thoroughly, can contribute to changes on societal level in youth.

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**THE PROGRESSION OF THE JOURNEY OF MAN IN MOTION**

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The progression of the journey of man in motion

During the Renaissance, history tells us that humanity again became the center of the universe, free to act and express itself. Education focused on well-being and physical movement became one way to develop the idea of balanced and integrated person. Educators recognized physical activity and the importance of play as a key of learning and personal growth helping people to connect with themselves and others.

After the Pandemic which forced us into isolation and lifestyle changes , the need for physical activity and sport became even more important . These activities are not only for personal health but help rebuild social connections.

Relationships are essential for well being and a strong society. However modern challenges, lack of physical activity and reduced social interaction, require new solution. One way to address is trough an Outdoor Experiential Relation Activity Model which strengthens the connection between sport , environment and sustainability.

The main goal is to encourage people to accept and take care of themselves with their own fragility which includes personal challenges.

This activity focuses on restoring balance between individual and community, using a holistic approach. It combines outdoor activities like trekking, free climbing, rafting, biking, with social experiences. An example in Ferentillo (Terni) where people of different ages (children, teenagers or adults) engaged in physical activity in nature , free from distraction like cell phones, tablet and computers.

Since considering humans are naturally social we found that well being improves when people learn through movement and shared experiences. Social well being grows through emotions, team work, sport challenges and play therapy.

**5 MINUTES OF DAILY SMS, A PHYSICAL ACTIVITY PROTOCOL, TO PREVENT WORK ACCIDENTS AND MUSCULOSKELETAL DISORDERS OF WORKERS IN AN INDUSTRIAL ENVIRONMENT**

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INTRODUCTION: The number of workers suffering from work-related musculoskeletal disorders, estimated to account for 21 to 28 % of all days of occupational sick leaves, is a major health problem for society and workers (1). In addition to other preventive actions, physical activity protocols (PAP) contribute to reduce Musculoskeletal Disorders (MSDs) in workers (2). The nature of the protocol, its implementation, its acceptability and the engagement of workers (3) to the protocol are essential determinants of the effectiveness of the PAP.

Objectives

The aims of the study are to evaluate the feasibility and acceptability of a preventive PAP of 5 minutes named SMS (Strength, Mobility and Stretch) to present the preliminary results, particularly in terms of engagement and the effects at 15 months on the reduction of work accidents (WA), their severity and the number of MSDs.

METHODS: A mandatory approach based on 5 minutes of SMS per day worked adapted to job families for all workers of an industrial company (n=250) was implemented from September 2021 through the intervention of a service company. The protocol was:

- Information about this approach to all workers and call for applications to become internal animators (IA);
- 3 weeks: Animation of SMS sessions by the service company;
- 4 x 1 day: Training of 4 groups of IA;
- 2 weeks: Co-animation of SMS sessions by IA and service company;
- 14 months: IA of SMS sessions.

The indicators monitored are the frequency and severity rates of WA, MSDs declared (indicators of the French Medical Health Care System) over the last 5 years, as well as the relative risks and level of engagement.

RESULTS: The share of volunteer workers trained to be IA is 14%. Protocols were followed by all workers and none of them refused.

The first results show a significant drop in 15 months in frequency and severity rates of WA:

- Decrease in the frequency rate from 51.25 to 14.21

- Decrease in the severity rate from 0.96 to 0.45

The relative risk analysis shows a reduction in the risk of WA of 53% and in the risk of minor accidents of 65%. The number of MSDs declared during the mandatory is zero.

Discussion and CONCLUSION: The proportion of volunteer workers trained demonstrates a certain interest in SMS and an appropriation of the approach by workers. This approach requested and organized by the companys management is well accepted by all workers.

According to these initial results, it would seem that 5 minutes of SMS every working day helps reduce WA and MSDs in this industrial environment. Further studies are needed to confirm these results, measure the evolution of the indicators presented and monitor workers engagement over the long term.

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**COMPARISON OF MODERATE AND VIGOROUS PHYSICAL ACTIVITY OF COLLEGE STUDENTS USING WEARABLE DEVICES TRACKING PHYSICAL ACTIVITY: A PRELIMINARY ANALYSIS**

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INTRODUCTION: Wearable devices (WD) are increasingly popular for promoting physical activity (PA) [1], especially among college students who often struggle with maintaining regular PA [2]. WDs can serve as motivational tools, yet most research on their effectiveness comes from structured interventions, leaving gaps in understanding their impact in everyday life [3]. This study compares moderate physical activity (MPA) and vigorous physical activity (VPA) between college students who use WDs and those who do not, with further distinctions based on active PA tracking.

METHODS: Participants were categorized into three groups based on self-reported WD use: (1) not using WD (NWD), (2) using WD but not tracking PA (WDNPA), and (3) using WD and tracking PA (WDPA). They wore a triaxial accelerometer on their right wrist for seven days to measure PA levels. The accelerometer recorded total minutes spent in MPA and VPA, classified using Troiano cut points [4]. PA differences among the groups were analyzed using ANOVA with Bonferroni post-hoc adjustment.

RESULTS: For this preliminary analysis, nine participants did not use a WD, two reported using a WD but not tracking their PA, and seven reported using a WD and tracking their PA. The average MPA for each group was 1308.14 minutes for NWD, 1497.00 minutes for WDNPA, and 1443.50 minutes for WDPA. For VPA, NWD had an average of 124.71 minutes, WDNPA had 95.50 minutes, and WDPA had 115.83 minutes. ANOVA results indicated no statistically significant differences in MPA ($F = 1.19$, $p = .30$) or VPA ($F = 0.07$, $p = .50$) among the three groups.

CONCLUSION: Although this analysis is limited by a small sample size, the findings suggest that the use of WDs, even with active tracking of PA, may not significantly increase engagement in MPA or VPA among college students. Simply wearing and tracking PA with these devices may not be enough to drive meaningful behavioral changes. Given the well-documented health benefits of MPA and VPA, future research should investigate more effective strategies to maximize the potential of wearable technology in promoting sustained PA increases.

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Physical Education and Pedagogics

**INCREASING PARENTAL INVOLVEMENT CHARACTERISTICS OF SPORTS ACTIVITIES OF HIGH-SKILL SWIMMERS AND THE LINKS WITH ATHLETES' SPORTS ACHIEVEMENT**

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INTRODUCTION: In the modern world many young athletes live very active lives where they need to combine learning and sports activities, sports, various extracurricular activities, homework, leisure, and other areas of life. All this causes daily stress, a constant sense of urgency, and fatigue, which reduces the motivation of young people to play sports (2). This problem is relevant for both advanced and high-performance athletes. Therefore, researchers (1,3), analyzed the impact of parental involvement in childrens sports activities on the successful sports and development and found that parents play a key role in youth sports education. The aim of the study is to reveal the characteristics of parents involvement in the sports activities of high-performance swimmers and links with athletes' and sports achievement.

METHODS: The Parental Involvement Sport Questionnaire (PISQ) developed by Lee and McLean (1997) is used for the study. During the research, 71 high-performance athletes and 60 of their parents were interviewed.

RESULTS: It was found that many parents show enthusiasm and joy before the competition (4.03 points). However, before the competition they still indicate what results the child should achieve (1.84 points). According to the parents assessment, they are very actively interested in their childs swimming (4.4 ± 1.0), while according to the athletes assessment, they are moderately active (3.4 ± 1.3) ($t(129) = -4.8$; $p = 0.000$). According to the parents assessment, they almost always (4.7 ± 0.6) praise their child for their effort after the competition, while according to the athletes - parents praise them only often (4.0 ± 1.3) ($t(129) = -4.1$; $p = 0.000$). Parents (4.5 ± 0.9) always say something encouraging after a swimming competition, even if their child swam poorly, while athletes often (3.7 ± 1.3) show their understanding ($t(129) = -4.2$; $p = 0.000$). Weak correlations were found between parental active involvement and personal athletic achievements of high-performance swimmers ($r = 0.293$). Strong positive correlations were also found between parental active involvement in athletes activities and praise and understanding ($r = 0.514$) and directive behavior ($r = 0.513$).

CONCLUSIONS

The activity of parents involvement in the training process is average, focused on childrens needs, organizational support and creating conditions for professional sports. Parents give their children psychological support, praise the child for achievements and efforts. Positive correlations between active parental involvement and swimmers personal sports achievements have been established.

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**ATTENTION AND PREFERENCES IN RESPONSES TO INSTRUCTION DURING RETURN-TO-PLAY EVALUATIONS**

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INTRODUCTION: Instruction can modulate performance, muscle activity, and affective responses during tasks [1] by directing the participant's attention. This reduces the likelihood of generating spontaneous or ineffective self-talk[2]. Sometimes, athletes tend to direct their attention toward controlling their own movements or to focus on aspects they personally prefer, rather than following the professional's instructions. Return to play tests, which are used to inform decision-making during rehabilitation, may yield altered data if the participant's attention is not controlled, potentially leading to misinterpretations of the athlete's physical condition. Therefore, the aim of this study was to investigate whether participants followed the instructions provided and to examine their preferences for specific instructions during assessment.

METHODS: Twenty-seven athletes were recruited for this study. Protocol was conducted using an leg extension isokinetic device under four experimental conditions: control, analogy, explicit, and encouragement instructions. Attention was recorded using the Knowledge Declared Questionnaire, which was administered immediately after each experimental condition [3].

RESULTS: Results are presented as percentage of the total 100%. Overall, participants followed the provided instructions in 75.93% of cases. Percentages ranged from 59.26% in the control group to 92.59% with explicit instructions. The values for the encouragement and analogy conditions were 70.37% and 81.48%, respectively. Regarding preferences, 59.26% of participants favored the encouragement condition, compared to 7.41% for explicit instructions and 33.33% for the analogy condition.

Discussion: Findings reveals that nearly 20% of the instructions provided were not followed by participants. In the context of testing, which are crucial for decision-making during rehabilitation processes, when attention not adequately controlled, failure to follow instructions may alter the data collected, potentially leading to incorrect decisions regarding an athlete's readiness to return to play.

Our results also suggest that the overall adherence to specific instructions (i.e., explicit, analogy and encouragement) was approximately 30% higher than in the control group, indicating that instructions may reduce the likelihood of generating spontaneous self-talk. However, individual preferences showed varying percentages across experimental conditions. From a practical perspective, these findings highlight the importance of incorporating different types of instructions during the familiarization phase of testing. By doing so, practitioners could ask athletes which type of instruction makes them feel most comfortable and prepared to optimize force application [1].

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**THE EFFECTS OF INTEGRATING LINE BOT TEACHING PLATFORM AND WICAS FLIPPED LEARNING MODEL ON BADMINTON SKILL LEARNING**

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INTRODUCTION: To facilitate learners acquisition of badminton skills, the researchers developed a LINE Bot teaching platform integrated with the WICAS flipped learning model. This platform enabled learners to preview, engage in class, and review after class through features like e-portfolios, expert videos, pre-class self-assessments, video analysis, and self-reflection. All functionalities were accessible through the LINE app, allowing learners to retrieve learning resources without spatial and temporal restrictions.

METHODS: A quasi-experimental design was employed. One class used the LINE Bot teaching platform combined with the WICAS flipped learning model (experimental group, EG), while the other used mobile devices with the WISER learning model (control group, CG). Teaching focused on badminton serve (Participants: EG=44, CG=48) and clear (Participants: EG=48, CG=47) over five weeks, aiming to determine whether significant differences exist in learning outcomes between the two groups. To assess learners' performance effectively, the researchers adopted the Badminton Learning Tutor app as a research tool. Data were analyzed using a mixed-design ANOVA to evaluate whether there were significant differences in learning performance within and between groups during pre-tests, post-tests, and weekly assessments.

RESULTS: The analysis of serve skill found no significant difference between the EG and CG in the between-subjects effect ($p = .187$). However, significant differences were observed in the within-subjects effect of testing time ($p < .001$) and the interaction effect of testing time and group ($p < .001$). Post-hoc analysis showed the EG significantly outperformed the CG at Week 5 and the post-test. For clear skill, the between-subjects effect revealed a significant difference between groups ($p < .001$), and the within-subjects effect of testing time was also significant ($p < .001$), while the interaction effect was not ($p = .213$). Post-hoc analysis indicated the EG consistently outperformed the CG (except during Week 3 and Week 4), with a marked improvement in the post-test. These results demonstrate the effectiveness of the LINE Bot teaching platform combined with the WICAS flipped learning model in improving badminton skills.

Discussion: The findings of this study align with previous research, confirming that the motion recognition functions offer learners accurate feedback, with which they adjust and improve their skills progressively. This study further innovates by incorporating the WICAS flipped learning model with the LINE Bot teaching platform, allowing learners to reflect on the system-offered suggestions, identify areas for improvement, and document these details before class. While in class, they can thus focus on improving skills and reflecting on their movements. This approach allows learners to overcome the traditional reliance on instructors for detailed skill corrections, helping them to solve problems independently.

**IMPLEMENTING RUBRICS FOR LEARNING AND ASSESSMENT IN UNIVERSITY PHYSICAL EDUCATION: INSIGHTS FROM TEACHERS AND STUDENTS**

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Background and Objective: Rubrics enhance grading transparency and consistency while improving learning quality through performance assessment. However, their application in university physical education classes is limited. Thus, this study explored teachers' practices and students' perceptions of implementing rubrics for performance assessment.

Methods: In a university physical education class, the teacher implemented a rubric to foster social and emotional skills (e.g. self-awareness, communication, and gratitude). This rubric was shared with students to guide their performance assessment. The class involved practising 10 new sports (e.g. Flying Disc, Gate Ball, Indiaca, and Kin-Ball), most of which were new to students. Semi-structured interviews with the teacher and focus group interviews with students were conducted mid-term and at the end of the semester to discuss teaching and learning practices.

Results: The teacher emphasised the importance of raising awareness of the rubric's criteria while fostering communication and group cooperation among students. However, they identified challenges, including insufficient emphasis on setting specific class goals, a lack of individualised engagement, and inadequate assessment feedback during the semester. Students viewed the rubric positively, noting that it supported goal setting, encouraged active communication, fostered dedication and engagement, and provided clearer assessment criteria than other physical education classes.

Nonetheless, the students suggested areas for improvement, such as the need for midterm feedback and difficulties in focusing consistently on the rubric criteria.

Discussion and Conclusion: Interviews with teachers and students highlighted the potential of rubric-based performance assessment to promote active and autonomous learning in physical education classes. However, the findings underscore the need for more robust teacher feedback to enhance the effectiveness of this approach. Future studies should explore innovative teaching strategies to integrate rubrics more effectively into classes, facilitating diverse and meaningful learning experiences and supporting student growth in physical education.

**A STUDY ON THE EDUCATIONAL EFFECTS OF SPORT: WITH FOCUS ON SPORTS IN SCHOOLS IN JAPAN**

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INTRODUCTION: At last years conference, participants discussed ways to eliminate corporal punishment and harassment in sport scenes in Japan. Historical circumstances serve as one of the causes of corporal punishment and harassment in Japan. The second cause is that instead of a seasonal team system, students in Japanese schools often practice sport on the same team throughout the year. Furthermore, there is no tryout system, and in some cases, a large number of students practice sport within a single team. Why is this kind of situation still continuing? A major factor is the belief that playing sport offers numerous educational benefits. The term "sport education" is based on the assumption that education based on sport and education via sport are possible. However, it is unclear what specific educational benefits or outcomes are being achieved through this approach.

Method: We conducted a questionnaire survey with college students to understand what they believe they have learned from their participation in sport and analyzed their responses.

Result

Students who participated in our questionnaire provided their responses to open-ended questions. The questions are broadly categorized into: (1) what they learned through sport activities, (2) what they learned through team and group activities, and (3) what they learned regarding daily activities (activities unrelated to sport).

Discussion: Regarding responses to question (1), these are lessons that can be learned through dedicating oneself to something and not limited to sports alone. Similarly, for question (2), many of the responses are applicable to any type of group not just sports teams or organizations. Regarding this, we believe that further study and exploration are needed to gain a deeper understanding of the unique aspects of sports. Many responses to questions (2) and (3) overlap, and some are difficult to categorize distinctly.

Here, we should be careful in handling the idea that what people achieve through sports is applicable to everyday life in general. The rules and disciplines used to maintain order within a group of athletes may differ from those practiced in everyday life and can sometimes seem thoughtless or absurd by ordinary standards.

Tano, a researcher of fascism, discusses the essence of fascism, which may be applicable to commonly found athletic communities. Characteristic features of such communities, like strong leaders, collective activities, and exercising while loudly shouting, can lead to the creation of exclusive communities and the formation of unique values and customs.

CONCLUSION: The culture developed within athlete communities may be adversely influencing various aspects of Japanese society. People involved in education need to carefully observe and examine the relationship and differences between the sport world and everyday life. What is learned in sport does not necessarily translate to everyday life.

**"EASY JAPANESE" IN LIFESAVING COMMUNICATION: GIVING INSTRUCTION IN "EASY JAPANESE" TO UNIVERSITY STUDENTS DOING LIFESAVING TRAINING**

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INTRODUCTION: "Easy Japanese" has been used as an effective way to provide information to foreign residents during disasters since the Great East Japan Earthquake in 2011. Recently it has also been used in a wide range of areas such as nursing care, medical care and disaster prevention information from the government. Despite this there is no study on "Easy Japanese" in lifesaving activities. Furthermore, linguistic research shows that "Easy Japanese" is useful not only for foreigners but also for native speakers with low Japanese language proficiency. The ways of communication in lifesaving are various. Therefore, learning "Easy Japanese" will be essential for lifesavers as a practical skill.

METHODS: First, we checked 27 student lifesavers' (Male 19, female 8) knowledge of "Easy Japanese" and asked them what is important to communicate to people with low Japanese proficiency. Next, we got students to rewrite a beach announcement (i.e. "No swimming due to lightning") to make it easier to understand. After that we gave a lecture to students to increase their linguistic knowledge of "Easy Japanese" and got them to rewrite another beach announcement ("No swimming due to fog"). Finally, students described how they should use "Easy Japanese" in lifesaving situations.

RESULTS: The 90% of the students did not know the fine details of "Easy Japanese". As to the importance of communication with those who are not able to understand Japanese, students mentioned that they would deal with them kindly and friendly. After the lecture of "Easy Japanese", students got the linguistic skills as follows, 1) To change formal expressions to simpler one's, 2) To emphasize the important parts of the announcement and repeat them, 3) To shorten a long sentence in order to make it simple and clear. However, they couldn't rewrite everyday Japanese phrases that are difficult for for-

eigners into "Easy Japanese". After this activity, for making effective use of "Easy Japanese", they referred that lifesaving skills based on having consideration for people are absolutely indispensable.

CONCLUSION: In this study, it turned out that student lifesavers' ability to use "Easy Japanese" in lifesaving had improved dramatically after the lecture. According to their reactions to a series of practice, interestingly we knew that they realized the significance of their caring attitude to communicate as well as language skills in lifesaving. As a result, we need to give student lifesavers further linguistic instruction for "Easy Japanese" systematically. In addition, we should study more about the practical relationship between language and communication skills of student lifesavers.

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**REFLECTION ON THE OBSERVATION OF THE AFFECTIVE DOMAIN IN PHYSICAL EDUCATION**

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INTRODUCTION: The affective domain is extremely important in physical education (PE) and is not as simple as it may seem at first glance, as it can be considered and studied broadly, going far beyond emotions. In Scotland, the affective domain is implemented in the PE curriculum through Personal Qualities (PG) [1], which include motivation, confidence and self-esteem, determination and resilience, responsibility and leadership, respect and tolerance, communication. This is important as part of physical education's response to the rising prevalence of mental health and wellbeing concerns among young school-age people [2].

METHODS: Non-participant Observational Study according to a specially developed protocol based on 1) Benchmarks PE [1] and 2) affective responses during a PE lesson using the Ecological Momentary Assessment [3].

As part of one of the research stages of the research project 'Developing and enacting pedagogies of affect in PE' supported by a grant from the British Academy, in April-May 2024, observations were made of PE lessons of 5 students at the University of Strathclyde on the Professional Graduate Diploma in Education programme.

RESULTS: The observation showed that all six aspects of PQ were present during the PE lesson by students, but the most complete implementation was in communication and motivation. Observation of pupils affective responses showed the absence of negative affective on their part. As for the positive affective responses, half of them were activated (happy, cheerful) and the other half were deactivated (calm or relaxed). The majority of pupils affective responses to the PE lesson tasks were at the level of 2-3 points and only in 3 cases the affective response was rated at 4 points. Only physical activity caused activated pleasure, and the more movement the lesson task required, the more pupils liked it. At the same time, any explanations immediately shifted pupils to deactivated pleasure.

CONCLUSION: This study shows that the student teachers were familiar with the PQ aspect of physical education within Curriculum for Excellence and were able to teach for affective learning of their pupils. At the same time, these outcomes were limited by the student teachers' relative unfamiliarity with the pupils since they were on a time-limited placement. For teachers familiar with their pupils, teaching for affective learning could be further extended. The positive responses of pupils offer encouragement for further investigation of this topic given the very challenging Pupil behaviours being exhibited relating to mental health concerns [2].

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**SWIMMING SKILLS DEVELOPMENT IN SECOND-GRADE STUDENTS IN THE 'LEARN TO SWIM AND STAY SAFE IN THE WATER' PROGRAM**

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Introduction. Swimming has deep traditions in Lithuania, and Lithuanian swimmers have excelled in international competitions. However, drowning rates remained high in the early 21st century. During the first decade, an average of 369 people drowned annually, including 33 children. Lithuania had one of the highest drowning rates in Europe, prompting LTU Aquatics (LSF) and government institutions to launch a national swimming education initiative. Swimming is a vital survival skill that enhances childrens motor skills, psychological resilience, and social competencies. In 2008, the Lithuanian government integrated a structured swimming education program into the National Sports Development Strategy to ensure that children acquire fundamental swimming skills and learn water safety.

Implementation of the Learn to Swim and Stay Safe in the Water Program. The program is aimed at second-grade students. Initially consisting of 18 lessons, it was later expanded to 32 per school year, funded by the state and municipalities. The program is designed to teach breath control, buoyancy, underwater orientation, and basic water movements. Over the past decade, more than 52,000 second-grade students have participated. Schools and municipalities have provided transportation, ensuring systematic participation.

Study on swimming skills in Kaunas Schools. A study assessed 63 second-grade students (40 boys, 23 girls, age 8.2±0.5 years) attending two 45-minute lessons per week at LSU's pool. After 18 lessons, swimming skills were evaluated based on ten competencies, including breath control, floating, propulsion, and water safety. Results showed that 86.1% adapted well to water, 77.8% mastered breath control, and 72.2% could float. Additionally, 69.4% could enter and exit the water safely, while 28% swam 25 meters unaided. While skill acquisition varied, the program significantly improved students' abilities.

Impact and Challenges of the Program. The initiative has yielded positive results. Government funding, standardized methodologies, and new pools have increased opportunities for children to learn to swim. From 2009 to 2021, drowning rates decreased from 9.4 to 5.6 cases per 100,000 population, while child mortality decreased from 6.4 to 2 per 100,000. Media campaigns and parental education on drowning prevention have also contributed to this trend. However, Lithuania still lacks a comprehensive national drowning prevention strategy. To increase the program's effectiveness, it is necessary to expand access, improve lesson structures, and optimize resources.

Conclusion. A structured swimming program has significantly improved childrens swimming skills and contributed to drowning prevention. Despite its successes, challenges remain, including inconsistent attendance, a shortage of pools, and an insufficient number of lessons. Future efforts should focus on expanding access and integrating a national drowning prevention strategy to enhance water safety education.

**WORKSHOPS ON PLAY: METHODOLOGICAL STRATEGIES BASED ON THE USE OF SCHOOL PLAY SPACES**

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INTRODUCTION: Play is a fundamental activity for child development, contributing to cognitive, emotional, social, and physical aspects. In the school context, playful practices can be limited by structural, cultural, and organizational factors that restrict childrens autonomy and creativity. This research explored teaching strategies through "play workshops," which aim to identify the impact of childrens playful experiences in the school environment.

METHODS: This research used "play workshops" as its central methodology, highlighting their relevance in the educational field. The workshops were designed based on the childrens own perceptions, valuing them as active participants. Rather than proposing a closed and replicable method, the intention was to establish principles that could guide the creation of formative practices aligned with their realities and needs. The workshops were planned after discussion circles with the children, during which interests such as toy creation, exploration of games, and the use of different school spaces and resources emerged.

RESULTS: The research highlighted childrens protagonism and the importance of including them in the process of reflecting on and transforming school spaces. The initial identification of games, characterized by low interest in traditional practices, guided the workshops toward activities more aligned with the childrens interests. The photographic documentation stage promoted autonomy and teamwork while revealing the childrens desire to explore less accessible areas of the school. The creation of photographic panels fostered collective engagement, allowing the children to express their perceptions and preferences about play spaces in the school.

At the end of the research, an exhibition open to the school community was held, consolidating the learnings and reinforcing the role of children as active agents in creating and valuing playful practices in the school environment.

DISCUSSION: The research demonstrated that play, in addition to being a spontaneous practice, is also a powerful means of expression and redefining school spaces. Through a sensitive and participatory approach, it was possible to reveal the complex dynamics that permeate childrens playful universe, highlighting their capacity for resistance, creativity, and appropriation of spaces. By exploring playful practices from the childrens perspective, the tension between institutional norms and the creative tactics used by students to subvert these rules and transform spaces into environments of freedom and belonging was identified. This underscores the central role that play assumes in the construction of meanings and school experiences. This final reflection reinforces the urgency of valuing childhood as a protagonist in the school environment and rethinking educational practices to incorporate childrens genuine demands and expressions.

**STRUCTURAL ANALYSIS OF GENERALIZED SELF-EFFICACY AND ITS ASSOCIATION WITH PHYSICAL FITNESS IN LATE ADOLESCENCE**

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INTRODUCTION: To date, studies have used the Generalized Self-Efficacy scale (GSE scale) with the one-factor structure and analyzed other factor structures; however, a consistent factor structure has not been obtained. In addition, few studies have examined the relationship between GSE-scale factor structure and physical fitness in late adolescence. Therefore, this study aimed to clarify the factor structure of the GSE scale in late adolescence and examine its relationship with physical fitness.

METHODS: A total of 354 subjects—132 male and 222 female university students(average age: 18.32 ± .80 years old, age range 18-26 years old)—were surveyed. Similar to previous studies, responses in this survey were given on a 5-point scale regarding the GSE scale. For physical fitness, six physical fitness test items were measured.

RESULTS AND DISCUSSION: First, exploratory factor analysis (maximum likelihood method, promax rotation) was performed on the GSE scale, and two factors and 11 items (factor 1; problem solving, factor 2; interpersonal relationships) were extracted. Next, a confirmatory factor analysis (maximum likelihood method, promax rotation) was conducted using a two-factor, 11-item model obtained by exploratory factor analysis, and it showed that GFI = .93, AGFI = .90, CFI = .90, and RMSEA = .08. Reliability coefficients for the GSE subscale were $\alpha$ = .80 for the first factor and $\alpha$ = .72 for the second factor. The goodness of fit of the factor structure model for the GSE scale was therefore judged to be within the acceptable range. The results revealed a two-factor structure for the GSE scale for new university students, consisting of the first factor "problem solving" and the second factor "personal relationships," for which both reliability and validity were confirmed. The correlation coefficients (Pearson's product-rate correlation coefficients) were then calculated for each of the extracted GSE factors with the six items of the physical fitness test by gender; a constant correlation was found for men and a weak correlation for women, both of which were significant ($p < .05$). This can be attributed to the behavioral traits shown by Bandura (1977), such as the willingness to exert a great deal of effort to solve problems when self-efficacy is highly recognized.

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**THE OLYMPIC VALUES EDUCATION LEARNING PERFORMANCE SCALE FOR PHYSICAL EDUCATION CLASSES**

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Introduction: Affective learning is a crucial goal in contemporary education. The International Olympic Committee (IOC) continues to promote the affective development of sports participants through the Olympic Values Education Programme (OVEP). While various Olympic values education assessment tools have been developed internationally, there is still a lack of instruments specifically designed for the physical education (PE) context. Furthermore, existing tools differ across countries due to cultural variations. Therefore, developing an Olympic Values Education Learning Performance Scale suitable for the Taiwanese cultural context in PE classes is necessary. Based on this need, this study aims to develop a learning performance scale for Olympic values education in PE classes for students aged 11 to 18. The scale is constructed based on the three core values of Olympism—Excellence, Respect, and Friendship, as proposed by the IOC (2017), serving as the foundational dimensions for learning assessment. Methods: This study was conducted in three phases. Phase one involved focus group discussions and expert consultations to establish the learning assessment indicators. Phase two included 285 participants aged 11 to 18, employing exploratory factor analysis (EFA), item analysis, and reliability analysis to establish the validity and reliability of the scale. Phase three involved 641 participants aged 11 to 18, providing confirmatory factor analysis (CFA), criterion-related validity, test-retest reliability, measurement invariance testing, and cross-validation evidence. Results: Following exploratory factor analysis, five dimensions were identified: "Pursuit of Excellence," "Team Cohesion," "Mutual Support," "Respect for Self and Others," and "Respect for Rules and Environment." The items demonstrated strong discriminant validity and internal consistency. In the confirmatory factor analysis phase, the scale met model fit criteria and obtained support for criterion-related validity, cross-validation, and measurement invariance, indicating strong psychometric properties. Overall, the Olympic Values Education Learning Performance Scale for PE classes was supported across multiple validity and reliability assessments. Conclusion: The Olympic Values Education Learning Performance Scale for PE classes, developed in this study, exhibits strong validity and reliability, making it a suitable tool for PE teachers to assess students' affective learning and values education in PE settings. Additionally, the scale provides a valuable instrument for researchers to conduct further studies on Olympic values education.

**INTEGRATING AN AI-BASED MARKERLESS MOTION CAPTURE SYSTEM IN THE VAULTING BOX UNIT OF ELEMENTARY SCHOOL PHYSICAL EDUCATION**

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INTRODUCTION: Studies have explored the use of applications in physical education. The Hudl Technique app [1] is a motion analysis tool that enables athletes to review and refine their movements. However, the Polar Beat [2] and Polar Club apps [3] are designed for heart rate monitoring and have been used to track physiological responses during exercise. While these applications offer valuable insights, their high cost limits their widespread adoption in school settings. Correspondingly, this study aimed to evaluate the effectiveness of the SPLYZA MOTION (SM) app, an affordable motion analysis tool, in elementary school physical education classes.

METHODS: This study involved 165 fourth-graders from public elementary school five classes in Japan. The vaulting box unit was conducted over five lessons per class, led by homeroom teachers. The SM app was introduced a month before lessons, allowing familiarisation. Students used the app in small groups, and its impact was assessed through diagnostic and summative lesson evaluations and perceived physical competence (PPC) scores before and after lessons. The Wilcoxon signed-rank test examined pre- and post-test differences, and the Mann–Whitney U test analysed gender distinctions.

RESULTS: The SM app was used once in one class and twice in others. Key features included dual-screen motion comparison (self-comparison and peer comparison) and AI-based motion capture. Students analysed movements inside and outside class. The total diagnostic lesson evaluation score was 54.0±5.09. The summative evaluation score was

54.5±5.59. Notable improvement was observed in the 'learning' factor (12.9±1.81 to 13.3±1.81, $p < 0.05$). In PPC, the pre-test 'perceived physical competence' factor was markedly higher in boys (15.8±3.69) than in girls (13.0±4.06, $p < 0.05$). However, total PPC scores illustrated no significant change (pre: 49.4±7.90, post: 49.4±7.90). Teachers noted increased student engagement in critical thinking and peer discussion, though the individual use of the app was suggested for superior effectiveness.

Discussion: The dual-screen comparison and motion capture functions of SM app provided a clear, accessible tool for students, likely contributing to the marked improvement of the 'learning' factor. Students analysed their movements outside class, which may have enhanced their understanding. PPC scores were already high before lessons, perhaps due to prior exposure to the app. Compared to previous studies, the high PPC scores suggest app-based learning may positively influence students' self-perception in physical education.

CONCLUSION: The SM app facilitated cognitive engagement and peer feedback, corroborating educational objectives as outlined in the Japanese Course of Study. Its use in physical education classes can enhance learning outcomes and perceived physical competence in students.

1. Hyeonho et al. (2021), 2. Lilyan et al. (2020), 3. Shishido et al. (2019, 2021)

**"A WIN-WIN OR A HARMFUL?" AN EMPIRICAL STUDY ON THE EFFECTS OF PE-IN-CLIL ON COGNITIVE PERFORMANCE AND PHYSICAL ACTIVITY IN TAIWANESE ELEMENTARY SCHOOLS**

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Background & Purpose: Taiwan has been actively promoting bilingual education policy to boost students English ability and subject learning ability. One of the outcomes is the introduction of bilingual Physical Education (PE) classes in elementary schools. Despite that, there is limited research on how effective they are, particularly whether they achieve a good balance between language learning and physical activity or rather reduce students physical activity levels through heightened cognitive load. This study investigates the effects of Content and Language Integrated Learning (CLIL) on the physical activity levels and cognitive load of Taiwanese elementary school children in the setting of Physical Education (PE-in-CLIL). As there is worry over the potential effect involved in including language acquisition within students physical education, this present study endeavors to generate empirical evidence that will describe the impact of Taiwans bilingual physical education programs on physical and mental performance.

Methods: Quasi-experimental design was utilized, with 315 students in grades 1, 3, and 5 in 12 experimental classes and 334 students in 12 control classes. The intervention targeted units on jump rope, soccer, and volleyball specifically. Physical activity was measured objectively by accelerometers, and cognitive outcomes were measured by standardized tests.

Results & Findings: Both groups had significant cognitive enhancements following the intervention [experimental: pre-test 71.79, post-test 73.99, $p = .016$; control: pre-test 64.21, post-test 68.95, $p < .001$], with no significant difference between the groups ($p > .05$). The physical activity measures were all in the favor of the control group: sedentary time (control: 14.92 min; experimental: 19.2 min), total MVPA (control: 9.97 min; experimental: 8.47 min), and step counts, all $p < .001$. These results imply that bilingual educations cognitive demands can decrease student physical activity levels, which in the long run can contribute to ill health.

Discussion & Conclusion: These findings emphasize the need for policymakers and educators to carefully design bilingual PE programs to ensure that language learning is effectively integrated without compromising students physical activity and overall well-being.

**A STUDY ON THE STATUS OF TEACHING AND LEANING IN PHYSICAL EDUCATION CLASSES IN KOREAN MIDDLE SCHOOLS**

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The purpose of this study is to understand the current status of physical education classes in Korean middle schools. Physical activities are essential for promoting health during adolescence. Therefore, participation in various physical activities is recommended. The WHO emphasizes the balanced development of mental, social, and spiritual health alongside physical health. Since the foundation of the Republic of Korea, the national curriculum has been continuously revised at the national level. This curriculum reflects the social, economic, and cultural contexts of the time and is developed with the aim of cultivating talents who will lead future society. According to the 2015 revised physical education curriculum of the Republic of Korea, physical education classifies the characteristics of physical activities into five domains: health, challenge, competition, expression, and safety. All students are recommended to learn physical activities in a balanced manner across these five domains. However, there are problems in that the physical education programs in middle schools are planned and operated with a focus on activities preferred by physical education teachers or students. Therefore, in this study, 27 middle schools in S City were conveniently sampled, and the physical education curriculum at the school level was analyzed. As a result, the proportion of competitive activities (61.1%) (e.g., basketball, soccer, volleyball, badminton, etc.) was the highest, followed by health activities (18.8%) (e.g., physical training, etc.), challenge activities (11.3%) (e.g., track and field, swimming, archery, etc.), expressive activities (e.g., dance, etc.), and safety activities (e.g., first aid, etc.). Physical education and the curriculum at the school level should lead to the balanced physical growth of adolescents. Nevertheless, the physical education curriculum at the school level is highly focused on specific activities. In conclusion, it

should be emphasized that schools should provide balanced educational opportunities for physical activities within physical education.

**CAN ONLINE PHYSICAL EDUCATION CLASSES IMPROVE SPRINTING SKILLS?: COMPARISON OF LEARNING EFFECTIVENESS AND SATISFACTION BETWEEN ONLINE AND IN-PERSON CLASSES**

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INTRODUCTION: In the field of physical and sports education and coaching, demand for both online and face-to-face instruction is growing. A key goal of physical education is to provide exercise opportunities and enhance students' skills. Although online classes offer many advantages, it remains unclear whether they can effectively promote physical activity and improve technique. This paper examined whether online track and field practical classes focused on short-distance sprints can improve sprint form and performance. By comparing online with face-to-face classes, we also aimed to identify challenges specific to online practical instruction.

METHODS: The study was conducted in two athletic classes: one delivered face-to-face and one online. Each class comprised fifteen 90-minute lessons, with sprinting practice provided from the second to the fifth lesson. Sprint form and 20-meter sprint times were recorded at the beginning of the second lesson and again at the end of the fifth lesson. Each class had 30 participants, with 29 completing both tests. Sprint times were measured using a smartphone app (Quality, Digital Standard Inc.) that utilizes the phones accelerometer. Sprint form was recorded using a smartphone with a side-view shot at the 15-meter mark. Two support phases were extracted from the footage and converted into still images (at 1/30-second intervals). A visual analog scale assessed sprint form from four perspectives: arm, leg, torso, and limb coordination. Evaluators were experienced university track and field coaches with over 10 years of specialized coaching.

RESULTS: When comparing the 20-meter sprint times between the second and fifth lessons, a significant improvement was observed in the face-to-face classes (from 3.51 ± 0.58 s to 3.35 ± 0.44 s; $p = 0.041$), whereas no significant difference was found in the online classes (from 3.42 ± 0.51 s to 3.40 ± 0.44 s; $p = 0.567$). Conversely, the overall score on the visual analog scale evaluating sprint form improved significantly in both face-to-face and online lessons. This suggests that while online classes can enhance the appearance of movement and help students understand essential sprinting techniques, they may be less effective at improving the less tangible aspects, such as movement power. In addition, there was no significant difference in class satisfaction between the face-to-face and online formats.

CONCLUSION: The results of this study suggest that even in online classes, it is possible to provide students with a certain level of learning by devising effective instructional methods. To improve motor skills in online classes, it may be essential to present core techniques clearly and develop strategies to convey the "internal feel" of force exertion.

**THE DOWN SIDE OF KNOWLEDGE-FOCUSED EDUCATION IN PHYSICAL EDUCATION TEACHER EDUCATION, MEASURED BY QUANTITATIVE AND QUALITATIVE METHODS.**

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INTRODUCTION: In Hungary, students in teacher education programs must demonstrate their suitability for the teaching profession based on a state-defined competency system at the end of their studies. These so-called teacher competencies define the preparedness of future teachers in the areas of knowledge, skills, and attitudes. Teacher training aims to develop these competency fields, but the question arises whether Hungarian teacher training is effective and modern enough to fulfil this aim. We first conducted a research on this topic in 2019 at a Hungarian university, examining the impressions of students in physical education teacher education, regarding their studies in terms of burnout and motivation factors. In the initial study, we found that the satisfaction and cynical levels of physical education teacher students, increased as their training progressed. We repeated our measures in every academic year until 2023, transforming our work into a longitudinal study. In accordance with methodological recommendations in educational science, we supplemented our research with qualitative methods in the 2023 academic year.

METHODS: In our quantitative study, students from the undivided physical education teacher and coach training programs at the University of Pécs participated from 2019 to 2023 (2019: N=160; 2021: N=128; 2022: N=143; 2023: N=82). We used a questionnaire package composed of several validated psychological tests (MBI SS, GMS-28). Our qualitative study involved a structured interview (N=51), with questions related to satisfaction and attitudes towards teacher training.

RESULTS: Among the physical education teacher students, the correlation between cynicism and satisfaction with the training was significant over the four years of the study. The average values of cynicism related to the training showed an increasing trend, meaning that students increasingly doubted the usefulness of their studies as they approached the end of their training. The year of teaching practice marked a turning point, with these values generally changing in a more favourable direction. In our previous studies, we hypothesized that experiences and impacts during the teaching practice played a significant role in this. The results of the interviews support this hypothesis.

Discussion: A demand to immediately associate theoretical knowledge with its practical applicability is rising among the students, so in the teachers educations would be worthwhile to increase the chance for students to practice, and try out the knowledge they acquired during their academic studies. However, it should be noted that the study was conducted at only one Hungarian university, so it should not be treated as a national trend.

**EXPLORING THE USE OF A DESIGNED FUNDAMENTAL MOVEMENT EQUIPMENT STORAGE TROLLEY IN SCHOOL PHYSICAL EDUCATION**

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Background: Hong Kong's limited space presents a significant challenge for storing sports equipment. Often, equipment is stored at high levels, making it difficult to access when needed. Presetting equipment in the teaching area is not an option with no breaks between lessons. Consequently, quickly retrieving teaching equipment within a limited time is a challenge Hong Kong teachers face when teaching fundamental movements in schools.

Methods: Semi-structured face-to-face interviews were conducted with 15 teachers from three Fundamental Movement Learning Community (FMLC) schools, each with teaching experience ranging from 2 to 30 years. These schools provided a Designed Fundamental Movement Equipment Storage Trolley (DFMEST) for two weeks. All teachers used the DFMEST during the first week and did not use it in the second week.

Results: There were three key findings: Increased teaching time, All participants agreed that the use of the Designed Fundamental Movement Equipment Storage Trolley (DFMEST) helped access fundamental movement equipment when needed, thereby increasing teaching time and reducing the time required to prepare teaching equipment; Design of the Storage Trolley, The design of the DFMEST and the selection of sports equipment to be included in the trolley were crucial for its effectiveness. The use of the trolley significantly improved class and equipment management.

Discussion: This pilot study provides an overview of the needs of PE teachers and assists manufacturers in producing a Designed Fundamental Movement Equipment Trolley (DFMEST). Furthermore, the study highlights future directions and considerations for factories to produce suitable equipment storage for FMLC schools, aiming to develop an effective system for storing sports equipment.

## Physiology

**THE AUTONOMIC NERVOUS SYSTEM AT HIGH ALTITUDE: INSIGHTS FROM HRV ANALYSIS. THE HIGH ALTITUDE CAMP PROJECT**

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INTRODUCTION: Acute exposure to hypoxia (i.e. at high altitude or during intense physical exertion) triggers significant autonomic nervous system (ANS) changes, including an increased sympathetic response. Heart rate variability (HRV) reflects fluctuations in heart rate due to complex interactions between the heart, brain, and ANS. Both excessive and diminished HRV are associated with disease and impaired physiological function. This study aimed to investigate whether individuals with a stronger sympathetic response to hypoxia may be more prone to acute mountain sickness (AMS).

METHODS: 18 healthy male members of the Italian Alpine troops were investigated. HRV was assessed by the non-invasive wearable device Shimmer ECG (Shimmer Research Inc., Dublin, Republic of Ireland). Additional physiological parameters, including vital signs, altitude sickness symptoms, cardiac function, and pulmonary pressure, were monitored. Data were collected twice daily, both at rest and post-exercise, at sea level (T0) and at high altitude (Rifugio Torino, Mont Blanc, 3,375 m, T1, T2 and T3).

RESULTS: Sympathetic activity was found modified after exercise at T0 (HR: 65.1±10.9 vs. 73.9±11.4 bpm, p=0.026, CSI: 2.8±0.6 vs. 3.5±1.0, p=0.008), whereas at T1 both sympathetic and vagal features were impacted by the physical activity (HR: 71.8±8.5 vs. 94.2±10.1 bpm, p<0.001, CSI: 3.0±0.6 vs. 3.7±1.0, p=0.009, CVI: 3.3±0.3 vs. 2.8±0.5, p<0.001). At T2, no modifications were observed. Correlations with other physiological parameters were sought at high altitude, with a significantly negative relationship between an increase in the Cardiac Sympathetic Index and a decrease in Diastolic Blood Pressure (r=-0.602, p=0.008). No correlation was otherwise found with AMS. Such results suggest that, despite the individual autonomic heterogeneity, physical activity at altitude significantly impacts the ANS especially in the phases of ascent, with a somewhat direct relationship with blood pressure variations.

CONCLUSION: The autonomic response to hypoxia is complex and not yet fully understood. While hypoxia-induced sympathetic activation is well established and is a common feature of AMS and high-altitude pulmonary edema, its precise role in AMS pathogenesis remains uncertain. Further large-scale studies are needed to clarify the relationship between autonomic function, HRV alterations, and susceptibility to AMS, and to prove the usefulness of wearables for ANS quantification.

**DOES DAILY BRIEF IMMERSION IN 14°C WATER AFFECT GLUCOSE TOLERANCE AND INSULIN SENSITIVITY?**

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INTRODUCTION: Cold exposure is often considered as an exercise mimetic. While short-duration cold therapy could be an alternative and attractive strategy, particularly for people individuals who do not engage in regular exercise because of lack of motivation, injury, disability or restricted free time, its impact on metabolic health is unknown. Thus, the main pur-

pose of this study was to investigate the effects of brief, repeated cold water immersion on glucose tolerance and insulin sensitivity in young males and females.

METHODS: Twelve non-obese subjects (6 females and 6 males) completed sixteen daily sessions, each involving 10 minutes of whole-body immersion in 14°C water. Resting catecholamine concentration, glucose, and insulin release in response to a 2-hour standard 75-g oral glucose load were assessed before, 24 hours after, and 1 week after the end of the cold intervention. The areas under the curves of glucose and insulin were calculated using the trapezoidal rule during an oral glucose load test. Additionally, insulin sensitivity was assessed using the Matsuda index.

RESULTS: Repeated brief immersion in 14°C water did not affect resting epinephrine and norepinephrine concentrations. However, such cold intervention significantly increased ($p < 0.05$) the areas under the curves of glucose and insulin, and significantly decreased ($p < 0.05$) insulin sensitivity, as indicated by a lower Matsuda index. No significant time and sex interactions were observed ($p > 0.05$). After one week, the metabolic changes induced by the cold intervention returned to baseline.

CONCLUSION: Sixteen sessions of brief 10-minute whole-body immersion in 14 °C water temporarily increased insulin resistance and glucose intolerance in healthy young adults. This program cannot replace the role of exercise; regular exercise remains essential for optimal metabolic health.

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**CHANGE IN OXIDATIVE STRESS BIOMARKERS AND DNA DAMAGE FOLLOWING 12 WEEKS OF HIIT AND MICT IN BREAST CANCER SURVIVORS**

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INTRODUCTION: The beneficial health effects of physical activity on breast cancer survivors (BCS) have been shown, though the role of exercise intensity on oxidative markers is unclear. This study assesses the effect of 12 weeks of high-intensity interval training (HIIT) and moderate-intensity continuous training (MICT) on oxidative stress markers, including superoxide dismutase (SOD), glutathione peroxidase (GPX), total antioxidant capacity (TAC), malondialdehyde (MDA), and DNA damage (8-OHdG) in BCS.

METHODS: A total of 45 BCS (age=57.3±3.9 years, BMI=28.2±2.3 kg/m², fat mass=31.2±3.7 kg) were randomized into HIIT (n=15), MICT (n=15), or control (CON, n=15). HIIT and MICT groups performed exercise on a cycle ergometer three times weekly for 12 weeks. Fasting blood samples were collected pre and post-intervention.

RESULTS: Both HIIT and MICT significantly increased SOD (HIIT 94.86±7.98 vs 97.36±9.10, MICT 93.78±7.40 vs 94.87±7.77), GPX (HIIT 184.20±6.15 vs 187.33±8.27, MICT 183.75±8.63 vs 185.42±8.62), and TAC (HIIT 12.43±1.98 vs 12.70±2.02, MICT 12.56±1.64 vs 12.67±1.61). MDA (HIIT 15.17±0.69 vs 14.92±0.71, MICT 15.48±0.84 vs 15.37±0.88) and 8-OHdG (HIIT 2.36±0.52 vs 2.33±0.52, MICT 2.68±0.50 vs 2.60±0.52) decreased in both groups ($p<0.05$). HIIT improved oxidative stress markers more than CON, while MICT reduced 8-OHdG versus CON. No significant differences were observed between HIIT and MICT ($p>0.05$).

CONCLUSION: Both HIIT and MICT improved oxidative stress markers, with HIIT potentially offering body composition benefits. Further research is needed to clarify the comparative advantages of HIIT for oxidative stress in BCS.

**THE EFFECT OF THE "SMART WEIGHT LOSS" INTERVENTION ON THE RISK FACTORS OF TYPE 2 DIABETES (T2D) AMONG OVERWEIGHT WOMEN**

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INTRODUCTION: In terms of the number of deaths, the leading risk factors globally are obesity and chronic hyperglycaemia. In Hungary, 68% of the adult population is considered being overweight (OTAP, 2019) and 1.1 million diabetics are registered (KSH, 2020). According to the literature, the stimulation of the GLP-1 hormone can be achieved naturally through dietary changes (Ren et al., 2020). The aim of our study was to investigate the effectiveness of the weight loss intervention "Smart Weight Loss" in relation to the stimulation of GLP-1. We assumed that the special dietary intervention results positive change in the participants body composition and eating habits and reduces the risk of developing T2D.

METHODS: The 12-week intervention was fulfilled by 48 healthy, overweight Hungarian women aged 25- 45 years. The methods were body composition examination with an InBody device, the risk of type 2 diabetes was estimated with the FINDRISC questionnaire, nutrition was analysed with a 3-day food diary and the NutriComp Diet-CAD program. Statistical analyses were performed using TIBCO Statistica 13.40.14. All statistics tests were performed at 5% significance level.

RESULTS: At baseline, all participants (n=48) were overweight and had an increased risk of diabetes. The intervention had a significant effect on body mass index (28.0±2.5 vs 25.8±4.3 kg/m2, p=0.00), waist circumference (100.8±7.2 vs 94.7 ±8.2 cm, p=0.00), body fat (37.5±6.3 vs 34.1±5.9%, p=0.03) and visceral fat (124.0±29.2 vs 109.0±24.6 cm2 p=0.04). We experienced a significant change in both energy intake and the distribution of macronutrients, in terms of fiber consumption (p=0.00). FINDRISC values showed no significant difference.

CONCLUSION: We concluded that the risk of developing type 2 diabetes can be modified by lifestyle intervention in overweight women. We observed a significant reduction in body fat, BMI, waist circumference, visceral fat and healthy eating characteristics, which results can be achieved in a 12-week lifestyle change programme.

**COMPARING 17-B-ESTRADIOL AND PROGESTERONE CONCENTRATIONS IN YOUNG, PHYSICALLY ACTIVE FEMALES: INSIGHTS FROM PLASMA VS. SERUM ANALYSIS**

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INTRODUCTION: Serum measurements of 17-β-estradiol and progesterone are widely used to verify menstrual cycle status and confirm contraceptive use, often through commercially available immunoassay kits. However, no studies have investigated whether blood collection tube chemistries influence hormone concentrations in young females, despite assays permitting the use of different biofluids with similar reference ranges.

METHODS: In this study, venous blood was drawn from physically active females (n=25) using EDTA and serum vacutainers, and 17-β-estradiol and progesterone concentrations were measured using competitive immunoenzymatic assays.

RESULTS: Median plasma concentrations of 17-β-estradiol and progesterone were 44.2% (plasma 40.75 vs serum 28.25 pg/mL) and 78.9% (plasma 1.70 vs serum 0.95 ng/mL) higher than serum, respectively ($p<0.001$ for both). Strong positive correlations were observed between plasma and serum concentrations for 17-β-estradiol ($r=0.72$; $p<0.001$) and progesterone ($r=0.89$; $p<0.001$). The mean bias and limits of agreement for plasma vs. serum were 12.5 pg/mL (-20.6 to 45.5 pg/mL) for 17-β-estradiol and 1.01 ng/mL (-5.6 to 7.6 ng/mL) for progesterone.

CONCLUSION: Ovarian hormone levels were consistently higher in EDTA plasma compared to serum, with these matrices not yielding statistically equivalent results. Despite these differences, the strong correlations and good agreement suggest that both matrices are suitable for biomarker analysis. Researchers using EDTA plasma should account for the higher hormone concentrations when applying inclusion or exclusion criteria, as adjustments may be necessary to ensure appropriate participant classification.

**BLOOD LACTATE AND NON-INVASIVE EXERCISE THRESHOLDS METHODS COMPARISON**

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INTRODUCTION: Lactate and ventilatory thresholds have been a hot topic in exercise physiology. However, the scientific literature contains several methods for determining lactate thresholds. Previous studies compared lactate thresholds through insufficient statistical analyses. This study aimed to verify whether any of the seventeen different lactate threshold methods are valid for estimating first and second ventilatory thresholds.

METHODS: Nineteen physically active participants (teen men and nine women) (age: 23.5±3.0 years; weight: 65.9±13.3 kg; stature: 169.6±7.8 cm; %fat mass: 20.2±8.6; VO2max: 37.8±7.0 mL.kg-1.min-1) performed a graded incremental exercise test until exhaustion on a treadmill to determine first and second ventilatory thresholds and nine different methods of lactate thresholds. Lactate thresholds were then compared with ventilatory thresholds to verify possible differences (P), effect size (ES), agreement (BA), equivalence (E), and probability (BF01) to be similar or different.

RESULTS: Bsln+ 0.5 (P=0.9; ES: 0.04, -0.41 – 0.49; BA: -0.06; -0.92 – 0.79; E: P=0.87; BF01: 4.2) and OBLA 3.0 (P=0.8; ES: -0.06, -0.51 – 0.39; BA: 0.11; -0.74 – 0.96; E: P=0.79; BF01: 4.1) are valid methods to estimate first and second ventilatory thresholds, respectively. The other methods are not interchangeable with any ventilatory thresholds.

CONCLUSION: We conclude that most lactate threshold methods used here are not interchangeable with ventilatory thresholds. Coaches and physiologists can use Bsln+ 0.5 and OBLA 3.0 methods to estimate first and second ventilatory thresholds when applying the same graded protocol.

**COMPARISON OF MOVEMENT ECONOMY BETWEEN ELITE AND SUB-ELITE FOOTBALL PLAYERS**

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INTRODUCTION: Movement economy (ME) is important for evaluating the energy efficiency and optimizing the physical performance in football-specific training to support sustained competitive play.Given its importance, this study aimed to investigate differences in ME between elite and sub-elite football players across football-specific skill tests and shuttle running.

METHODS: The 18 male participants (9 elite and 9 sub-elite football players) were recruited on the basis of their competitive level and number of training sessions per week. Participants wore the COSMED K5 wearable metabolic system while performing a sequence of football-specific skill tests: 3-min juggling the ball, 3-min short passing, 3-min long passing, 3-min dribbling-and-shooting, and 20m and 10m shuttle run at 10 km/h for 5 min. The oxygen consumption (VO2, ml/mine), respiratory quotient (RQ, Kcal/L) were recorded continuously and averaged during the final minute of each test to determine ME expressed as oxygen cost (OC, ml/kg/min) and energy cost (EC, Kcal/kg/min) (calculated as EC = RQ×OC/1000). Rate of Perceived Exertion (RPE, Borg scale: 6 to 20 scale) was recorded after each test, and blood lactate levels (BLa) were measured immediately following the shuttle run and at 1, 3, and 5 minutes post-shuttle run.

RESULTS: Results showed that the elite group demonstrated lower OC and EC across all skill and run tests compared to the sub-elite group. The elite group had significantly lower OC than the sub-elite group in the dribbling-and-shooting test (51.40±7.76 vs. 60.95±10.05 ml/kg/min, $p<0.05$, ES=1.06) and the 20m shuttle run test (55.77±6.88 vs. 64.02±9.10 ml/kg/min, $p<0.05$, ES=1.02). The elite group had significantly lower EC than the sub-elite group in the juggling the ball

test (0.16±0.02 vs. 0.2±0.04 Kcal/kg/min, p<0.05, ES=1.26) and long passing test (0.18±0.04 vs. 0.22±0.04 Kcal/kg/min, p<0.05, ES=1). BLa were lower in the elite group than the sub-elite group after the 20m and 10m shuttle runs, RPE was also lower in the elite group. However, the differences between the two groups in BLa and RPE were not statistically significant (p>0.05).

CONCLUSION: Elite players exhibited higher movement economy when performing medium- to high-intensity football-specific movements and shuttle running. These findings suggest that elite-level players may have physiological adaptations allowing for greater energy efficiency during sport-specific tasks.

**EFFECTS OF SERUM MAGNESIUM CONCENTRATIONS ON ANAEROBIC PERFORMANCE IN MALE WEIGHT-CATEGORY ATHLETES**

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INTRODUCTION: Adenosine triphosphate exists in the body as a compound with magnesium, serving as the direct energy source for all body activities. Therefore, the serum magnesium status of athletes may influence anaerobic performance. Weight-category sports are defined by the requirement of a weigh-in before competition to provide performance equity and restricted the diet intake may associated with lower serum micronutrients. Our previous study recruited 180 collegiate athletes to analyze serum magnesium levels, it showed that 2nd and 3rd quartile levels were 3.1 and 4.0 mg/dL, respectively. Therefore, the aim of this study was to examine the differences in anaerobic power and the levels of magnesium, calcium, glucose, and lactate before and after anaerobic exercise in male weight-category athletes with different serum magnesium concentrations.

METHODS: Twelve male athletes with serum magnesium level below 3.1 mg/dL were recruited from taekwondo, judo, and weightlifting teams and assigned into the lower magnesium (LMg) group. An additional 12 athletes with serum magnesium level above 4.0 mg/dL and matched for the same sport and weight categories as the LMg group were also recruited into the higher magnesium (HMg) group. The average body mass index for athletes in LMg and HMg groups were 25.66 ± 2.85 and 26.73 ± 4.61 kg/m2, respectively. The mean serum magnesium concentrations in LMg and HMg groups were 2.37 ± 0.31 and 4.79 ± 0.66 mg/dL ($p < 0.05$), respectively. Participants then underwent a Wingate anaerobic test for 30 seconds to collect the values of peak power, minimum power, average power, power drop (power decline from peak to trough), and fatigue index (percentage of power decline from peak to trough). And calculated the relative values of the PD and FI. Data were analyzed by independent samples t-tests to examine the differences in anaerobic power between two groups. Statistical significance was set at $\alpha = .05$. All data are expressed as mean ± SD.

RESULTS: The absolute and relative fatigue index in LMg group were significantly higher than that in HMg group (61.52% ± 10.40% vs 54.25% ± 7.93%, and 0.82% ± 0.13% vs 0.71% ± 0.17%/kg BW, respectively; $p < 0.05$). Moreover, the relative power drop in LMg group were also significantly higher than that in HMg group (5.73 ± 1.57 vs 4.48 ± 1.11 W/kg BW, $p < 0.05$). However, there were no significant differences in the performance of peak power, minimum power, average power, and power drop between the two groups.

CONCLUSION: The result of the present study indicates that the male athletes in weight-category sports with lower serum magnesium levels would produce greater fatigue after anaerobic exercise. Therefore, these athletes should pay attention to their dietary magnesium intake, especially during periods of caloric restriction. Further studies are needed to investigate the relationship between blood magnesium concentration and anaerobic performance in female athletes in weight-category sports.

**BODY COOLING IMPROVES AEROBIC EXERCISE CAPACITY UNDER COMBINED HEAT STRESS AND MENTAL FATIGUE.**

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INTRODUCTION: The combination of mental fatigue resulting from a prolonged cognitive task and exposure to heat stress has been demonstrated to result in impaired exercise capacity in the heat. However, the efficacy of body cooling as a strategy to prevent impairment of subsequent exercise capacity when exercises are performed in combined heat and mental stress remains unclear. The purpose of this study was to investigate the effects of body cooling prior to and during exercise with mental fatigue on aerobic exercise capacity in the heat.

METHODS: Seven non-heat-acclimatized recreational male athletes (age: 22 ± 1 years, height: 174.8 ± 8.3 cm, body mass: 72.25 ± 11.2 kg, maximal oxygen uptake [VO2max]: 46.2 ± 4.6 mL/kg/min) performed three trials: thermoneutral condition (22°C, CON), hot condition (35°C, HOT), and hot condition (35°C) with cooling intervention (COOL). Participants were conducted AX-Continuous Performance Task (AX-CPT) during the 45-min 50%VO2max cycling exercise under each condition. After rest for 5 min, participants performed the cycling exercise at an intensity equivalent to 75%VO2max until reaching voluntary exhaustion. Cooling intervention was conducted before and during exercise used total ingestion of approximately 450 g ice slurry and wearing ice vest.

RESULTS: All participants had the shortest time to exhaustion for the HOT trial. Time to exhaustion was longer in the CON trial (623.1 ± 152.6 sec; Effect size (ES) = 1.48) and COOL trail (571.0 ± 197.8 sec; ES = 0.84) than in the HOT trial (441.9 ± 83.4 sec). There were small differences in time to exhaustion between the CON and COOL trials (ES = 0.29). The change in rectal temperature at the onset of exercise was observed to be lower in the COOL trial than in the CON and HOT trials ($p < 0.05$). In the CON trial, the 45-min 50%VO2max cycling exercise with AX-CPT resulted in a lower change in rectal tempera-

ture compared to the HOT and COOL trials ($p < 0.05$). Perceptual sensations at the onset of exercise were observed to be lower in the COOL trial than in the HOT trial ($p < 0.05$). Self-reported mental fatigue using visual analog scale was significantly higher after tasks in each trial ($p < 0.001$), but no significantly differences between trials (CON: 6.4 ± 1.9, HOT: 6.5 ± 1.8, COOL: 6.9 ± 1.7 $p > 0.05$).

CONCLUSION: The results of this study showed that the body cooling before and during exercise under combined heat stress and mental fatigue improved subsequent aerobic exercise capacity compared with no-cooling. This observation suggested that athletes who exercise with mental fatigue in the heat should be cooling to mitigate elevation in core temperature equivalent to hyperthermia.

**THE RESPONSE OF REACTION TIME AND FATIGABILITY TO EXHAUSTIVE EXERCISE IN YOUNG MALE**

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INTRODUCTION: Cognitive function is enhanced after a single session of moderate aerobic exercise; however, the effects of exhaustive exercise on cognitive function remain controversial. The post-exercise effect on cognitive function is associated with exercise intensity, duration, and psychological and physiological factors [1]. The present study aimed to investigate the impact of exhaustive exercise on cognitive function and the differences in psychological and physiological parameters between positive and negative responders to exercise.

METHODS: Seventeen young males performed an exhaustive incremental submaximal exercise task. Reaction time in the incongruent Stroop task, salivary cortisol and immunoglobulin A (SIgA) levels, and visual analogue scale scores for fatigue were evaluated. Participants were divided into 2 groups: slower group, which exhibited an increase in reaction time; and faster group, which exhibited a decrease in reaction time after the exercise.

RESULTS: There were no differences in changes in the salivary cortisol and SIgA level between the slower and faster groups. The slower group exhibited a greater increase in fatigue than the faster group. The increase in fatigue score was positively correlated with the changes in reaction time.

CONCLUSION: Results of this study demonstrated that the excessive increase in fatigue after exhaustive exercise delays cognitive response time. Findings suggest that the individual differences in perceived fatigability, rather than physiological responses, may be modulated to alter cognitive performance after exhaustive exercise.

**THE RELATIONSHIP BETWEEN SCLEROSTIN AND OSTEOGENIC RESPONSES IN ATHLETES: INFLUENCE OF MECHANICAL STRESS**

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INTRODUCTION: Sclerostin (SCL), which strongly inhibits bone formation, increases with reduced mechanical stress (inactivity or unloading), aging, and menopause. Some studies have reported increased bone mass and bone formation markers and decreased SCL with training. By contrast, others have reported higher SCL in athletes compared with non-athletes, or elevated SCL in rugby players (strength sports) compared to cyclists (non-impact sports), the latter being considered to have a lower bone mass. As the relationship between SCL, sports characteristics, and osteogenic responses remains unclear, this study investigated the effects of SCL on the osteogenic responses in athletes under different mechanical stresses.

METHODS: Participants were male college athletes: cyclists (CY; n = 19, age = 20.7 ± 0.7 years, height = 171.7 ± 6.3 cm, weight = 70.4 ± 6.9 kg), rugby players (RG; n = 20, age = 20.8 ± 0.8 years, height = 173.3 ± 5.1 cm, weight = 86.9 ± 11.3 kg), baseball players (BB; n = 17, age = 20.9 ± 0.8 years, height = 171.6 ± 6.1 cm, weight = 70.7 ± 8.0 kg; odd-impact sport), and volleyball players (VB; n = 12, age = 19.7 ± 0.8 years, height = 177.5 ± 7.4 cm, weight = 70.2 ± 9.6 kg; high-impact sport). Serum SCL, osteocalcin (OC), bone-specific alkaline phosphatase (BAP), tartrate-resistant acid phosphatase 5b (TRACP), free testosterone (T), and total calcium (Ca) were measured. Bone stiffness (BS) and Z-score of the dominant-side calcaneus were assessed using quantitative ultrasonography.

RESULTS: The SCL in RG was significantly higher than that in CY ($p < 0.001$). The OC in RG was also significantly higher than that in CY and BB ($p < 0.05$). The TRACP, T, and Ca levels did not change significantly. While a significant group main effect was observed in BAP, post-hoc analyses did not reveal any specific group differences. The BS and Z-scores in RG were significantly higher than those in CY ($p < 0.001$). SCL was positively correlated with OC ($p<0.001$) and TRACP ($p < 0.01$) but not with bone strength indices.

CONCLUSION: These results indicate higher bone turnover in RG, which may explain the elevated SCL levels compared to those in CY. However, an increase in SCL did not negatively affect bone strength. During active remodelling, a temporary increase in SCL may have helped balance bone metabolism. This suggests that SCL regulates adaptive bone remodelling rather than inhibit bone formation.

Our findings highlight complex interactions between SCL and mechanical stress. While mechanical loading generally promotes bone formation, sustained high-intensity stress, as seen in rugby, may increase SCL to regulate the balance between bone resorption and formation.

**MODELING OF CORE BODY TEMPERATURE DURING GRADED TREADMILL RUNNING**

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INTRODUCTION: During incremental treadmill running neuromuscular and metabolic changes, which determine the gas exchange thresholds (GET), are associated with changes of core body temperature (CBT). The main objective of this research was to investigate the relationship between GET (first and second ventilatory threshold, VT1 and VT2) and the eventual presence of nonlinear trend changes in rectal temperature (RT), defined as CBT thresholds (TT1 and TT2), measured concurrently during an incremental treadmill running test (GXT)

METHODS: Thirty-two male paricipants were subjected to an all-out GXT (0.5 km/h increments/30 sec, 1.5% incline), with measurement of RT and gas exchange parameters. Three independent evaluators evaluated the VE and RT thresholds. RT was measured with a fast-response temperature probe connected to a datalogger (Xplorer GLX, PASCO Scientific) with DataStudio software for data storage and analysis. The logger contains built-in temperature sensors with a resolution of 0.01°C. The frequency of data collection was set at 2 Hz. The temperature probe was inserted into the rectum, 8 cm from the anal opening, fastened and additionally secured with an elastic strap around the waist. After the test, temperature data were exported (Microsoft Excel) and analyzed graphically. The Quark b2 (Cosmed, IT) system was used for breath-by-breath acquisition of spiroergometry data. For all subjects, the relative running speed (as percentage of maximal running speed) was calculated for every running step. RT data for all participants were related to relative running speed averaged at 2% step increase, in order to visualize and confirm the eventual presence of rectal temperature thresholds delineating the three intensity domains (moderate, heavy and severe) during a GXT to volitional exhaustion. Three linear regressions for temperature data within the three domains were calculated with average VT1 and VT2 values as breakpoints

RESULTS: The increase of RT with increasing running speed in most of our participants followed a 3-phase model, while a two-segment model was detected in three of our participants. Overall, smoother between-phase transitions and a higher signal-to-noise ratio was noted for CBT data, than for breath-by-breath gas exchange parameters. In the moderate intensity range a slow rise, or even stagnant CBT with increasing running speed was observed. A 7-fold steeper rise in CBT was observed in the heavy compared to the moderate intensity domain. In the severe domain, the slope of the CBT rise with increasing speed almost doubled in comparison to the heavy domain

CONCLUSION: During graded treadmill running, there is close coupling between trend changes of rectal temperature and changes in gas exchange parameters that determine VT1 and VT2. The results of the study imply that measurement of core body temperature during graded treadmill running may be used as a new method for determination of thresholds demarcating the transition from aerobic to anaerobic metabolism

**NAILFOLD CAPILLARY PATTERNS IN BALLGAME AND ENDURANCE ATHLETES**

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INTRODUCTION: Nailfold capillary patterns can be observed noninvasively using light microscopy. Nailfold capillaries are straight, U-shaped, and densely looped in healthy individuals and may be altered by disease or lifestyle factors, such as diet. However, the effects of daily physical activity and exercise training on nailfold capillary patterns remain unclear. This study aimed to examine the effects of exercise training on nailfold capillary patterns by investigating these patterns in endurance athletes, ballgame athletes, and sedentary healthy men.

METHODS: Five healthy men participated in nailfold capillary pattern measurements on 3 consecutive days to test the reproducibility and bilateral differences in the nailfold capillary loop number, length, and width measured using light microscopy and a commercial analysis system. The nailfold capillaries of 10 endurance athletes (endurance group; 8 long-distance runners and 2 triathletes), 10 ballgame athletes (ballgame group; 7 soccer players and 3 basketball players), and 9 sedentary healthy men (sedentary group) were then examined using light microscopy.

RESULTS: The day-to-day coefficient of variation for the nailfold capillary loop number, length, and width were 4.9±1.6%, 7.5±1.3%, and 4.2±1.5%, respectively. No significant differences in these measurements were observed between the dominant and non-dominant hands. The number of nailfold capillary loops was greater in the ballgame group than in the endurance and sedentary groups. Capillary loop length was shorter in the ballgame group than in the endurance and sedentary groups. No significant differences in capillary loop number and length were observed between the endurance and sedentary groups. No significant intergroup differences were observed in capillary loop width.

CONCLUSION: These results suggest that the nailfold capillary patterns of male ballgame athletes differ from those of endurance athletes and sedentary healthy men. Ballgame training may affect nailfold capillary patterns in sedentary healthy men.

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**EFFECTS OF A 10-WEEK AEROBIC EXERCISE OR DIETARY AND NUTRITIONAL GUIDANCE INTERVENTION ON GLYCATION MARKERS**

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INTRODUCTION: Advanced glycation end-products (AGEs) are harmful compounds formed through reactions between proteins and sugars in the body. They are known to accelerate senescence and contribute to the pathogenesis of lifestyle-related diseases such as arteriosclerosis and diabetes mellitus. Previous studies have demonstrated that the cutaneous AGE content increases with age, unhealthy diet, and a disordered lifestyle. Poor lifestyle factors may worsen and accelerate AGE accumulation. This study aimed to experimentally investigate whether aerobic exercise or dietary and nutritional intervention could influence skin AGEs and other glycation markers in young women without regular exercise habits.

METHODS: Our study participants were 20 healthy young women without chronic disease or regular exercise habits. They were randomly divided into two groups: an exercise group (Ex group, n = 10) and a dietary intervention group (Nu group, n = 10). In the Ex group, participants engaged in 30-min cycling sessions on an ergometer twice a week for 10 weeks. Exercise intensity was determined based on the heart rate targets calculated from the maximum oxygen consumption ($VO_2$max). In the Nu group, participants recorded their daily meals using a diet management app and received weekly feedback. Skin AGE levels were measured on the dominant forearm using an AGE Scanner (Diagnoptics). Blood glucose levels, blood HbA1c titers, and body composition (e.g., body fat percentage) were also measured. Measurements were taken at weeks 0 (baseline), 5, 10, and 25.

Participants in the Ex group had the following features: Age, 19.7 ± 1.7 years; $VO_2$max, 36.4 ± 5.2 ml/min/kg. In the Nu group, participants had the following characteristics: Age, 20.1 ± 1.2 years; $VO_2$max, 26.4 ± 2.5 ml/min/kg.

RESULTS: In the Ex group, the percentage change in cutaneous AGE levels decreased significantly at weeks 5 ($p = 0.045$) and 25 ($p = 0.039$) compared to week 0. HbA1c levels also decreased significantly at weeks 10 ($p = 0.032$) and 25 ($p = 0.021$) compared to week 0. In the Nu group, no significant changes in cutaneous AGE levels were observed at any measurement point. Statistical analyses included the repeated measures ANOVA and independent t-tests, with the threshold for statistical significance set at $p < 0.05$.

CONCLUSION: HbA1c reflects the average blood glucose levels over the past 1–2 months, whereas skin AGEs indicate a longer-term glycation state. In the Ex group, a notable improvement in glycation marker levels was observed after week 10, suggesting that aerobic exercise effectively reduces glycation stress. In contrast, the Nu group showed minimal changes, indicating that short-term dietary management alone may not be sufficient to affect glycation marker levels significantly. Both interventions may require longer-term implementation to achieve significant and sustained results.

**RELATIONSHIP BETWEEN SWEAT LACTATE AND HEART RATE DURING SWIMMING TRAINING**

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INTRODUCTION: Sweat lactate measurement has been proposed as a non-invasive method to monitor exercise intensity and fatigue. While previous studies have validated its use in flume swimming, direct assessment in a standard swimming pool remains limited. The aim of this study was to investigate the relationship between sweat lactate and heart rate (HR) during swimming exercise in a conventional swimming pool and to explore its potential as an indicator of exercise load.

METHODS: Competitive swimmers swam at three different intensities (low, moderate, and high). A portable sweat lactate sensor and a waterproof heart rate monitor were used for real-time data collection. The correlation between sweat lactate and HR was analyzed to investigate their association across exercise intensities.

RESULTS: Sweat lactate and HR increased proportionally with exercise intensity. This suggests that sweat lactate may reflect physiological responses to exercise intensity in a similar manner to HR.

CONCLUSION: The results indicate that sweat lactate measurement in a standard swimming pool is feasible and shows a significant relationship with HR. Due to its non-invasive nature, sweat lactate monitoring may serve as an additional tool to assess training load in swimmers. Further research is needed to refine the accuracy of the measurement and to explore its application in long-term exercise monitoring.

**MENSTRUAL CYCLE IN FEMALE MOUNTAIN RUNNERS. INTERACTIVE GUIDE. A DELPHI SURVEY-BASED DEVELOPMENT AND VALIDATION.**

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INTRODUCTION: Fluctuations in blood concentrations of endogenous sex hormones during the menstrual cycle (MC) affect body systems, such as the cardiovascular, muscular and nervous systems, and are associated with several symptoms. MC fluctuations can impact on exercise and training adaptations; but women often have limited knowledge of their MC and its influence on sports performance.

Trail running is one of the most popular sports in Catalonia (Spain), where women's participation has recently increased to about 24,7% of the participants. MC psychobiological fluctuations may be a barrier to women's participation in trail running, and the demanding training load can increase the prevalence of MC disorders. Therefore, it would be beneficial to

have good quality educational tools to empower female runners and improve their knowledge of MC and its relationship to trail running.

The purpose of the study was 1) to create an educational booklet entitled "Menstrual Cycle in female mountain runners. Interactive Guide" to empower female runners and 2) to assess and improve its adequacy and legibility using the Delphy methodology.

METHODS: A 9-phase Delphi methodology was used. The first booklet version had 70 pages, distributed in 5 sections: 1) Women and trail running events, 2) Female reproductive system, 3) The menstrual cycle, 4) Menstrual Cycle disorders and 5) Menstrual Cycle and sport performance.

The evaluation committee (20 female and 5 males) comprises different health, sport, research, documentation and gender professionals, who scored the booklet using the Suitability Assessment of Materials (SAM) on two occasions (Original and revised versions).

RESULTS: SAM score of the booklet was over 70% (which was "superior" according to SAM results interpretation). Categories related to typography and design, motivation for learning and cultural adequacy had a superior punctuation, while other SAM categories, such as educational level required, had a lower and more scatter punctuation in the first booklet's version. Considering its lower punctuation, some categories were revised and improved before the second SAM round.

CONCLUSION: The main reason for the lower punctuation of "educational level required" category was because of the difficulty people with low educational level may have understanding the document.

The use of an expert panel to validate educational tools allows the identification of weaknesses and the improvement of the material before it is used.

In terms of knowledge transfer, the use of appropriate materials for end users can have a positive impact on the effectiveness of the interventions in which these materials are used.

**EFFECTS OF PHYSICAL EXERCISE AND EICOSAPENTAENOIC ACID INTAKE ON BLOOD COMPONENTS AND VASCULAR ENDOTHELIAL FUNCTION IN A HYPERBARIC OXYGEN ENVIRONMENT**

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INTRODUCTION: Astronauts undergo physical adaptation training in a hyperbaric oxygen (HBO) or underwater environment. HBO has been reported to be effective in treating decompression sickness and improving athletic performance by increasing the partial pressure of oxygen in the body, blood volume, and dissolved oxygen levels. In addition, eicosapentaenoic acid (EPA) has been shown to reduce muscle inflammation after exercise and improve vascular endothelial function. However, most previous studies on EPA intake and vascular endothelial function have targeted subjects with specific diseases, and there are only a limited number of studies on healthy young adults. The aim of this study was to clarify the effects of physical exercise and EPA intake in a HBO environment on blood components and vascular endothelial function.

METHODS: This study was a randomised crossover trial. The subjects (n=16) were divided into two groups (HBO group: n=8, C group: n=8), and during the first, middle and final stages of the experiment, they underwent medical examinations including blood sampling, and had their morphology, body composition and vascular endothelial function measured. The HBO environment was 1.41±0.008 ATA, 21.7±0.7°C, 73.5±4.6%, and the normal environment was 1.00±0.998 ATA, 22.1±1.1°C, and 70.5±6.5%. Exercise was performed twice a week for 8 weeks, for 60 minutes each time, at 60-70% of $VO_2$peak. The number of revolutions of the bicycle ergometer was set at 50-60 rpm. After a 4-week washout period, each group continued the same exercise in the other environment. EPA was taken as a supplement at a dose of approximately 2 g/day for 8 weeks. Repeated measures two-way analysis of variance was used for statistical analysis, and the significance level was set at less than 5%. This study was conducted with the approval of the Kyushu Sangyo University Ethics Review Committee (2023-0006) and was supported by a Grant-in-Aid for Scientific Research from the Japan Society for the Promotion of Science (23K01975).

RESULTS: There was an interaction between the environment (HBO vs. C environment) and time (before and after the experiment) for red blood cell count, haematocrit value, HDL cholesterol value, and BFA, an interaction between environment (HBO vs. C) and time (before and after the experiment) was observed (red blood cell count: $F=7.16$, $p=0.012$, $\eta^2=0.19$, haematocrit: $F=6.12$, $p=0.019$, $\eta^2=0.17$, HDL cholesterol: $F=5.35$, $p=0.028$ , $\eta^2=0.15$, BFA: $F=7.16$, $p=0.012$, $\eta^2=0.19$). However, there were no significant changes in red blood cell count, hematocrit, or HDL cholesterol levels in the HBO environment ($p>0.05$), and Brachial Flow Acceleration increased slightly in the normal environment, but not significantly ($p>0.05$).

CONCLUSION: Physical exercise and EPA intake in an HBO environment may improve blood flow and reduce blood viscosity, but there is a suggestion that in the long term they may cause a decrease in oxygen transport capacity and an increased risk of anaemia.

**EFFECTS OF ISCHEMIC PRECONDITIONING ON ARTERIAL STIFFNESS WITH AND WITHOUT MENTAL STRESS**

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INTRODUCTION: Acute mental stress (MS) induces autonomic imbalance and increases arterial stiffness [1]. Conversely, ischemic preconditioning (IPC) restores autonomic balance [2]. We hypothesized that IPC would attenuate the MS-induced increase in arterial stiffness.

METHODS: Nineteen healthy young (21 years) adults (female = 9) completed this factorial (IPC and MS) cross-over trial. The conditions consisted of 15 min quite rest, IPC, MS, then 45 min quiet, supine rest. IPC consisted of four cycles of 5 min alternating unilateral thigh cuff inflation to 220 mmHg (IPC-true) or 20 mmHg (IPC-sham). MS factor consisted of a 5-min supine rest with (MS-true) or without (MS-sham) MS. The four experimental conditions were: (i) IPC-sham/MS-sham; (ii) IPC-sham/MS-true; (iii) IPC-true/MS-sham; and (iv) IPC-true/MS-true. Outcomes were recorded prior to the IPC and MS (baseline), then at 5, 15, 30, and 45 min during the supine rest. Outcomes were brachial-ankle pulse wave velocity (baPWV), arterial stiffness index (ASI) and heart rate variability (HRV). ASI was recorded on the legs (leg-ASI, local to IPC) and arms (arm-ASI, remote to IPC). Data are reported as mean (standard deviation [SD]).

RESULTS: A significant main effect of trials was observed for baPWV (P=0.01) without no time course and interaction effects (both P>0.05). Overall average value of baPWV was higher (worse) in the IPC-sham/MS-true trial (10.9 [1.2] m/s) than those in the IPC-true/MS-sham (10.7 [1.1] m/s, P=0.02), in the IPC-sham/MS-sham (10.7 [1.1] m/s, P=0.07), and in the IPC-true/MS-true trials (10.7 [1.2] m/s, P=0.06). There was a significant interaction effect (time course×four experimental conditions) for both leg- and arm-ASI (both P<0.05). The overall average value of leg-ASI in the IPC-sham/MS-true trial (124 [22] arbitrary unit [a.u.]) was higher than those in the IPC-sham/MS-sham (119 [20] a.u.), IPC-true/MS-sham (117 [21] a.u.), and IPC-true/MS-true (119 [20] a.u.]) trials (all P<0.01). The overall average value of arm-ASI in the IPC-sham/MS-true trial (39.4 [8.5] a.u.) was higher than those in the IPC-sham/MS-sham (38.3 [9.6] a.u.) and IPC-true/MS-sham trials (38.2 [9.2] a.u.], both P<0.05), but comparable to IPC-true/MS-true trial (38.7 [10.2] a.u.], P=0.42). Contrary to our hypothesis, there were no interaction, time course or condition effects for HRV (P>0.05).

CONCLUSION: IPC could not restore MS-induced arm arterial dysfunction, but restored MS-induced leg arterial dysfunction, indicating a protective effect of IPC on local vasculature. While MS did not influence HRV, suggesting that the MS was not notably stressful to healthy young adults, the MS did increase (worsen) each of the arterial stiffness outcomes. Further research is warranted to test the effects of alternative and additive stressors.

References

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**THE EFFECTS OF APPETITES, MAJOR NUTRIENTS AND DIETARY CHOICES OF LOW- ALTITUDES HIKING IN TYPE 2 DIABETES**

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INTRODUCTION: Type 2 Diabetes mellitus patient engaged in hiking activities may have different considerations for dietary needs and choices due to disease factors, hiking intensity and physical factors related to altitudes. The present study investigated the differences in calorie and macronutrient intake, as well as food choices, between hiking days and regular days in individuals with type 2 diabetes.

METHODS: We recruited fifteen Type 2 diabetes to participant study. Food photography was used to record dietary intake for a total of six days, including two days of regular food intake, one day of holiday food intake, one day before a hike, the day of the hike, and the day after the hike. Appetite questionnaires, food choice records, subjects descriptions of dietary selection considerations, and ratings of perceived exertion were also collected. A dependent samples t-test was used to analyze the differences in calorie and nutrient intake between hiking days and regular diet days. One-way repeated measures analysis was used to examine appetite and food choices at different time points: regular diet days, the day before the hike, the day of the hike, and the day after the hike.

RESULTS: There were no significant differences in total calorie, carbohydrate, protein, and fat intake between regular days and hiking days. Total calorie intake on the day after the hike was significantly higher than on the day of the hike (2309.2 ± 622.87 kcal vs. 1940.4 ± 544.60 kcal). Hunger and perceived capacity to eat were significantly lower when subjects felt tired and breathless during the hike compared to before the hike (Hunger: 1.3 ± 1.11 vs. 5.3 ± 2.66, p=0.000; perceived capacity to eat: 1.7 ± 1.11 vs. 5.6 ± 2.16, p=0.000). The most important factor influencing food choices during hikes was ease of consumption (85.7%), followed by ease of digestion (57.1%), high protein content (35.7%), and high calorie content (21.4%).

CONCLUSION: The prestnt study indicated that total calorie, carbohydrate, protein, and fat intake did not significantly differ between usual daily and hiking days. Convenience, ease of digestion, high protein content, and high calorie content were important factors influencing food choices on hiking days.

**NEUROMUSCULAR PERSPECTIVES ON MENINGITIS SEQUELAE: INSIGHTS FROM A CASE STUDY.**

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INTRODUCTION: Bacterial meningitis is a life-threatening condition characterized by inflammation of the meninges surrounding the brain and spinal cord. Severe cases may result in sepsis and death. Survivors often face neurological sequelae and motor impairments. However, research on neuromuscular function and fatigue remains lacking. This case study provides a preliminary insight into neuromuscular function and fatigue in a survivor of severe bacterial meningitis (AL) compared with an age-matched healthy control (Ctrl).

METHODS: Maximal voluntary contraction (MVC), voluntary activation (VMA%, central component), and potentiated twitch force (Qtw.pot, peripheral component) were assessed using the interpolated twitch (IT) technique in the lower limbs of AL (37 years, male, 10 years after 5-month hospitalization, lower legs-amputated, fingers amputation, well trained ) and Ctrl (35 years, male, well trained). Torque for MVC and Qtw.pot was calculated and normalized to the limb cross-sectional area. MVC+IT measurements were taken at rest and within 30 seconds after a fatiguing task, which consisted of a time-to-exhaustion (TTE) cycling task performed at 80% of maximal exercise capacity (VO2max), to assess strength neuromuscular component and fatigue.

RESULTS: At rest, MVC was 2.6N for AL and 3.7N for Ctrl, while Qtw.pot was 0.6N and 1.1N, respectively. VMA% was 68.5% for AL and 93.9% for Ctrl. Post-TTE, ΔMVC was -10.9% for AL and -33.1% for Ctrl, Qtw.pot was -23.9% for AL and -29.6% for Ctrl, and ΔVMA% was +14.0% for AL and -14.4% for Ctrl.

CONCLUSION: Although MVC, peripheral, and central components are reduced in AL compared to Ctrl, the fatiguing task elicited different responses. Unlike Ctrl, AL exhibited only a minor decrease in MVC and Qtw.pot, alongside an increase in VMA%. Despite both subjects being well-trained and experienced in mountain sports, AL appeared less fatigable than the healthy controls.

**UNRAVELING THE ROLE OF GUT MICROBIOTA IN LACTATE METABOLISM AND ENDURANCE PERFORMANCE OF ELITE MARATHON RUNNERS**

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INTRODUCTION: Lactate, once viewed as a mere metabolic byproduct linked to muscle fatigue, is acknowledged as a crucial energy substrate. Certain gut microorganisms can metabolize lactate into short-chain fatty acids (SCFAs), potentially influencing endurance performance. Given the individual differences in lactate metabolism and gut microbiota composition, this study aims to investigate lactate changes after a 10-kilometer run and classify participants based on lactate metabolism efficiency, and examines the relationship between gut microbiota composition, lactate metabolism, and endurance performance.

METHODS: This study recruited 46 male marathon runners (ages 20-55 years) who met specific performance criteria and trained regularly. Participants completed a 10-kilometer run under standardized conditions, with blood samples collected pre-exercise, immediately post-exercise, and 60 minutes post-exercise to measure lactate levels. Lactate clearance rate was calculated as: Lactate clearance rate (%) = [(Lactate_post-exercise - Lactate_60min) / Lactate_post-exercise] × 100. Participants were classified into a high lactate metabolism group (HL, top 20%) and a low lactate metabolism group (LL, bottom 20%) based on a lactate clearance rate threshold of 67%. Running performance, body composition, food frequency questionnaire (FFQ), and gut microbiota composition (via 16S rRNA sequencing) were analyzed. Statistical analyses included independent t-tests, Welch's t-test, and repeated-measures ANOVA ($p < 0.05$).

RESULTS: Post-exercise lactate concentration was significantly higher in the HL group than in the LL group ($p<0.05$), while pre-exercise levels showed no significant difference ($p > 0.05$). At 60 minutes post-exercise, the HL group exhibited a significantly higher lactate clearance rate ($p < 0.05$). However, no significant difference was found in 10-kilometer running performance between the two groups ($p>0.05$). FFQ did not differ between the two groups ($p > 0.05$). Gut microbiota analysis identified a significantly greater abundance of Prevotella copri in the HL group ($p< 0.05$).

CONCLUSION: This study confirms inter-individual differences in lactate metabolism, with the HL group displaying superior lactate clearance efficiency. However, despite this physiological advantage, no significant difference in endurance performance was observed. Since FFQ did not differ between the two groups, the higher abundance of Prevotella copri in the HL group suggests a potential role in enhancing lactate metabolism and energy efficiency, possibly through carbohydrate fermentation and metabolic regulation. These findings emphasize the critical role of gut microbiota in endurance adaptation and underscore the necessity for further research to elucidate the precise mechanisms through which gut microorganisms regulate lactate metabolism and influence athletic performance.

**REPETITIONS TO FAILURE ARE NOT AFFECTED BY ISCHEMIC PRECONDITIONING BUT ARE DIRECTLY ASSOCIATED WITH MUSCLE STRENGTH**

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INTRODUCTION: Ischemic preconditioning (IPC) may serve as an ergogenic aid in sport and health. There is, however, less known regarding potential pressure-specific effects and/or the influence of muscle size and strength on exercise performance following IPC. The purpose of this investigation was to examine the acute effects of various IPC pressures on repetitions to failure (RTF) and if muscle size and/or strength are associated with RTF.

METHODS: Twenty-one males (21.4 ± 2.2 years; 177.4 ± 8.6 cm; 80.6 ± 12.5 kg) visited the laboratory on four separate visits. The first visit consisted of baseline measurements of muscle size (cross-sectional area [CSA]) and strength (one-repetition maximum [1RM]) of the dominant leg. The next three visits consisted of IPC randomly implemented at low (SHAM [20 mmHg]), moderate (80% of total arterial occlusion pressure [TAOP]), and high (220 mmHg) pressures. A total of three cycles, consisting of pressure applied for five minutes followed by five minutes of rest, was completed with a pneumatic cuff placed most proximally on the dominant leg. Following IPC, participants completed one-set of unilateral, isotonic leg extension muscle actions to volitional failure at 30% of their 1RM. A one-way ANOVA was performed to determine mean

differences in RTF while separate stepwise linear regressions were performed to determine the associations of CSA and 1RM on RTF for each IPC pressure.

RESULTS: There was no significant main effect for Pressure (p = 0.059) on RTF. The stepwise linear regression indicated that 1RM was a significant (p < 0.001) predictor for RTF in the low (r = 0.68; R2 = 0.46), moderate (r = 0.71; R2 = 0.51), and high conditions (r = 0.69; R2 = 0.48), while the addition of CSA did not significantly (p = 0.879 to 0.972; R2 change = 0.00 to 0.024) improve the model.

CONCLUSION: There was no ergogenic effect of IPC on RTF. Instead, RTF was positively related to muscle strength which explained approximately 50% of the variance in RTF. Thus, improving fatigue resistance may be accomplished through resistance exercise.

**EFFECTS OF HIGH AND COMFORTABLE TEMPERATURE ENVIRONMENTS ON COUNTERMOVEMENT JUMP PERFORMANCE**

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INTRODUCTION: Athletes may experience different fatigue responses when training under varying environmental temperatures. This study examines the effects of training under high-temperature conditions (average ~35°C) and comfortable-temperature conditions (average ~22°C) on lower-body explosive performance, as assessed by countermovement jump (CMJ) performance, following identical training loads (RPE 6-8).

METHODS: Thirteen participants, all university rugby players with regular training habits, were recruited for this study. The participants had an average height of 174.27±3.25 cm and body weight of 71.86±7.99 kg. Each participant completed one week of training under each environmental condition, with daily training sessions lasting approximately two hours and maintaining consistent training loads. CMJ tests were conducted before each training session, recording jump height (cm) as an indicator of fatigue. Data analysis compared the trends in CMJ performance across different temperature conditions to evaluate the impact of environmental temperature on post-exercise fatigue. Paired-sample t-tests were conducted, with statistical significance set at .05.

RESULTS: Preliminary data showed a significant decrease in CMJ performance under high-temperature conditions (average decrease of 2.5±1.2 cm, p < .05), whereas CMJ values remained more stable in the comfortable-temperature environment (change of 0.5±0.8 cm, p = .12), with some participants even maintaining or improving their performance. Additionally, greater variability in CMJ scores was observed in the high-temperature condition, possibly related to individual heat tolerance and hydration status.

CONCLUSION: The results indicate that high-temperature environments may exacerbate fatigue accumulation and negatively impact lower-body explosive performance, even when training loads are consistent. These findings have practical implications for sports training and competition planning, suggesting that enhanced recovery strategies and fatigue monitoring should be implemented to mitigate performance declines in high-temperature conditions.

**EFFECTS OF TART CHERRY JUICE ON EXERCISE PERFORMANCE AND NEUROMUSCULAR FUNCTION IN REPEATED BOUTS OF EXERCISE**

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INTRODUCTION: Nutritional strategies play an important role in recovery between games for athletes who play multiple games in a day. Anthocyanin-rich tart cherries enhance endurance performance through Nrf2 upregulation [1]. It has been reported that Nrf2 signaling is related to anaerobic capacity [2]. Therefore, it is expected that anthocyanin-rich tart cherries inhibit the decline in aerobic and anaerobic function induced by exercise. The purpose of this study is to investigate whether a 7-day supplementation of tart cherry juice attenuates declines in endurance and anaerobic performance and neuromuscular function in repeated cycling exercise.

METHODS: Fifteen men who habitually performed aerobic exercise (age 21±1 years; BMI 20.7±2.0 kg/m2) participated in the study. In this randomized double-blind crossover trial, the subjects consumed 200 g of tart cherry juice (TC) or placebo (cherry-flavored maltodextrin solution, PL) twice a day for 7 days. On the test day, the subjects consumed 200 g of beverage and completed 2 sets of time trials (equivalent to 30 minutes of cycling at 70% peak power output) followed by the Wingate test with a 100-min interval (Ex1 and Ex2). Maximal voluntary contraction (MVC) force and force steadiness in knee extension and index finger abduction, along with blood lactate and glucose levels, were measured at baseline, post Ex1 and post Ex2. The parameters of the time trial and Wingate test were compared between conditions at Ex1 and Ex2 using paired t-tests. A two-way repeated-measure ANOVA with Bonferroni post hoc test was used to examine the main and interaction effects on MVC, force steadiness, lactate and glucose levels.

RESULTS: The time trial completion time was significantly shorter in TC (1449±174 s) than PL (1566±244 s) in Ex2 (p=0.04, d=0.64), while there was no significant difference between TC (1431±150 s) and PL (1418±180 s) in Ex1. The fatigue index in the Wingate test was significantly lower in TC (29.6±13.0 %) than PL (34.2±12.5 %) in Ex1 (p=0.02, d=0.75), but not in Ex2. MVC and force steadiness in the isometric knee extension showed a significant main effect of time (p<0.01), while showing neither significant interaction nor main effect of condition. In the isometric abduction task of the index finger, MVC showed neither significant interactions nor main effects. Force steadiness in the isometric abduction task of the index finger showed a significant main effect of time (p<0.01), while showing neither significant interaction nor main effect of condition.

CONCLUSION: Anthocyanin-rich tart cherry juice supplementation attenuated the decline in endurance and anaerobic exercise performance in repeated cycling exercise, but had no effect on neuromuscular function. Further research is needed to clarify the underlying physiological mechanisms of attenuating fatigue by tart cherry.

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**EFFECTS OF MENSTRUAL CYCLE PHASES ON METABOLIC RESPONSES DURING INTERVAL TRAINING**

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INTRODUCTION: Understanding how the menstrual cycle affects exercise metabolism is vital for optimizing training and nutrition in female athletes. While prior studies have characterized the metabolism and respiratory exchange ratio (RER) during steady-state exercise (e.g., Hackney et al., 2022; Ortega-Santos et al., 2018), research on interval training is limited, leaving questions about how hormonal variations modulate metabolic responses during high-intensity interval training (HIIT).

METHODS: We examined whether RER varies during HIIT across menstrual phases. Eleven moderately active, naturally cycling women (age: 27.2 ± 3.1 years; BMI: 22.2 ± 2.20 kg/m²) completed HIIT sessions on a bicycle ergometer during the early follicular (EFP), late follicular (LFP), and mid-luteal phases (MLP). Each session comprised four 3-minute intervals at 95% of the second ventilatory threshold (VT2), interspersed with 3-minute recovery at 70% VT2. RER was measured continuously via spiroergometry.

RESULTS: Multilevel analysis revealed that in the MLP the RER was 1.024 during the first interval ($t(230)=116.01$, $p<.001$) and decreased by 0.011 per interval ($t(230)=-5.77$, $p=.009$). Notably, RER during the EFP was 0.021 lower than in the MLP ($t(230)=-2.61$, $p=.010$), whereas the LFP's RER was 0.003 higher—a non-significant difference ($t(230)=0.28$, $p=.779$). Pairwise comparisons between EFP and LFP showed an estimated 0.025 difference ($t(230)=1.62$, $p=.239$).

CONCLUSION: These findings indicate that metabolic responses during HIIT may vary across the menstrual cycle, with a significantly lower RER during the EFP compared to the MLP - possibly reflecting a shift toward fat oxidation due to lower resting glycogen levels (Isacco & Boisseau, 2023). However, although the difference in RER between EFP and MLP is statistically significant, it is relatively small, and the practical implications of this shift should be considered alongside other factors (nutrition, training status, exercise duration, and intensity).

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**ACTIVATION OF AMPK BY HIGH-INTENSITY INTERMITTENT EXERCISE DOES NOT INTERFERE WITH MTOR SIGNALING INDUCED BY MECHANICAL OVERLOAD IN MICE**

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INTRODUCTION: Concurrent training (CT) is a training regimen that combines different exercise modalities. When endurance exercise (EE) and resistance exercise (RE) are combined, EE is known to attenuate muscle hypertrophy induced by RE, a phenomenon called the "interference effect". This effect is primarily attributed to EE-induced activation of AMPK, which suppresses the activation of mTOR signaling pathway responsible for muscle hypertrophy (Coffey & Hawley, 2017). Our previous experiment revealed that 4 weeks of CT combining mechanical overload with high-intensity intermittent exercise (HIIE) did not suppress hypertrophic adaptation in mice. However, the acute molecular signaling response, which is critical for understanding the interference effect, remains insufficiently explored. Therefore, we focused on the influence of HIIE-induced AMPK activation on mTOR signaling in acute state.

METHODS: 8-week-old male C57BL/6J mice were divided into 3 groups: the sham group (sham operation), the myotenectomy-induced functional overload group (OL), and the OL+HIIE group (OL combined with HIIE) (n=8 per group). HIIE consisted of 10 sets of 20-second forced swimming with a 10-second rest interval, using a tail-attached weight equivalent to 8% of body weight. Sampling of plantaris muscle was performed 3 hours after myotenectomy surgery, and the OL+HIIE group underwent HIIE immediately before sampling.

RESULTS: Phosphorylation level of AMPK was significantly higher in the OL+HIIE group than those in the sham and OL groups. The phosphorylation levels of rpS6, a downstream protein of the mTOR signaling pathway, were significantly higher in both the OL and OL+HIIE groups compared with that in the sham group, with no significant difference between those in the OL and OL+HIIE groups. ERK1/2 phosphorylation levels were higher in OL and OL+HIIE groups than that in the sham group, and OL+HIIE group showed greater increase compared with OL group. These results suggest that HIIE-induced AMPK activation does not interfere with protein synthesis induced by mTOR signaling.

CONCLUSION: In previous study concerning CT combined with RE and HIIE, RE induced phosphorylation of p70S6K is not interfered with subsequent HIIE induced AMPK activation. (Apró et al., 2015). Also in chronic training, HIIE does not interfere with RT-induced myofibrillar protein synthesis (Lee et al., 2024). These pieces of evidence suggest that the combination of HIIT on hypertrophied muscles does not cause an interference effect.

In conclusion, HIIE-induced AMPK activation does not suppress the activation of downstream proteins in the mTOR signaling.

**THE EFFECTS OF A PRE-EXERCISE SUPPLEMENT ON ATP STATUS AND ENDURANCE PERFORMANCE.**

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INTRODUCTION: ATP is the sole substrate for skeletal muscle contraction and must be continually resynthesised to prevent fatigue. Increasing muscle ATP concentration theoretically improves exercise performance, but ingested ATP is not bioavailable. A supplement containing plant-derived, water-soluble trace elements and apple polyphenols previously increased blood ATP concentration by 40% (Reyes-Izquierdo et al. Aging Res Clin Practice. 2013;2:178–84), perhaps by increasing endogenous synthesis. To further explore the role of ATP availability in fatigue, we hypothesised that this supplement would increase plasma and muscle ATP concentrations and muscle ATP turnover (reflected by changes in associated metabolites) at rest and following a specific glycogen depleting endurance exercise, and improve subsequent endurance exercise performance.

METHODS: Ten recreationally-active participants (1 female; age 26±2y; V̇O2max 48±2mL/kg/min) took part in this randomised, placebo-controlled, crossover study. After exercise familiarisation, participants visited the laboratory in the fasted state and consumed the test material (TML) or cellulose placebo (PLA). After 2 h rest, participants cycled to exhaustion at 75% V̇O2max, followed by a 15-min work output performance test. Skeletal muscle biopsies were obtained prior to consuming the supplement, prior to starting exercise, and immediately at the onset of exhaustion. Venous blood samples were collected throughout. The reverse condition was conducted after 1 week. All time course data were analysed by 2-way ANOVA (time and supplement factors). Performance data were analysed by paired T-test. This study was approved by the institutional ethics board (ID: 516252) and registered on ClinicalTrials.gov (NCT05641454).

RESULTS: Resting whole blood ATP concentration was 471±37 and 489±26 μM in PLA and TML trials prior to supplement ingestion, and was unchanged by TML. Resting muscle ATP content was 24.2±2.0 and 22.8±1.2 mmol/kg dry muscle (DM) in PLA and TML trials, and was unchanged by TML. Muscle ADP, creatine and phosphocreatine content was unchanged by TML. At exhaustion, total work (PLA: 16.5±1.6; TML: 15.3±1.0 kJ/kg) and time to exhaustion (PLA: 105.1±7.4; TML: 98.0±4.4 min) was unaffected by TML. Muscle glycogen decreased from pre-exercise (by 165±40 and 216±29 mmol/kg DM, PLA and TML respectively; $P<0.001$), with no effect of TML. Circulating ATP and ADP concentration, and muscle ATP, ADP, creatine and phosphocreatine content were unaffected by TML. During the performance test, TML had no effect on work done (PLA: 1.8±0.1; TML: 1.9±0.1 kJ/kg).

CONCLUSION: Under these experimental conditions, we show that TML did not affect circulating or skeletal muscle ATP concentrations (nor related metabolites) at rest or following endurance exercise, nor endurance performance in the glycogen depleted state. Other strategies may be required to observe increased skeletal muscle ATP concentration and to investigate the effects on exercise metabolism and fatigue.

**EFFECTS DIETARY FAT ON SKELETAL MUSCLE HYPERTROPHY AFTER FUNCTIONAL OVERLOADING IN ADULT, MATURE AND OLD C57BL/6J MICE**

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INTRODUCTION: The aim of the study was to investigate effects of dietary fat on glucose tolerance (GT), body mass, muscle mass and extent of skeletal muscle hypertrophy after functional overloading (FO) of plantaris muscle in adult, mature and old C57BL/6J mice.

METHODS: Male mice of C57BL/6J strain were studied at 6 months (adult), 19 months (mature) and 27 months (old) of age after 12-week exposure to regular chow diet (RD, 13.4 kcal% fat, 66.8 kcal% carbohydrate, 29.8 kcal% protein), high fat diet (HFD, 60 kcal% fat, 20 kcal% carbohydrates, 20 kcal% protein) and ketogenic diet (KD, 80 kcal% fat, <1 kcal% carbohydrates, 20 kcal% protein). After 6 weeks of feeding, FO of plantaris muscle (PL) was induced by denervation of gastrocnemius (GAS) and soleus (SOL) muscles in one of the hindlimbs while another hindlimb served as a control (n=8-10 per group). Body mass, glucose tolerance (GT), muscle mass of PL, GAS and SOL muscles as well as plantaris muscle IGF1 levels were assessed six weeks after FO.

RESULTS: Body mass depended on the diet ($p < 0.05$). HFD induced a greater ($p < 0.05$) increase in body mass compared to RD and KD in adult mice, also HFD caused a greater ($p < 0.05$) increase in body mass compared to RD in mature and old mice. GT depended on the diet ($p < 0.001$). HFD and KD induced greater ($p < 0.01$) impairments in GT compared to RD. GT improved with age ($p < 0.001$). FO induced hypertrophy of PL decreased ($p < 0.001$) with age and did not depend on the diet ($p = 0.897$). PL IGF1 levels were greater ($P < 0.001$) in the overloaded compared to control muscles, PL IGF1 levels decreased ($p < 0.05$) with age. Control muscles showed reduced ($p < 0.05$) IGF1 levels when fed HFD and KD compared to RD.

CONCLUSION: Extent of compensatory muscle hypertrophy after FO does not depend on dietary fat content, but decreases with age in C57BL/6J mice

**EFFECTS OF 8-WEEK ASHWAGANDHA SUPPLEMENTATION ON THE EXERCISE ADAPTATIONS TO HIGH-INTENSITY INTERVAL TRAINING IN YOUNG HEALTHY MEN**

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INTRODUCTION: High-intensity interval training (HIIT) is believed to be effective in increasing physical performance, both aerobic and anaerobic, as well as promoting fat loss. In addition, ashwagandha (Withania somnifera) root extract contains various active compounds, including steroidal lactones known as withanolides. These substances have the potential to regulate adrenal and gonadal functions, and thus may result in improved health parameters and physical performance. The purpose of this study was to evaluate the effects of ashwagandha supplementation (600 mg/day) on anaerobic capacity, body composition and anabolic-catabolic status in healthy male non-athletes undergoing a fully supervised 8-week HIIT.

METHODS: Thirty eight men participated in randomized, double-blind, placebo-controlled study (placebo group, P, n=20; ashwagandha group, A, n=18). HIIT was performed on a rowing ergometer (3 sessions/week, 5-7 sets of 1.5 minutes in each session, at a load of 85-95% of maximum aerobic power, and with rest intervals between sets of 1.5 minutes). Before (term 1) and after (term 2) the 8-week intervention, participants performed a 30-second Wingate test on a cycle ergometer (lower limb muscles). Body composition was also assessed using dual energy X-ray absorptiometry (DEXA). In addition, blood samples were taken before (pre), 5 minutes after (post) and 24 hours (24h) after a maximal graded exercise test (performed on a rowing ergometer) to assess serum testosterone (T) and cortisol (C) levels. Participants were asked to refrain from dietary modification throughout the study period.

RESULTS: HIIT induced an increase in fat free mass ($p< 0.05$), without significant changes in body weight and fat mass ($p> 0.05$). Also, there were no changes in anaerobic capacity parameters (peak power, total work, time to achieving and maintaining peak power; $p> 0.05$) throughout the study period. In contrast, 8-week training increased serum testosterone levels (A: at all time points, $p<0.05$; P: post and at 24h, $p<0.05$). In addition, in both P and A groups, resting cortisol levels (pre) were elevated in term 2, compared to term 1 ($p<0.01$). Moreover, the T/C ratio increased after the 8-week study period: post and at 24 h in the A group ($p<0.05$), while at 24 h only in the P group ($p<0.05$). However, there were no main effects of group or interaction of group and time/term in the parameters studied ($p>0.05$).

CONCLUSION: Periodic (8-week) HIIT on a rowing ergometer is effective in increasing fat free mass by promoting anabolic status. On the other hand, it does not improve anaerobic capacity. Probably, more intense training regimen (with all-out sprint intervals) is needed to increase anaerobic performance. More importantly, ashwagandha supplementation does not appear to affect physical performance, as well as changes in body composition and anabolic-catabolic status in response to an interval training program in a population of non-athletes. Further research is needed on a group of competitive athletes representing various sport disciplines.

**THE INFLUENCE OF THE MENSTRUAL CYCLE ON RECOVERY AND PERFORMANCE: A CASE STUDY FROM SKI JUMPING**

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INTRODUCTION: Based on the current body of literature,1 naturally menstruating athletes are advised to take an individualized approach and record their training sessions, recovery measures, and performance in relation to their menstrual cycle (MC). A world-class Norwegian ski-jumping athlete did exactly this and the goal of this project was to investigate the influence of her MC on recovery and ski-jumping performance.

METHODS: The athlete recorded MC length (19 MCs), daily sleep score (five months), and resting heart rate (13 months), and premenstrual syndrome symptoms (two MCs). Ski-jumping results of three years were gathered from fis-ski.com. The MC was divided into three phases: menstrual bleeding (MB), day 1-5; pre-menstruation (PM), 1-4 days before the start of the first day of menstrual bleeding of the next MC; mid-phase (MP), the remaining days. Ski jumping results were recalculated to adjust for wind points and take-off speed and get a physical performance score.2 The sleep score and resting heart rate were collected using a Garmin watch. Data are reported as median (interquartile range).

RESULTS: The average MC length was 24 ± 4 days. Ski flying performance was 2.19 (0.079) during MB and 2.04 (0.020) during PM. Performance at the large hill was 1.29 (0.11) during MB, 1.27 (0.000018) during MP, and 1.04 (0.016) during PM, while performance at the normal hill was 0.95 (0.015) during MB, 0.92 (0.037) during MP, and 1.01 (0.00079) during PM. The sleep score was 90.0 (10) during MB, 86.5 (9) during MP, and 90.0 (13) during PM. Resting heart rate was 45 (4) during MB, 47 (3) during MP, and 48 (4) during PM. Premenstrual syndrome symptoms like feeling blue, having mood swings, difficulty concentrating and feeling lethargic appeared during PM and ranged from minimal to severe in severity.

CONCLUSION: The performance level in ski flying and the large hill was in general higher and more stable than in the normal hill. Performance decreased with respectively 7 and 19% in PM compared to MP in ski flying and the large hill, whilst such a decline was not observed in the normal hill (improvement of 6%). Premenstrual syndrome symptoms during PM may be an explanation of the lower performances at the larger hills when competing during PM, as the risks are larger at these hills and thereby the influence of for example feeling blue and having difficulty concentrating being larger. The slightly higher resting heart rate during PM corresponds with findings in the literature and might indicate a slightly

impaired recovery status.3 This case study shows that the MC might influence recovery and performance on an individual level, whereby ski flying and large hill performance were lowest during the phase with most symptoms.

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**INFLUENCE OF MAXIMUM OXYGEN CONSUMPTION WHEN DETERMINED IN DIFFERENT EXERCISE PROTOCOLS: A PILOT STUDY**

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INTRODUCTION: Currently, different exercise protocols are used to identify Maximum Oxygen Consumption (VO2max), such as incremental load exercise on a ramp or in graded. However, the best protocol model for identifying VO2max still generates discussion in literature. Thus, the main of the present study was to verify whether different incremental test protocols can influence the determination of the VO2max value and compare it with the verification test.

METHODS: Six healthy men, age of 24 ± 0.7 years, who used bicycles recreationally participated in this study. Participants made 6 visits to the laboratory, one session to familiarize themselves and five sessions carried out in a crossover and randomized manner. Participants performed 5 maximum incremental tests on a cycle ergometer, a ramp protocol (28 W.min -1; 7-Watt increments every 15 seconds), and 4 graded protocols with 25-Watt increments at each stage of 1, 2, 3, or 4 minutes. Respiratory variables were recorded continuously by a gas analyzer (VO2000) during the tests. After completing each test, the subjects performed a 10-minute passive recovery and then a verification test until exhaustion with a load 5% higher than the maximum achieved in the test. VO2max was determined by analyzing the average values from the last minute of each test.

RESULTS: The mean and standard deviation values of VO2max were (incremental testing vs verification testing, respectively; mean effect size and 95% confidence interval): ramp test (43.66 ± 6.20 mL · kg–1 · min–1 vs 40.68 ± 7.98 mL · kg–1 · min–1; ES 0.38, -3.66;4.43); graded test 1' (43.61 ± 4.97 mL · kg–1 · min–1 vs 39.80 ± 7.06 mL · kg–1 · min–1; ES 0.58, -2.88;4.03 ); graded test 2' (44.61 ± 8.41 mL · kg–1 · min–1 vs 38.90 ± 4.32 mL · kg–1 · min–1; ES 0.79, -2.99;4.57); graded test 3' (43.91 ± 7.32 mL · kg–1 · min–1 vs 39.18 ± 6.80 mL · kg–1 · min–1; ES 0.62, -3.38;4.62); graded test 4' (42.53 ± 7.98 mL · kg–1 · min–1 vs 37.90 ± 7.63 mL · kg–1 · min–1; ES 0.55, -3.87;4,96).

CONCLUSION: The VO2max value does not appear to influence significant changes when determined in different incremental protocol models. Although the VO2max determined in the verification test is, on average, below the VO2max of the incremental test, the confidence interval crosses the zero line, preventing us from concluding that they are different. Therefore, for a faster test, it is suggested to perform the test on a ramp or in a graded with 1-minute stages.

## Physiotherapy

**EVALUATING THE EFFICACY OF DUAL-TASK TRAINING COMPARED TO SINGLE-TASK TRAINING AND NO INTERVENTION IN THE REHABILITATION OF LOWER EXTREMITY MUSCULOSKELETAL INJURIES: A SYSTEMATIC REVIEW**

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INTRODUCTION: Dual-tasking refers to the simultaneous performance of two independent tasks, each with distinct goals. While evidence suggests that dual-task training (DTT) can enhance physical and cognitive outcomes, particularly in healthy populations, its effectiveness in rehabilitation and its long-term impact on musculoskeletal injuries remain underexplored. This systematic review aimed to evaluate the effectiveness of DTT compared to single-task training (STT) or no intervention (NI) on clinical outcomes and physical performance metrics in adults with lower-extremity musculoskeletal injuries.

METHODS: A systematic search was conducted in PubMed and Web of Science databases up to April 2024, with additional backward and forward citation tracking. Data were extracted on participant demographics, diagnoses, interventions, measured outcomes, assessment tools, and main findings. The Cochrane Risk-of-Bias Tool 2 was used to evaluate study quality.

RESULTS: Following screening 8,017 articles, four randomized controlled trials met the inclusion criteria, providing data on 107 participants (Mean ± SD age: 25.4 ± 10.4) with lower extremity injuries. Three studies showed a high risk of bias, while one was rated as low risk. The findings indicate that DTT significantly improved ankle proprioception and peroneus longus muscle activation compared to STT, although both DTT and STT yielded similar outcomes in postural control and jump-landing kinematics, showing no clear advantage. DTT also demonstrated greater effectiveness than NI across all parameters.

CONCLUSION: DTT may offer advantages over STT in enhancing ankle proprioception and peroneus longus activation for patients with chronic ankle instability. However, the limited number of studies, high risk of bias, and limited range of clinical outcome measures underscore the need for further research in this area.

**ASSESSMENT OF INJURIES IN YOUTH SOCCER PLAYERS IN RELATION TO BODY POSTURE**

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INTRODUCTION: The incidence of injuries among junior football players is remarkably high. Adolescents may be particularly vulnerable due to the rapid physical changes that occur during growth spurts. Poor posture might be linked to an increased risk of injuries in this population.

This study aimed to examine the connection between poor posture and injury patterns in youth football players.

METHODS: A total of 116 football players (aged 11–18 years) participated in the study. Participants were categorized based on age and academic level. Data on training and injuries were collected through questionnaires and injury registration software. Habitual posture was assessed using the PostureScreen mobile application. During statistical analysis descriptive statistic, independent sample t-test, one-way ANOVA with Tukey post-hoc test and Kruskal-Wallis H test was performed. Chi-squared test was applied to assess relationship between postural parameters and injury occurrence

RESULTS: Injury rates were high across the entire study group, with the highest rates observed in the U14 and U15 age categories. Significant positive correlations emerged between various postural parameters and injury occurence ($p \leq 0,05$) while academic groupings showed less pronounced associations. . For the full study sample, the most important observation is that "total" frontal value in posture and the pelvic translation can be considered as risk factors for re-injury.

CONCLUSION: The findings indicate a clear association between postural parameters, as measured in both the frontal and sagittal planes, and the occurrence of injuries among youth football players. Our findings highlight the role of using posture screening methods as the part of the injury prevention program among youth football players.

**INVESTIGATED BETWEEN KNEE JOINT BEHAVIOR DURING INSTEP KICKS INVOLVING KNEE JOINT EXTENSION, THE FACTORS CONTRIBUTING TO THE OCCURRENCE OF THE ANTERIOR HORN TEAR OF THE LATERAL MENISCUS OF KNEE JOINT.**

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INTRODUCTION: In sports activities, damage to the knee joint meniscus is a relatively common occurrence, with particularly rare cases of the anterior horn Tear of the lateral meniscus of knee joint (AHLM).According to past reports, the incidence of AHLM associated with sports activities is reported to be 2.5%, with soccer considered to carry a higher risk. Among soccer players, AHLM has been attributed to repetitive kicking motions involving knee joint extension. Therefore, we investigated the correlation between knee joint behavior during instep kicks involving knee joint extension and meniscus behavior, aiming to verify the factors contributing to the occurrence of AHLM.

METHODS: 23 university students were instructed to perform maximum effort instep kicks, and measurements were taken using a 3D motion analysis system. The analysis focused on calculating the knee joint extension and rotation angles from the moment of BI until the acceleration of the foot reached zero during the follow-through. The analysis was conducted using Vicon Nexus 2.16 software. Knee joint rotation was enhanced by adding markers to the inner side of the knee joint according to the conventional Plug-in-Gait marker set definition, and the segments were redefined using 3 points markers on the outer side of the thigh and lower leg, and the added marker on the inner side of the knee joint.

RESULTS: A total of 43 instep kicks were performed. Knee joint hyperextension was observed in 69.8% of kicks, with an average angle of -7.0±4.1° and a maximum of -15.9°. The maximum extension position for each kick occurred between 0.052 to 0.072 sec after "Ball Impact" (BI). Furthermore, to increase the reliability of rotation angles, the rotation angle at the time of maximum knee flexion before the kick BI was normalized to 0°, and changes in rotation angles after BI were considered as knee joint rotation angles. As a result, the average maximum rotation angle after BI was -14.5±12.9° (average knee flexion angle of 35.1±7.5°), indicating external rotation. Additionally, 81.6% of external rotation was observed during the period of 0.052 to 0.072 sec after BI, with an average angle of -7.5±1.3°.

CONCLUSION: It is known that the knee joint meniscus moves forward with knee joint extension and influenced by the "Screw Home Movement function" during extension, undergoes external rotation, causing the meniscus to move anteriorly and laterally. AHLM are frequently observed in soccer players, especially those involving instep kicks that accompany knee joint extension. The repetitive nature of this motion is believed to be a contributing factor to AHLM. The results of this study confirm that knee joint external rotation increases significantly at this moment of knee joint hyperextension in the kicking leg during instep kicks. This supports the conclusion that the kicking motion (instep kick) contributes to the induction of AHLM.

**INTEGRATED APPROACHES OF THERMAL MEDICINE AND CLINICAL HYDROLOGY FOR SPORTS REHABILITATION: OPTIMIZING POST-EXERCISE RECOVERY AND TREATMENT OF SPORT INJURIES**

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INTRODUCTION: Thermal medicine and clinical hydrology are innovative and complementary approaches in sports rehabilitation, with applications ranging from injury prevention to post-exercise recovery. Thermal therapies, including balneotherapy, mud therapy, and hydrokinetic therapy, are increasingly being used to support athletes in reducing inflammation, accelerating muscle recovery, and improving joint mobility. Despite the growing interest, there is limited research on

the specific effects of these therapies within sports medicine, highlighting the need for further investigation into their benefits and mechanisms of action.

METHODS: The study involved a cohort of athletes undergoing rehabilitation for various sports injuries, with a particular focus on those recovering from shoulder injuries. Participants received a combined therapeutic protocol that included immersion in thermally controlled water and localized mud applications. Hydrokinetic therapy, based on Archimedes principle, was also incorporated to reduce joint stress and enhance recovery. The rehabilitation protocol for post-operative shoulder recovery lasted 26 weeks and included progressive phases: hydrokinetic therapy, mud therapy, and controlled muscle strengthening, culminating in full motor recovery. Physiological responses, including muscle recovery rates, inflammation markers (C-reactive protein), and joint mobility improvements, were measured pre- and post-treatment. Additionally, psychological well-being was assessed through validated questionnaires

RESULTS: The results indicate that the application of thermal therapies significantly accelerated muscle recovery and reduced joint inflammation. Thermal water treatments and mud therapy led to notable improvements in microcirculation, enhancing oxygen and nutrient delivery to tissues while promoting the removal of pro-inflammatory metabolites. Hydrokinetic therapy effectively reduced joint load, allowing for early rehabilitation without increasing the risk of further injury. Biologically, thermal treatments were shown to stimulate the release of β-endorphins and cortisol, enhancing pain tolerance and modulating the inflammatory response. Moreover, levels of insulin-like growth factor (IGF-1), which is essential for cartilage regeneration, were elevated following thermal therapy.

CONCLUSION: This study demonstrates the potential of integrating thermal medicine and clinical hydrology into sports rehabilitation protocols. The findings underscore the ability of thermal therapies to accelerate recovery, reduce inflammation, and improve mental well-being in athletes. Given the promising results, further research is required to standardize protocols and optimize the use of these therapies in clinical settings. The integration of these treatments into rehabilitation programs may offer a scientifically grounded and sustainable approach to managing sports injuries and optimizing athletic performance.

**EFFECTIVENESS OF A NOVEL FIGURE-EIGHT TAPING TECHNIQUE FOR MANAGING ANTERIOR SHOULDER INSTABILITY IN PITCHER: A CASE REPORT**

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INTRODUCTION: Shoulder instability, particularly in overhead athletes, such as baseball pitchers, poses significant challenges in management, often leading to chronic pain and functional impairment. This case report highlights the immediate and sustained benefits of a novel figure-eight taping technique for managing anterior shoulder instability confirmed using ultrasound in a recreational baseball pitcher.

METHODS: A 41-year-old male unable to pitch for six years due to progressive shoulder pain, which significantly affected his daily life. The initial clinical examination revealed severe pain localized to the rotator cuff interval and posterior shoulder, with marked limitations in range of motion and muscle strength. Ultrasound imaging confirmed significant anterior shoulder instability, characterized by anterior subluxation of the humeral head and inflammation around Bennett's lesion.

RESULTS: A novel figure-eight taping technique was used to control shoulder anterior instability while maintaining functional alignment. The intervention led to immediate improvement in muscle strength and a significant reduction in pain, which decreased Numeric Rating Scale (NRS) pain scores (1-3/10). Moreover, the patient could perform painless and smooth pitching motions immediately after the intervention. Remarkably, he pitched from 18.44 meters at 85% intensity on the same day. Four months later, the patient successfully returned to competitive pitching, achieving a maximum pitch speed of 115 km/h with minimal pain (NRS, 3/10). The patient continued to practice independently, adhering to the rotator cuff exercises and pitching form corrections learned through the taping intervention. Notably, the positive effects of taping persisted even eight months after the intervention, underscoring the potential of this technique as a valuable non-invasive treatment option within conservative management strategies for shoulder anterior instability.

CONCLUSION: The figure-eight taping technique demonstrated potential as an effective non-invasive option for managing anterior shoulder instability, aiding sustained pain relief, and functional recovery.

**COMPREHENSIVE ANALYSIS OF RECOVERY METHODS AMONG RECREATIONAL MARATHON RUNNERS IN JAPAN**

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INTRODUCTION: Endurance athletes employ a variety of recovery strategies to maintain and enhance performance. High training loads often lead to an imbalance between physical and psychological stress and recovery. Therefore, optimizing recovery strategies has become increasingly important. In Japan, cultural practices such as hot springs(onsen) and acupuncture have become widely used for recovery, yet their impact on recreational runners remains unclear. This study aimed to investigate the association between athletic performance and recovery methods through a large-scale web-based questionnaire survey exclusively among recreational marathon runners in Japan.

METHODS: An online survey was conducted using Google Forms. A random sample of 200,000 recreational runners was selected from 1.1 million registered users on web-based marathon registration site, who had participated in a full mara-

thon in the past three years. The survey included items on age, gender, running history, best race times, and average monthly training volume over the past three years. It also assessed the usage and frequency of various recovery methods—including bathing, alternating baths, cold water baths, bedrock baths, hot springs, saunas, massage, stretching, icing, compression wear, active recovery, transcutaneous electrical nerve stimulation (TENS), acupuncture and moxibustion, oxygen capsules as well as interest in using these methods in the future.

RESULTS: A total of 5,189 responses were obtained. The average running history was 12.1±8.8 yrs, and the mean best race time was 4h08m11s. A significant negative correlation was found between training volume and best race time ($r = -0.34$, $p < 0.0001$). Among recovery methods, bathing (86.5%), stretching (85.0%), hot spring usage (66.7%), and massage (47.0%) were most prevalent. Notably, runners who used acupuncture achieved a significantly faster average best race time (3h48m38s) compared to non-users (4h14m37s, $p < 0.001$) and had longer running histories. Factor analysis identified four distinct clusters of recovery methods: (1) traditional passive heat therapies (hot springs, saunas, bathing, bedrock baths), (2) active recovery methods (active recovery, stretching, compression wear), (3) passive methods whose efficacy was demonstrated in previous studies (cold water baths, alternating baths), and (4) passive therapies requiring ongoing costs (acupuncture, TENS, oxygen capsules, massage).

CONCLUSION: This study revealed that higher training volumes are associated with faster best race times among recreational marathon runners in Japan. Moreover, the use of acupuncture was linked to better performance and longer running histories. The findings also highlight the widespread use of culturally embedded recovery practices, such as bathing and hot spring therapy, which appear to be adapted according to individual lifestyle and resource availability. The findings provide a valuable foundation for developing evidence-based recovery strategies for endurance athletes.

**COMPARISON OF THE ACUTE EFFECTS OF DIFFERENT WARM-UP PROTOCOLS IN OVERHEAD ATHLETES WITH POSTERIOR SHOULDER TIGHTNESS: A PILOT STUDY**

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INTRODUCTION: Posterior shoulder tightness (PST) is common in overhead athletes and may contribute to upper extremity injuries due to restricted total and internal shoulder rotation [1]. While static stretching (SS) is widely used to address PST, its potential to impair strength performance raises concerns about its use in warm-ups. To address this, researchers have proposed reducing stretching duration or combining it with dynamic stretching (DS) to maintain warm-up benefits without strength loss. Roller massage (RM) has also gained popularity for improving flexibility without compromising performance. However, most research on warm-up strategies has focused on the lower extremities. This study aimed to compare the effects of static stretching, dynamic stretching, and roller massage on upper extremities flexibility and performance in overhead athletes with PST.

METHODS: Seven healthy collegiate overhead athletes with PST were recruited. The original study was a crossover study with all participants undergoing three different interventions (DS, SS+DS, and RM+DS groups) in a randomized order. In our pilot study, all participants were only allocated to perform the first intervention. The outcome measures included shoulder range of motion (ROM), posterior deltoid and infraspinatus muscle stiffness, shoulder external and internal rotation isometric strength and rate of force development (RFD), upper quarter Y-balance test and closed kinetic chain upper extremity stability test (CKCUEST) performance, and posterior shoulder muscle fatigue resistance. All participants were tested before and immediately after the intervention.

RESULTS: In the RM + DS group, there were 2 participants, while the SS + DS group also had 2 participants, and the DS group had 3 participants. The descriptive statistics showed increased active shoulder internal rotation (RM+DS: 27%; SS+DS: 17%; DS:7%) and horizontal adduction ROM (RM+DS: 63%; SS+DS: 29%; DS:13%) in all groups. Similarly, all groups improved CKCUEST performance (RM+DS: 27%; SS+DS: 13%; DS: 3%). However, the RM+DS group showed a decreasing trend in shoulder external and internal rotation RFD (-13% and -15%, respectively), while no clear trends were observed in the DS and SS+DS groups. No notable trends were observed in the other measurements.

CONCLUSION: RM combined with DS during warm-up may have a trend of enhancing more active shoulder ROM and CKCUEST performance while potentially reducing shoulder RFD compared to DS combined with SS and DS only. The full crossover experiments should be completed with more participants to compare group differences and confirm these findings.

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**ASSESSMENT OF FALL RISK IN A POPULATION OF PATIENTS WITH CARDIOVASCULAR DISEASES UNDERGOING CARDIAC REHABILITATION.**

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INTRODUCTION: Cardiac rehabilitation is recommended for patients with chronic heart disease and those recovering from acute cardiovascular events to restore functional capacity or maintain autonomy in daily activities, especially in elderly and frail individuals. Prolonged immobility from hospitalization increases risks of hypokinetic syndrome, orthostatic hypoten-

sion, mood swings, and vascular complications. This study evaluates the impact of cardiac rehabilitation and adapted physical activity on fall risk, balance, cervical mobility, and sleep quality in elderly patients post-acute cardiovascular event.

METHODS: 20 participants over 65 (6 women, 14 men; 72.7±5.4 years) were recruited from the cardiology department at IRCCS Pisana in Rome following a recent acute cardiac event. Initial assessments measured fall risk (Conley scale), the postural control (stabilometric test), cervical mobility (Moover® inertial sensor), and sleep quality (Pittsburgh Sleep Quality Index - PSQI). Participants underwent a 20-day intensive training protocol: day I: walking, days II-VII: calisthenics/balance exercises (30 min) and aerobics with pedals (30 min); day VIII-discharge: gym activity with aerobic exercise (50-60% maximum HR, 30 min) and group exercises. The final assessments were conducted before discharge.

RESULTS: Post-intervention, participants showed a low fall risk (0.5 ± 0.9 Conley Scale). the training protocol carried out in the gym allowed a maintenance of the stabilogram length with open eyes (pre 229 ± 63.1 mm, post 228,5 ±72.2 mm) and a reduction with closed eyes, demonstrating an improvement in postural control. Cervical mobility improved by an average of 2 degrees in all directions, with statistically significant improvement ($p<0.01$) in anterior flexion-extension. Sleep quality (PSQI) increased by 12% ($p=0.3$).

CONCLUSION: Intensive cardiac rehabilitation improved postural control and cervical mobility within 20 days in elderly patients post-acute cardiovascular event. Although sleep quality showed a 12% increase, it was not statistically significant, possibly due to the short duration of the study. The protocol supported functional capacity and autonomy, highlighting the value of a structured, personalized approach in post-cardiac event rehabilitation. Future research should examine the benefits of continuing the training protocol at home to determine if regular physical activity can sustain or enhance observed improvements.

**THE EFFECT OF BODY MASS INDEX ON BALANCE IN ADOLESCENT ATHLETES**

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INTRODUCTION: Body mass index (BMI) is one of the key determinants of balance in adolescent athletes. Preventing potential injuries and maintaining balance are crucial for athletes during their developmental stages. The aim of this study was to examine the effect of BMI on balance in adolescent athletes.

METHODS: A total of 300 adolescent athletes (mean age = 15.29±4.75 years, mean BMI = 20.31±3.28 kg/m²) participated in the study. Body weight was assessed using the Tanita BC 418 MA (Tanita, Japan) device. BMI was classified as underweight (≤18.5 kg/m²), healthy weight (18.5-24.9 kg/m²), overweight (25-29.9 kg/m²), and obese (30-39.9 kg/m²). The Y-balance test was used to measure athletes dynamic balance. Participants were instructed to stand at a designated point of a pre-drawn "Y" shape and extend their toes in anterior, posteromedial, and posterolateral directions. Pearson correlation test and linear regression analysis were used for statistical analysis.

RESULTS: Among the participants, 50% were volleyball players, 20% were basketball players, and 30% were tennis players. BMI was weakly correlated with the anterior ($p=0.001$, $r=-0.348$), posteromedial ($p=0.023$, $r=-0.149$), and posterolateral ($p=0.001$, $r=-0.220$) directions of the Y-balance test. A one-unit change in BMI was found to affect anterior balance by 12%, posteromedial balance by 2%, and posterolateral balance by 4%.

CONCLUSION: This study has shown that adolescent athletes with a high BMI experience impaired balance. Balance deficiency can negatively affect not only athletic performance but also increase the risk of injuries. Particularly during adolescence, excessive body mass may hinder motor control and reduce movement efficiency. To maintain optimal performance and prevent injuries, athletes should carefully manage their body mass, especially during this developmental period. Additionally, incorporating aerobic exercises that support balance into their training programs is essential.

## Psychology

**PERSONAL VALUES, SPORT VALUES AND ATHLETES' CLEAN SPORT LIKELIHOOD**

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INTRODUCTION: Doping in sport is a form of cheating, and while progress has been made in education and prevention, it remains a contentious issue in sports psychology [1]. Antidoping education now increasingly emphasizes the promotion of clean sport [2], which can be defined as achieving athletic potential without doping [3]. However, the relationship between athlete's personal and sport values and clean sport likelihood is still underexplored. This study aims to address this gap, controlling for other personal and contextual factors.

METHODS: Participants included 948 athletes (477 males and 477 females, Mage = 20.32; SD = 2.45) from team and individual sports. The athletes' personal and sport values were assessed using the Portrait Values Questionnaire-21 and Youth Sport Values Questionnaire-2. Clean sport likelihood was measured using a hypothetical scenario describing key temptations to dope. Control variables included moral identity, doping self-regulatory efficacy, attitudes toward doping, and coach-created motivational climate.

RESULTS: The study employed hierarchical regression analysis. The first step included personal and sport values as a predictor and the model significantly predicted clean sport likelihood (R2adj = 0.61, F = 212.62, p < .001). Self-transcendence (β = 0.32, p < .001) and conservation (β = 0.48, p < .001) were positive predictors, while self-enhancement (β = -0.24, p < .001) and openness to change (β = -0.16, p < .001) were negative. Moral values (β = 0.45, p < .001) positively predicted clean sport likelihood, while status values (β = -0.19, p <.001) had a negative effect. Including other personal factors, the model still predicted clean sport likelihood (R2adj = 0.67, F = 195.82, p < .001), with moral identity (β = 0.23, p < .001) and doping self-regulatory efficacy (β = 0.24, p < .001) as positive predictors. Attitudes toward doping (β = -0.07, p = .03) negatively predicted clean sport likelihood. Finally, including the coach-created motivational climate, the model remained significant (R2adj = 0.68, F = 164.70, p < .001), with a disempowering climate (β = -0.07, p = 0.02) as a negative predictor, while an empowering climate showed no significant relationship.

CONCLUSION: This study supports previous research that moral identity and doping self-regulatory efficacy are positive predictors of clean sport likelihood. Interestingly, an empowering coach-created motivational climate was not related to clean sport likelihood. The novelty of this study lies in highlighting the importance of both personal and sport values in predicting clean sport likelihood. Different values related with athletes intentions differently, suggesting that understanding these values is important aiming to encourage athletes to compete clean.

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**EXPLORING THE EFFECTS OF FASTING ON COGNITIVE EFFICIENCY DURING 8-H AN OFFICE-LIKE SIMULATED MENTAL WORKING DAY**

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Introduction: When sustained neural firing is disrupted due to impaired energy production and supply in the brain, it can result in lapses of attention and a decline in working memory. Fasting for two days reduces the levels of glucose in the bloodstream, and the brain is particularly sensitive to these changes. Therefore, the primary goal of this study was to investigate the effects of fasting-related changes in glucose levels on cognitive efficiency during an 8-hour period of office-like computer work.

Methods: Twenty healthy young adults, consisting of 10 men and 10 women, completed two separate study trials for both fasting and control conditions in a random order. Each trial took place during a standard 8-hour working day, with 10-minute breaks every 50 minutes. A battery of nine cognitive tasks was presented in random order and performed twice during the 50-minute work sessions. Ketone and glucose concentrations in response to the trial conditions were assessed at several time points: before the trials, 2 hours after starting, 3 hours in, post-lunch, after the working day, during a 4-hour recovery period, and the following morning. Subjective scales were utilized to evaluate feelings of fullness, hunger, and motivation.

Results: Fasting resulted in a gradual increase in ketone levels, accompanied by a significant decrease in glucose levels ($p < 0.05$). During an 8-hour workday, participants who were fasting reported lower motivation, increased mental fatigue, heightened hunger, and reduced feelings of fullness compared to those in control conditions ($p < 0.05$). Interestingly, despite experiencing greater psychological stress, fasting seemed to enhance cognitive efficiency across various tasks ($p < 0.05$). These tasks included working memory, attention, concentration, reaction times, visual tracking, learning, memory, visuospatial function, selective attention, and executive function, all of which are critical for office employees. However, these cognitive benefits were not consistently maintained throughout the day and demonstrated significant variability.

Conclusion: While fasting may lead to a heightened subjective stress response, it also appears to improve cognitive efficiency during a simulated office workday.

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**THE STRATEGIC ORIENTATION OF ANTI-DOPING EDUCATION FOR YOUNG ATHLETESAN EMPIRICAL STUDY BASED ON THE INFLUENCING FACTORS OF ANTI-DOPING ATTITUDE AND PARTICIPATION WILLINGNESS OF YOUNG ATHLETES**

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INTRODUCTION: The World Anti-Doping Agencys statement that "athletesfirst contact with anti-doping should be through education rather than doping control" reflects the importance of education in anti-doping work. Young athletes, as a unique group, face challenges in anti-doping education. This study will examine the characteristics of young athletes to understand what influences their attitudes toward anti-doping and their willingness to participate. It will also explore the differences in anti-doping attitudes and willingness among young athletes with varying characteristics. This will help construct strategies for implementing anti-doping education for youth, effectively improving the results of anti-doping education for young athletes.

Method: This study will survey approximately 1,500 young athletes from sports schools in both urban and district areas of Shanghai. It will employ field research, expert interviews, and questionnaires to investigate the factors influencing their

attitudes towards anti-doping and their willingness to participate. The data will be analyzed using methods like factor analysis, regression analysis, and heterogeneity analysis.

RESULTS: (1)Young athletes demonstrate a favorable attitude towards anti-doping initiatives and express a strong desire to engage in anti-doping education. (2) Self-awareness, anticipated benefits, and social support strongly influence young athletes willingness to participate in anti-doping education. In contrast, the content and format of the education do not significantly affect their willingness. Positive attitudes towards anti-doping enhance the likelihood of young athletes participating in education programs.(3)Young athletes with different characteristics exhibit significant differences in their willingness to participate in anti-doping education.

Discussion: The findings revealed that young athletes recognize the significance of anti-doping and possess some knowledge about it. Several factors influence young athletes participation in anti-doping education. Improved self-awareness boosts their confidence in completing educational tasks. Additionally, athletes understand that anti-doping education enhances their knowledge and supports their competitive careers, making them more willing to participate.Social support also encourages their involvement in anti-doping education.Therefore,to improve the effectiveness of anti-doping education in the future, programs should focus on enhancing athletes self-awareness, clarifying the necessity of such education, and tailoring content to their unique characteristics.

**EFFECTS OF DIFFERENT EXERCISE PATTERNS ON SPATIAL AND VERBAL WORKING MEMORY UPDATING IN WOMEN WITH METHAMPHETAMINE USE DISORDER**

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Objective: To explore the chronic effects of moderate-intensity cycle ergometer and aerobic calisthenics training on spatial and verbal working memory (WM) updating and brain activity. Methods: Forty female methamphetamine (MA) users were randomly assigned to receive either moderate-intensity cycle ergometer or aerobic calisthenics training twice a week for 10 weeks. Before and after exercise, a modified 2-back task, which contained the word and position task, was used to assess changes in spatial and verbal WM updating, and functional near-infrared spectroscopy (fNIRS) was used to assess activation of prefrontal cortex. Results: The cycle ergometer group showed significant reductions in response times in both WM task types examined, whereas the aerobic calisthenics group showed a significant reduction only for the spatial WM task. fNIRS showed reduced activity in orbitofrontal cortex (OFC) after both interventions. The cycle ergometer group exhibited significantly greater right dorsolateral prefrontal cortex (DLPFC) activity during word task performance than did the aerobic calisthenics group. Conclusion: Cycle ergometer training can effectively promote spatial and verbal WM updating, while aerobic calisthenics training only accelerate spatial WM updating and the two exercise types having different impacts on prefrontal cortical activity, particularly in the right DLPFC.

**A STUDY ON THE INFLUENCING FACTORS OF COLLEGE ATHLETES CAREER SELF-EFFICACY**

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A Study on the Influencing Factors of College Athletes Career Self-Efficacy

INTRODUCTION: College athletes with higher career self-efficacy are more proactive in career exploration and decision-making. This also helps individuals organize and coordinate their talents, adapt to life's challenges and pressures, and achieve greater career satisfaction. The study explores the influence of college athletes perceived calling, self-esteem, hope, and career adaptability on career self-efficacy.

METHODS: This study conducted data collection through a questionnaire survey, and 500 college athletes participated in this study. In total, 437 valid questionnaires were returned. The data obtained were statistically analyzed using structural equation modeling.

RESULTS: The hypothesized model constructed in this study achieved an acceptable fit with the sample data. Calling, self-esteem, and career adaptability had a direct positive impact on career self-efficacy, while hope indirectly influenced career self-efficacy through career adaptability.

Discussion: This study revealed that calling, self-esteem, and career adaptability have direct effects on the career self-efficacy. College athletes with higher career adaptability are better able to establish a clear self-concept, gradually build confidence in their chosen profession. Furthermore, college athletes with higher self-esteem experience fewer psychological distress, demonstrate better career self-efficacy. In addition, by cultivating a sense of calling, college athletes can clarify their career goals, enhance passion and a sense of mission for their profession, ultimately leading to higher career self-efficacy. The study revealed a positive correlation between hope and career adaptability. College athletes with higher hope experience less subjective distress and a lower frequency of negative emotions when facing life and career development pressures, thus improving career adaptability. Additionally, a strong sense of calling not only helps athletes pursue careers imbued with value and meaning but also facilitates future career transitions. Athletes with a sense of calling demonstrate better self-concept awareness and are more motivated and capable of changing their circumstances, which enhances their career adaptability. In terms of hope, college athletes with higher self-esteem tend to pursue more ambitious career goals, which guide them toward positive thinking, resulting in greater hope. Moreover, through calling, college athletes identify their career values and choose the most meaningful career goals, thereby enhancing their hope.

Finally, the process of developing a calling allows athletes to perceive their professional tasks as unique and meaningful. This perception strengthens their commitment to pursuing career goals, elevates their self-esteem.

**STYLE OF INTERACTION IN SUPPORT OF BASIC PSYCHOLOGICAL NEEDS, THE QUALITY OF MOTIVATION AND SUSTAINABILITY OF PA BEHAVIOR**

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Background: The self-determination theory encompasses three fundamental needs: competence, autonomy, and positive relationships. This framework can be effectively applied to fitness professionals through the integration of intrinsic and extrinsic motivation strategies.

Purpose: This study aims to compare the "motivating" interaction style characterized by autonomy support and structure with the "demotivating" interaction style defined by control and chaos. We will examine how these interaction styles influence the satisfaction of basic psychological needs, the quality of motivation, and the sustainability of physical activity (PA) behavior.

Method: This research was conducted as a cross-sectional observational study, facilitating data collection through the systematic observation of participants over a designated time frame. The sample consisted of 93 individuals, balanced in terms of gender, recruited from various fitness centers. Participants were requested to complete a questionnaire accessed via a unique link distributed by their respective exercise coaches. The data gathered were subsequently analyzed and evaluated to draw relevant conclusions regarding the subject matter.

Results: In this study, 93 individuals were recruited as participants, with females composing 50.5% of the sample. The participants had a mean age of 46.07 years (± 14.4) and an average weight of 70.1 kg (± 10.9). The results indicate that 19.4% of participants do not utilize gym facilities; approximately 45.1% reported a preference for training in budget-friendly gyms, while only 5.4% indicated a preference for family-oriented gyms, and 30.1% favored premium gyms. A statistically significant difference was found between the individuals who do not engage in gym training and those who train in either low-cost or premium gym environments.

Conclusion: The support that fosters sustained adherence to physical activity and a sense of self-determination is enhanced through the alignment of support with the psychological needs of autonomy and structure. To promote increased adherence and uniformity in the practice of physical exercise, it is imperative for women to mitigate demotivating interactions characterized by control and chaos. Furthermore, the fundamental psychological needs and the long-term sustainability of physical activity are significantly correlated with high levels of intrinsic motivation and self-regulation observed across both genders

**RESISTANCE TRAINING FOLLOWING METABOLIC-BARIATRIC SURGERY: MOTIVATORS, BARRIERS AND PREFERENCES**

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Introduction. Metabolic and bariatric surgery (MBS) induces substantial muscle mass loss. Resistance training (RT) is an effective strategy to maintain muscle mass. This study aimed to gain insight in the motivators, barriers and preferences regarding RT after MBS.

Methods. A digital survey assessing RT was sent to patients who had MBS 1 to 18 months prior. Patient characteristics were extracted from electronic health records. Motivators, barriers and preferences were assessed with a questionnaire and compared across three groups: patients currently (RT-group), previously (ex-RT) or never engaged in RT (non-RT).

Results. Of 1 609 participants (77% female, 47±11 years old, BMI 42±5 kg/m2) 68% belonged to RT-group, 11% to ex-RT and 21% to non-RT. The RT-group reported improving fitness (78% vs. 67%), mental health (65% vs. 43%) and overall health (63% vs. 41%) more often as motivators for RT than the ex-RT. Barriers for RT were similar for ex-RT and non-RT, most frequently: lack of motivation (37% vs. 40%), time (33% vs. 28%), enjoyment (29% vs. 29%) and physical complaints (39% vs. 37%). Ex- and non-RT reported a preferred exercise frequency of 2 sessions/week with 30 minutes/session, in their home setting with a training schedule and guidance from a professional.

Conclusion. The majority of participants in our study engaged in RT. Motivators were improving overall fitness and limiting strength or muscle loss. Barriers are lack of motivation, physical complaints, lack of time and enjoyment. RT participation could benefit from professional guidance and a training schedule for RT at home.

**UNDERSTANDING MENTAL HEALTH CHALLENGES IN ELITE SPORT: THE CASE OF BRAZILIAN COACHES AND ATHLETES**

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Introduction: Elite sport presents significant mental health (MH) challenges for both athletes and coaches. While the MH of athletes has been extensively studied, less attention has been given to coaches, despite their critical role in managing team dynamics, athlete performance, and overall wellbeing. Coaches face unique stressors, such as organizational demands, leadership responsibilities, and balancing professional and personal roles, in addition to sharing many of the pressures experienced by athletes. Purpose: To explore and compare the MH states of elite Brazilian athletes and coaches, analyzing risk and protective factors. Methods: This mixed-method study included 148 elite athletes and 106 elite coaches (≥18 years) with a minimum weekly training workload of 20 hours. Participants were active in regional, national, and/or international competitions. Quantitative data were collected using an online questionnaire, evaluating demographic information, mental health risk factors, and protective factors, based on Keyes dual-factor mental health model. Instruments included: Patient Health Questionnaire (PHQ-9), General Anxiety Disorder-7 (GAD-7), Alcohol Use Disorders Identification Test (AUDIT-C), Sport Motivation Scale (SMS), and others validated in this context. Statistical analyses were conducted using SPSS, with significance set at $p<0.05$. Qualitative data was obtained through semi-structured interviews with 7 athletes and 8 coaches, exploring factors which influence MH, performance and coping strategies. Results: Quantitative findings revealed significant differences between athletes and coaches regarding MH risk and protective factors. Female participants, particularly female coaches, reported lower resilience, social support, and motivation, alongside higher anxiety and depressive symptoms compared to male participants. Coaches reported more alcohol use and faced unique occupational stressors, such as precarious contracts and administrative issues. Athletes indicated higher anxiety levels related to performance pressures, injury, and team dynamics. Qualitative data highlighted themes such as the culture of extreme competition, stigma around mental health, and lack of professional psychological support. Both groups emphasized the importance of protective factors like psychological support, positive relationships, and effective coping strategies. Conclusion: The study underscores gender and role-specific MH disparities in elite Brazilian sport. Female coaches exhibited the most significant vulnerabilities, while athletes struggled with performance-related pressures. Findings highlight the need for tailored interventions to address MH challenges in elite sport, emphasizing the importance of organizational support and stigma reduction.

**RUGBY FOOTBALL PLAYERS COGNITION OF TACKLING**

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INTRODUCTION: Tackling is an important part of the game in rugby football. It is also essential for coaches to grasp players' cognitive structure of tackling. This study aims to develop a cognitive scale and demonstrate a structure of tackling for rugby football players.

METHODS: This study used a questionnaire answered by 323 male rugby football players (101 high school students and 222 college students). The questionnaire consisted of 71 questions about tackling. The data collected was subjected to exploratory factor analysis, reliability analysis and confirmatory factor analysis by structural equation modeling.

RESULTS: Five factors were extracted from the results using exploratory factor analysis. In the next exploratory factor analysis, the number of items of each factor is made equal, and each item was subordinated to each factor. The result also showed that each item had a factor loading amount over .40 and a simple structure. The Cronbach's α of each factor was .79, .79, .76, .71 and .67, starting from factor 1. The fit coefficients by confirmatory factor analysis were sufficient (GFI=.937, AGFI=.903, CFI=.951, RMSEA=.056). All pass coefficients that observed variables from latent variables were significantly ($p<.001$) and showed positive values more than a medium level (.38–.89).

Discussion: The factors extracted by exploratory factor analysis were called Assertiveness, Sense of achievement, Fortune, Decision making, and Decisiveness. We judged that the scale was sufficiently reliable, because the Cronbach's α was over .65. The result of confirmatory factor analysis showed sufficient construct validity of the model, which comprised of 15 items of the five factors. Rugby football player's cognition of tackling consisted five factors. The resulting scale had sufficient reliability and validity, and we provided suggestions about using this scale.

**DIFFERENT RECOGNITION OF TACKLING FOR RUGBY UNION PLAYERS; DIFFERENCES BASED ON LIKE/DISLIKE FEELING (WITHDRAWN)**

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INTRODUCTION: Tackling is one of crucial parts in rugby union game. In addition, it is important for coaches to understand how players perceive tackling. The purpose of this study was to investigate whether the feelings of like/dislike influence to recognition of tackling for rugby union players.

METHODS: A questionnaire was conducted to 323 rugby players (101 high school students and 222 university students). The questionnaire was a self-evaluation scale for tackling consisting of 15 items on 5 factors: aggressiveness, achievement, luck, situational judgment, and decisiveness. Players were divided into two groups, like vs dislike for tackling, to compare the difference of recognition of tackling.

RESULTS: Results showed that players who liked tackling scored significantly higher on all four factors except the luck factor (luck: $t(321)=-0.17$, n.s.) (aggressiveness: $t(316.51)=4.27$, $p<.001$; achievement: $t(317.19)=10.92$, $p<.001$; situational judgment: $t(267.96)=3.14$, $p<.01$; decision-making: $t(321)=6.99$, $p<.01$; and decision-making: $t(321)=6.99$, $p<.001$). 001; situational judgment: $t(267.96)=3.14$, $p<.01$; decision making: $t(321)=6.99$, $p<.001$).

Discussion: The results indicated that players who like to tackle are more likely to perceive themselves as playing with good judgment, better decision making, and playing aggressively, with higher sense of accomplishment. The results of this study suggested the importance of a coaching method that makes it possible for players to like tackling.

**A STRATEGY AGAINST ACUTE MENTAL FATIGUE: A NEURAL OSCILLATIONS INVESTIGATION**

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INTRODUCTION: Cognitive effort is a constant component of daily life, influencing decision-making and the capacity for sustained attention during effortful tasks. Prolonged engagement in such tasks can lead to acute mental fatigue (AMF) and impaired cognitive function. Understanding AMF and its underlying mechanisms is essential for coping with it more effectively, particularly in sports requiring endurance capacity. The principal aim of the present study is to identify behavioral and electrophysiological markers of AMF during a 30-min cognitive task requiring continuous working memory updating. More precisely, two wave bands already associated with AMF (i.e., theta and alpha waves stimulus-locked power densities) were examined as a function of time on task.

METHODS: Seventy adults attended three sessions. During the first session, participants trained on the dual 2-back (D2B) task. In the second and third sessions, participants performed either a control task (watching a documentary) or a fatiguing task (D2B task). The order of the second and third sessions was counterbalanced across participants. The D2B task included 1,100 trials with 67% of 'no' trials (no match between trial n and n-2) and 33% of 'yes' trials (match between trials n and n-2). Electroencephalographic (EEG) activity was recorded continuously with 64 electrodes. The data were sampled at 1,000 Hz and recorded using a Biosemi system. Preprocessing of the EEG data was performed using BrainVision. Stimulus-locked theta and alpha wave power densities were extracted from the signal with a time–frequency analysis using Morlet wavelets on the median central electrode (Cz).

RESULTS: Reaction times for correct responses decreased over time, but significantly more sharply for 'no' trials. Error rate for 'yes' trials (i.e., omissions) increased significantly over time, whereas error rate for 'no' trials (i.e., false alarms) remained stable throughout the task. D-prime, an index of discrimination between trials n and n-2, decreased over time. Stimulus-locked theta wave power density (STWD) increased significantly in the last part of the task for the 'yes' and decreased throughout the task for the 'no' trials. Stimulus-locked alpha wave power density (SAWD) increased over time for 'yes' trials and decreased over time for 'no' trials. In addition, we observed a significant correlation between the decrease in STWD for 'no' trials and the decrease in d-prime over time.

Discussion: Based on behavioral and electrophysiological data, we can conclude that participants had the tendency to respond 'no' more and more automatically over time and consequently deployed less and less cognitive effort to perform the task and thus decreased their ability to discriminate between trials n and n-2 over time. Subjective data suggest that this disengagement of effort would be due to boredom and a decrease in motivation.

**EXAMINING THE RELATIONSHIP BETWEEN GOAL SETTING, MOTIVATION, AND JUMP PERFORMANCE IN A SINGLE-MOVEMENT TASK**

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INTRODUCTION: Goal setting is widely recognized, both theoretically and empirically, as being effective in enhancing performance. Past sports psychology research shows that setting moderately difficult goals improves performance in single-movement tasks like standing long jumps [1]. Although it demonstrates this effect, the underlying mechanisms remain unclear. Atkinsons achievement motivation theory suggests that motivation peaks when the probability of success is approximately 50%, as this optimally balances challenge and attainability [2]. It also explains why moderately difficult goals enhance performance by maintaining high motivation levels. However, the quantitative relationship among goal difficulty, motivation intensity, and motor control mechanisms remains little explored. Recent sports science research

shows that goal difficulty impacts psychological motivation, neuromuscular activation, and motor execution strategies [3]. However, most studies focus on endurance-based or multi-trial tasks, leaving a research gap on instantaneous, single-movement tasks like the standing long jump. This study aims to bridge this gap by quantifying motivation intensity under different goals and examining its impact on jump performance and motor control mechanisms.

METHODS: Three participants performed three trials per condition for six conditions in total: (1) no goal (control) and (2-6) goal conditions set at 90%, 100%, 110%, 120%, and 130% of their best performance. Participants reported their perceived probability of success before each jump using a visual analog scale (VAS). We collected kinetic and kinematic data using a high-speed camera (300 Hz) and force plate (1000 Hz). Key performance variables analyzed were jump distance, takeoff angle, peak force in the vertical and horizontal directions, and impulse (force-time integral).

RESULTS: The 110% goal condition yielded the longest jump distance—approximately 10% longer than the best one under the control condition—aligning with past findings showing that moderately difficult goals improve performance. The VAS data showed that motivation peaked at approximately 50% perceived probability of success, supporting Atkinson's above theory. Motion analysis revealed an association of a longer jump distance in the 110% condition with a higher impulse generation, particularly in the anterior–posterior direction, thus leading to an optimized takeoff angle and velocity. These biomechanical adaptations imply that goal setting influences both psychological motivation and movement execution, optimizing force production strategies.

CONCLUSION: The study provides novel insights into the role of goal setting in single-movement tasks, indicating that moderately difficult goals optimize performance by enhancing motivation and movement control. The findings contribute to the sports psychology field and have practical implications for coaching and training.

Refs.

1) King & Max, 2021

2) Atkinson, 1957

3) Locke & Latham, 2002

**EFFECTS OF IN-MATCH MISTAKES ON PSYCHOLOGICAL, PHYSIOLOGICAL, BEHAVIORAL, AND PERFORMANCE ASPECTS IN SOCCER, FIELD HOCKEY, AND KENDO**

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INTRODUCTION: Mistakes made during a match have been shown to affect subsequent performance. Making a mistake under pressure increases the likelihood of another mistake on the next play [1, 2]. Furthermore, athletes experience negative and positive effects of mistakes on their subsequent play [3, 4]. These studies focused on net-type and racing sports [3, 4]. Nonetheless, other sports, such as goal-type and individual-contact sports, may have different effects. Therefore, this study examined the psychological, physiological, behavioral, and performance effects of mistakes made during soccer, field hockey, and kendo matches.

METHODS: Semi-structured interviews were conducted with four university student-athletes (two men and two women) about the memorable mistake they made during a match. The questions assessed (1) the situation at the time of the mistake, (2) feelings and thoughts at the time of the mistake, (3) physiological symptoms at the time of the mistake, and (4) the effect of the mistake on subsequent play. Another effect was asked if either a negative or positive effect was answered. The interviews were analyzed using Steps for Coding and Theorization [5], a qualitative analysis method that involves step-by-step coding.

RESULTS: All participants reported negative effects, whereas one reported negative and positive effects. Negative psychological effects included feelings of depression and impatience. The negative physiological effects included thirst and palpitations. Negative behavioral effects are safety-oriented strategies. Negative effects on performance included the repetition of unusual mistakes. Positive effects were reported by a soccer goalkeeper who failed to save goals but decided not to give up an additional goal and improved concentration and performance.

Discussion: Most reports were consistent with those reported in previous studies [3, 4], suggesting that sports characteristics had no influence. Negative psychological, physiological, and behavioral effects caused by mistakes are consistent with the changes reported in studies on choking under pressure, such as negative emotions [6], physiological symptoms [7], and safety-oriented strategies [8]. While studies on choking under pressure suggest that mistakes can trigger it [9], the present study, which examines the effects of mistakes, also found that serious mistakes can cause choking under pressure.

References

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**EFFECTS OF PRE-EXERCISE CAFFEINE SUPPLEMENTATION ON THE PSYCHOPHYSIOLOGICAL RESPONSES TO HIGH-INTENSITY INTERVAL TRAINING: A SINGLE-SUBJECT RANDOMIZED EXPERIMENT**

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INTRODUCTION: Caffeine is well known to reduce perceived effort in athletes, but its effects in unfit people are not clear and may not be as pronounced [1]. This single-subject randomized controlled study aimed to preliminarily investigate the effects of pre-exercise caffeine supplementation on perceived effort, affective valence and enjoyment in unfit adults participating in high-intensity interval training (HIIT) to improve their cardiorespiratory fitness.

METHODS: An unfit adult female (baseline VO2max 26 ml/kg/min) participated in a single-subject randomized experiment involving two conditions: caffeine supplementation (3 mg/kg) 60 min prior to exercise and a placebo condition. The participant visited the lab for: a) Baseline VO2max test, b) Three HIIT sessions for familiarization, c) Eight HIIT sessions (4 caffeine, 4 placebo in random order), d) Follow-up VO2max test. The HIIT protocol consisted of uphill walking on a treadmill with 4 min at 85% VO2max followed by 3 min at 55% VO2max repeated four times (4 x 4 protocol). During exercise, the participant was asked to rate her perceived exertion (6-20 RPE scale) and affective valence (Feeling Scale, FS). Heart rate (HR) was continuously recorded with a HR monitor. Enjoyment was measured after each HIIT session with the Physical Activity Enjoyment Scale (PACES). Randomization tests [2] were used to assess for mean differences between the Caffeine and Placebo conditions. Data are presented as mean + SD of the values recorded at the end of the 4th interval (HR, RPE, FS) or after exercise (PACES). Statistical significance was set at $p < 0.05$.

RESULTS: After 5 weeks of training, VO2max increased to 29 ml/kg/min. Pre-exercise caffeine supplementation did not have a significant effect on HR (Caffeine 173 + 2 vs Placebo 172 + 1 beats/min, $p > 0.05$) but significantly reduced RPE (Caffeine 16.5 + 0.4 vs Placebo 17.3 + 0.5 a.u., $p < 0.05$). Caffeine also increased the FS score (Caffeine -1.3 + 0.5 vs Placebo -3.0 + 0.9 a.u., $p < 0.05$) and the PACES score (Caffeine 55.8 + 2.9 vs Placebo 47.3 + 5.0 a.u., $p < 0.05$).

Discussion: These findings provide preliminary evidence that pre-exercise caffeine supplementation can make vigorous exercise feel less effortful and more pleasant while maintaining the same level of physiological intensity in an unfit adult subject. If replicated in a large randomized controlled trial, these beneficial psychological effects of pre-exercise caffeine supplementation may result in improved adherence to HIIT programs that are highly effective in improving cardiorespiratory fitness and metabolic health but challenging from a motivational point of view.

References

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**EATING DISORDER SYMPTOMS AND KNOWLEDGE OF RELATIVE ENERGY DEFICIENCY IN ADOLESCENT ARTISTIC GYMNASTS: UNCONTROLLED RISKS?**

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INTRODUCTION: Excessive pressures to maintain a lean physique may lead adolescent athletes to dietary restraint and disordered eating behaviors. Lack of understanding the nutritional requirements of sport also influences athletes' dietary habits and increases the risks of eating disorders and Relative Energy Deficiency Syndrome (RED-S); however, evidence is lacking in competitive athletes. This study examined eating disorder symptoms and knowledge of Relative Energy Deficiency Syndrome in a sample of 12–18-year-old artistic gymnasts.

METHODS: Seventy-nine female adolescent artistic gymnasts, 34 international and national level (high-level; age: 14.4±1.3 y, BMI: 18.5±1.3 kg/m2) and 45 recreational and club level gymnasts (low-level; age: 14.0±1.3, BMI: 19.7±1.8 kg/m2) completed the Eating Disorder Examination Questionnaire (EDE-Q), the knowledge of the Relative Energy Deficiency Syndrome Questionnaire, the Social Desirability Scale (SDS), and provided information on their training.

RESULTS: High-level gymnasts scored higher than low-level gymnasts in EDE-Q (32,35 vs. 6,67%, respectively; $p = 0.002$) and its subscales Restraint ($p = 0.005$), Eating Concerns ($p = 0.002$), Weight Concerns ($p = 0.001$), and Shape Concerns ($p = 0.001$). High-level gymnasts also reported more binge eating episodes than low-level (26,4 vs. 8,9%, respectively; $p \leq 0.007$) and more menstrual disturbances ($p = 0.002$). No differences were observed between groups in purging, compulsive exercise, and knowledge of RED-S. Furthermore, knowledge of RED-S negatively correlated with self-induced vomiting in high-level gymnasts ($r = -0.380$, $p = 0.05$) and positively with menstrual disturbances in low-level gymnasts ($r = 0.313$, $p = 0.05$). Over 85% of the gymnasts in both groups reported having no prior knowledge of low energy availability or RED-S in sports, and 28.6–88.6% of all gymnasts failed to recognize known associations between insufficient energy intake and RED-S symptoms.

CONCLUSION: High-level, adolescent artistic gymnasts show more eating pathology than low-level. Furthermore, gymnasts demonstrate limited awareness of how inadequate energy intake for the demands of the training may impair health and performance, irrespective of competitive level. Overlooking these risks may have significant implications for gymnasts eating behaviors and may also hinder early detection, self-control, and autonomy of female athletes, as well as the treatment of RED-S where necessary.

**EFFECT OF MBI(YOGATES) ON PSYCHOLOGICAL AND PHYSIOLOGICAL HEALTH IN TIMES OF POST-COVID-19 PANDEMICS**

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Background:

Current pharmacological treatments and psychotherapeutic approaches often have adverse effects or are ineffective in late-life cognitive and mental illnesses. Mind-body interventions (MBI) offer a holistic approach and are of interest because of potential patient acceptability and scalability.

Mind-body interventions (MBI) have been developed, and have demonstrated promising potential to improve health-related quality of life (HRQoL) in elderly people. We sought to systematically review current evidence on the effectiveness of MBI in addressing HRQoL deficits in elderly people and many patients.

Objectives: Mind-body interventions has been generally recognized as a beneficial strategy to improve mental health in those with elderly people and many patients. However, to date, no attempt has been made to collate this literature. The aim of the present study was to systematically analyze the effects of mind-body interventions for elderly people with anxiety and depression and provide scientific evidence-based exercise prescription.

Methods: PubMed, CINAHL, Scopus, Web of Science and Google Scholar search engines were used to identify the definition, mechanism, pathophysiology of MBI and yogates and to find out psychological and physiological exercise-intervention benefits

Results: The major role of (mind body interventions) MBI was to promote psychosocial health outcomes, depression, body functionality, sleep quality and health-related quality of life (HRQoL) in elderly people. Various MBE such as yoga, Tai Chi, Qigong, Meditative movement, Pilates and yogates have become an recognized as a part of physical exercise, serving to improve sleep quality, physical activity, fitness, health, psychosocial health, and reducing physical limitations, chronic pain and even cancer through meditation, relaxation, breathing, and integrating postures and so forth.

**OPPONENT MOVEMENT UNCERTAINTY AND REACTION TIME: A SIMULATED KENDO MATCH EXPERIMENT**

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Introduction

In kendo and similar sports, athletes face unpredictable situations where their opponent's actions constantly change. This creates uncertainty in decision-making and requires rapid judgment. The attack–defense decision evolves throughout the match, maintaining both options until the final moment, akin to the superposition of states in Schrödinger's cat thought experiment (1). Athletes observe their opponent's movements while retaining both options, making a split-second decision. This study quantifies uncertainty using entropy and examines its impact on reaction time (RT) under varying conditions, evaluating how it affects decision-making speed and accuracy.

METHODS: Owing to limited prior RT research (2), this study was conducted as a pilot study with one participant to explore human response characteristics in uncertain situations. Participants quickly pressed a key in response to the stimuli on the screen. Two stimuli were used: a preparatory stimulus (a white circle) for the tactical phase and a main stimulus (a red circle) for the decision moment. The preparatory stimulus appeared eight times consecutively, followed by the main stimulus on the ninth trial. Uncertainty was adjusted by manipulating the time intervals between stimuli using entropy, with three conditions: low (450–550 ms), medium (400–600 ms), and high (300–800 ms). Six experimental patterns were created by sequencing these conditions (e.g., low → medium → high), with one trial per pattern, totaling six trials. The participant pressed the "F" key with the left hand for the preparatory stimulus and either the "K" key (attack) or the "L" key (defense) with the right hand for the main stimulus. A response within 0.3 s was considered a successful attack, preventing random selection. After each trial, the RT and attack success were recorded and displayed as feedback.

RESULTS: RTs for the preparatory stimulus were 0.30 ± 0.08 s (low uncertainty), 0.30 ± 0.05 s (medium uncertainty), and 0.28 ± 0.05 s (high uncertainty). RTs for the main stimulus were 0.28 ± 0.01 s (low uncertainty condition), 0.28 ± 0.02 s (medium uncertainty), and 0.29 ± 0.02 s (high uncertainty). The participant chose to attack in all trials, with two of six trials in the high uncertainty condition exceeding the 0.3-second response limit, indicating failure.

CONCLUSION: The results suggest that the reaction time increases under higher uncertainty (greater entropy), reducing decision-making speed. Under high uncertainty, some trials showed difficulties in decision-making within the time limit. Further investigation with additional participants is expected to provide a more generalizable understanding of the relationship between uncertainty and decision-making.

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2 .Klemmer,E.T. (1957)

**EFFECTS OF PHYSICAL ACTIVITY INTERVENTION ON INHIBITION CONTROL IN CHILDREN AND ADOLESCENTS WITH ADHD: A META-ANALYSIS**

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Background: Children and adolescents with attention deficit hyperactivity disorder (ADHD) often have trouble with inhibition control (IC), which is a critical executive function in regulating inappropriate behaviors. Physical activity (PA) is a non-pharmacological approach to improve IC, but the optimal design, such as the setting of intensity, time per session, and frequency, remains unclear. This meta-analysis aims to assess the effect of PA intervention in inhibition control on children and adolescents with ADHD.

Methods: Following PRISMA guidelines, the systematic search was conducted across four databases, including PubMed, Web of Science, Embase, and Cochrane Library. Study quality was assessed using the PEDro scale. Stata 18.0 and R software were used to perform the pairwise meta-analysis, involving subgroup analysis, heterogeneity, publication bias, and sensitivity analysis tests. Subgroup analyses were conducted based on the moderating factors, including the intensity, session duration, weekly frequency, and total intervention duration.

Results: A total of 17 studies (784 participants aged 7-17 years old) were included with good methodological quality (Mean = 6.1 scores). PA interventions improved IC (SMD = 0.58, $p < .05$) with high heterogeneity ($I2=85.27\%$, $p < .00$). Long-term PA interventions improved IC (SMD = 0.68, $p < .00$), while acute-term PA interventions showed no significant effect. For moderating factors, non-specific intensity requirement (SMD=0.80, $p < .05$), moderate frequencies (≤ 3 times per week: SMD = 0.96, $p < .05$), and around 60 minutes per session (SMD = 1.00, $p < .00$), were statistically significant. However, there was no significance in higher intensity and high frequency. Leave-one-out sensitivity analysis showed a 13.93% to 21.96% reduction in overall effect size but confirmed the role of PA in improving IC in children and adolescents with ADHD.

Conclusion: The long-term PA intervention has a positive effect on improving IC, and the optimal intervention design is 1-3 times per week and 60 minutes per session, as well as long-term engagement without specific intensity requirement. The high heterogeneity, due to different study designs and non-differentiated ADHD types, suggests careful interpretations of the results. Future research should evaluate this PA intervention structure and stratify ADHD subtypes to explore more targeted intervention strategies.

**PERFECTIONISM, MOTIVATION AND CONCENTRATION IN TEAM SPORTS**

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INTRODUCTION: Based on the self-termination theory (SDT)[1] that postulates a sequence of theoretical relationships that goes from contextual environment-psychological mediators-motivation-consequences, in the present study a contextual environment variable is proposed, the perception of pressure for perfection, from the multidimensional theory of perfectionism[2]. This variable is defined as the coachs tendency to impose high goals and put pressure to achieve them, as well as to critically evaluate (PCP)[3]. As psychological mediators, we take up the SDT postulates to incorporate the basic psychological needs (BPN), innate and universal: competence, relatedness and autonomy. Regarding motivation, SDT suggests that behavior can go along a continuum of motivation from autonomous, through controlled to amotivation. As a outcome variable we incorporate the concentration of attention, which is the process that allows the "focusing of all attention on the relevant aspects of a task, ignoring or eliminating everything else"[4]. It is an important aspect during the competition, as well as in the learning phase and in training, since it allows attention to be focused on the relevant stimuli[5].

The objective was to relate psychological variables (PCP, BPN satisfaction's, motivational regulations, and concentration) in young practitioners of team sports in Mexicali City.

METHODS: Under a cross-sectional and correlational design, sixty soccer and field hockey players (32 men and 28 women), with an age between 12 and 23 years, participated voluntarily. They answered a set of questionnaires that measured the study variables.

RESULTS: The practitioners reported moderate PCP ($M=3.35$; $SD=1.50$), high BPN satisfaction's (e.g. $M=5.73$; $SD=1.28$ for competence; $M=5.89$; $SD=1.15$ for relatedness), high autonomous motivation ($M=5.83$; $SD=1.09$) and concentration ($M=4.42$; $SD=0.95$), as well as low amotivation ($M=1.66$; $SD=0.88$). Since the Kolmogorov-Smirnov test showed that the variables deviate from a normal distribution ($p<.05$), the Spearman correlation matrix indicated that PCP was not related to the satisfaction of any BPN ($p>.05$), the satisfaction of each BPN was positively related to autonomous motivation ($\rho$ between .40 and .64; $p<.05$), and negatively related to amotivation ($\rho$ between -.53 and -.65; $p<.01$). Finally, concentration was related to autonomous motivation ($\rho=.47$; $p<.01$).

Discussion: In this study sample, the PCP in athletes is not associated with BPN satisfaction's. These, in turn, do increase the practice of these team sports for reasons of enjoyment and pleasure, which aligns with the theoretical assumptions of the SDT. This motivation increases concentration, an important psychological skill in sport performance, which can contribute to the projection of future sporting talents.

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**BRAIN HEALTH AND FITNESS CLASSES IN OLDER ADULTS: EFFECTS ON FEELINGS OF SUBJECTIVE HOPE**

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INTRODUCTION:

Cognition declines exponentially as individuals age, highlighting the importance of strategies to offset age-related conditions. Studies show that a healthy lifestyle can preserve cognitive function in older individuals. However, the number of individuals engaging in healthy lifestyle interventions like exercise decreases rapidly after the age of 60. Research suggests that more hopeful individuals are more likely to be engaged in healthy habits. This study evaluated whether participation in a brain health and wellness class improved the feeling of hope among older individuals.

METHODS:

Participants aged 60-76 years old took part in an 8-week brain health and fitness class. The class focused on teaching participants about nutrition, socialization, sleep, stress, and exercise as methods for improving brain health. Weekly classes were tailored to include relevant activities to encourage classroom participation. Participants were given the opportunity to participate in research and 4 individuals from the class chose to participate. Prior to the start of class, participants completed the Adult Hope Scale (AHS), which they completed again following the conclusion of the 8-week class. Their results were compared to 5 other individuals aged 53-71 who were on the wait list for the class and as such, were the control group.

RESULTS:

The 4 participants completed the 8-week course intervention and pre- and post-assessments with overall satisfaction about the requirements of the study and the course length. After the course, it was found that, on average, the intervention group experienced an increase in hope scale score from 56.5 to 58.5, whereas the control group showed no increase.

CONCLUSION:

Current literature shows that people with more hope are more likely to follow healthy habits. Individuals who took the Brain Health and Fitness class experienced increased feelings of subjective hope on average. Conversely, the control group who did not participate in the class, did not experienced an increase in feelings of subjective hope. These findings suggest a correlation between taking a Brain Health and Fitness class and improving subjective hope for older individuals. Future research will include larger sample sizes, including individuals with Parkinson's Disease and other neurological conditions, as well as the general population.

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**THE FEMINIZATION OF SEA RESCUE WITHIN THE NATIONAL SOCIETY FOR SEA RESCUE (SNSM, FRANCE):**

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Introduction:Sea rescue is known to be a predominantly male domain due to the inherent missions such as rescuing people in hostile environments, maritime accidents, training, and preparing rescuers under difficult conditions. The low level of gender diversity within the SNSM can be attributed to the physical requirements of the job, which are often associated with masculinity in sports and similar to other traditionally male-dominated professions (military). This relates to the concept of gender stereotypes, linked to masculinity and femininity. Masculinity includes traits such as "aggressiveness, strength, and a drive for success," while femininity includes "passivity, kindness, and dependence" (Renard, 2021). However, despite the marginal presence of women, we analyzed the role of women in the sea rescue sector within the SNSM. We questioned the low proportion of female sea rescuers and explored potential ways to modify this distribution.

Methods:We used the semi-structured interview method (Lincoln, 1995) with 6 experienced rescuers : 3 women and 3 men from the SNSM. The interviews were recorded using a voice recorder. We also coded the data based on themes such as motivation and commitment to the SNSM, gender diversity in rescue teams, levels of operational responsibility, and well-being within the team. This data analyzed to identify gender-related differences.

Results:Our data revealed that all 3 female rescuers reported experiencing sexist and sexual remarks from male colleagues, regardless of their level of responsibility (supervisors or fellow rescuers). These findings also highlighted a negative impact on their self-esteem: "So if I drown, are you capable of rescuing me? Since you're a woman, I have to ask." A lack of respect was identified, which challengers the legitimacy of female sea rescuers, as well as a lack of consideration

from male colleagues. The study on gender diversity showed that all women and men rescuers prefer mixed-gender rescue teams over single-gender teams.

Discussion: These results illustrate that the way men perceive women in this field leads to gender stereotypes. This concept refers to the process by which individuals learn behaviors, attitudes, associated with their gender. Male rescuers have likely been shaped by this process since childhood. In conclusion due to gendered socialization, gender stereotype develop, including in the field of sea rescue. Women in this operational context contribute to establishing a climate of trust with victims, as female rescuers are perceived as warm, affectionate, and emotional—contrary to stereotypes associated with men. Women entering this profession put their bodies at the forefront as a key tool in sea rescue. The physical aspect of the job clearly remains a barrier to the feminization of sea rescue teams. To address this challenge, it would be effective to implement an inclusion awareness module in SNSM training programs to protect female rescuers.

**THE RELATIONSHIP BETWEEN MENTAL HEALTH STATUS AND SPORTS INJURY OCCURRENCE AMONG MALE UNIVERSITY ATHLETES**

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In recent years, as part of the Olympic Agenda 2020+5, the International Olympic Committee (IOC) has highlighted the issue of mental health among athletes by outlining 16 actions to be implemented by 2026 (IOC, 2025). As indicated by the stress-injury model (Andersen & Williams, 1988; Williams & Andersen, 1998), stress and mental health issues can lead to various symptoms such as depression and anxiety, and they have also been reported as risk factors for sports injuries and disorders (Rogers et al., 2023). However, research on this topic remains limited. Therefore, this study aimed to investigate the mental health status of male university athletes and clarify its relationship with injury occurrence.

The participants of this study were 193 male athletes belonging to university sports teams. A questionnaire survey was conducted, collecting information on their profile and the Japanese version of The International Olympic Committee Sport Mental Health Assessment Tool 1 (SMHAT-1). Three months after the initial survey, injury occurrences during this period were assessed. A two-sample t-test was performed to compare SMHAT-1 scores between injured and non-injured athletes. Furthermore, for items that showed significant differences, a binomial logistic regression analysis was conducted, with injury occurrence as the dependent variable. The significance level was set at less than 5%.

Regarding mental health status, 69 athletes (35.8%) tested positive in Form 1 of the Athlete Psychological Strain Questionnaire (APSQ). In Form 2, the number of athletes reporting specific issues was as follows: Anxiety (11 athletes, 5.7%), Depression (14 athletes, 7.3%), Suicidal ideation (7 athletes, 3.6%), Sleep disturbance (73 athletes, 37.8%), Alcohol misuse (49 athletes, 25.4%), Substance misuse (3 athletes, 1.6%), and Disordered eating (71 athletes, 36.8%).

The independent t-test results showed that the injured group had significantly higher APSQ scores than the non-injured group ($p<.05$). Subsequently, a binomial logistic regression analysis was conducted using APSQ as an independent variable. The model chi-square test indicated statistical significance ($p<.01$), and the Hosmer-Lemeshow test showed good goodness of fit ($p=.99$). Additionally, the odds ratio was 1.09 (95% CI: 1.03–1.15, $p<.01$).

The results of this study revealed that an increase in APSQ scores was associated with a higher risk of injury among male university athletes. In other words, these findings support the stress-injury model, which demonstrates the relationship between psychological factors and injury occurrence. Based on these results, it is suggested that maintaining good mental health may contribute to the prevention of sports injuries.

**PERSONALITY TRAITS AND SPORTS PERFORMANCE IN UNIVERSITY SOCCER PLAYERS**

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INTRODUCTION: The study of personality traits in athletes has gained relevance in sports psychology due to its potential influence on performance. The purpose of this study was to analyze the relationship between the Big Five personality traits and the sports performance of university football players.

METHODS: A cross-sectional, correlational study was conducted with a sample of five male football players from the representative team of the Universidad Autónoma de Nuevo León. The Big Five Inventory (BFI) was used to assess personality traits, while a customized sports performance questionnaire, completed by the team coach, evaluated players performance. Descriptive and inferential statistical analyses were performed, including means, standard deviations, and correlation tests using SPSS.

RESULTS: The findings indicated that agreeableness was the most prevalent personality trait among the players. The goalkeeper position showed a higher association with openness to experience, while midfielders and defenders exhibited higher levels of agreeableness. Additionally, sports performance was positively correlated with conscientiousness, but no significant relationships were found between performance and neuroticism or openness to experience. A negative correlation was observed between extroversion and technical skills.

CONCLUSION: The results suggest that personality traits, particularly agreeableness and conscientiousness, may play a role in the perceived sports performance of football players. Further studies with larger samples and longitudinal designs are recommended to establish causal relationships and explore the influence of personality traits in different playing positions and competitive levels.

**EFFECTS OF TAEKWONDO CLUB PARTICIPATION ON COLLEGE STUDENTS POSITIVE AND NEGATIVE EMOTIONS**

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INTRODUCTION: In recent years, the mental health of college students has received widespread attention, with high rates of negative emotions such as anxiety and depression. Physical exercise is proven to regulate emotions and improve mental health. This study aims to explore the effect of Taekwondo club participation on college students emotions.

METHODS: A total of 20 Taekwondo club members were recruited, including 12 females and 8 males, with an average age of 19.4 ± 0.9 years. All participants were first-time members of the Taekwondo association. Additionally, 20 participants were recruited for the control group, consisting of 10 females and 10 males, with an average age of 19.9 ± 0.8 years. The control group did not participate in any physical activities other than physical education classes. The experimental group participated in Taekwondo club activities over the course of one semester (16 weeks), attending 2-3 sessions per week, each lasting 1.5 hours. The sessions included warm-up, stretching, Taekwondo-specific training, physical conditioning, and relaxation, with moderate to high intensity. Both groups completed the Positive and Negative Affect Schedule (PANAS) before and after the intervention to assess Positive Affect (PA) and Negative Affect (NA). The PANAS consists of 20 adjectives, including 10 for PA and 10 for NA, with each item scored on a 1-5 scale. The PA and NA scores were calculated as the sums of their respective 10 items. The data were organized and summarized in Excel, and statistical analysis was conducted using SPSS 25. A 2 (group: club vs. control) × 2 (time: 0 and 16 weeks) repeated measures analysis of variance (ANOVA) was used to assess changes in positive and negative affect scores over time. Post-hoc tests were then carried out to further explore significant main effects and interactions.

RESULTS: (1) The Taekwondo group retained 18 participants (2 withdrew due to physical/personal reasons); baseline PA （29.0±6.2 vs 30.7±5.2, p=0.377） and NA （19.6±7.0 vs 20.1±4.9, p=0.781） showed no intergroup differences.

(2) A repeated measures ANOVA revealed a significant main effect of time on PA (F=6.395, p=0.016). Specifically, the Taekwondo group showed a significant increase in PA scores post-intervention at week 16 compared to week 0 (19.6±7.0 vs 20.1±4.9, p = 0.017), indicating a significant improvement in positive emotions following the intervention.

(3) Meanwhile, the time × group interaction effect on NA was significant (F=4.788, p=0.35), indicating that the effect of time on NA differed between the two groups. Post-intervention, the Taekwondo group exhibited significantly lower NA scores compared to the control group (17.4±3.8 vs 23.4±5.3, $p<0.001$), suggesting that the Taekwondo intervention significantly reduced negative emotions.

CONCLUSION: Participation in Taekwondo club significantly improves college students emotional well-being, particularly in controlling negative emotions. These findings support the inclusion of

**THE IMPACT OF MONGOLIAN MIND-BODY INTERACTIVE PSYCHOTHERAPY ON DEPRESSION IN ELDERLY PATIENTS**

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INTRODUCTION: Studies have shown that elderly individuals with pre-existing medical conditions are at higher risk of depression, which negatively impacts their quality of life and physical health.Mongolian Mind–Body Interactive Psychotherapy (MMIP) is a psychotherapy that combines modern psychology with traditional Mongolian medicine.By examining EEG and ECG signals from three elderly patients across three intervention stages, this research aims to investigate whether MMIP can improve the mood of elderly patients with depression.

METHODS: Three elderly patients,living with depression and other chronic illnesses, participated in a total of 32 days of MMIP. Data were collected on days 5, 19, and 32 of the treatment.Participant one was a 65-year-old male with psoriasis and cerebral thrombosis;participant two was a 66-year-old female with emphysema, hypertension, and sleep disorders; and participant three was a 67-year-old male with high blood pressure, diabetes, and a history of cerebral hemorrhage. MMIP included listening to Mongolian songs, engaging in Mongolian meridian exercises, and a debriefing session. The music phase featured six calming Mongolian songs aimed at relaxation.The Mongolian meridian exercises, a traditional practice to stimulate energy flow, included slow stretches, controlled breathing, and mindfulness, tailored to participants physical limitations. The session lasted 30 minutes and consisted of nine parts .The debriefing phase encouraged empathy by having participants listen to the stories of others recovery or significant improvement in disease symptoms owing to the therapy.

RESULTS: Although the three phases of MMIP did not show significant differences in physiological data or mood changes across all participants, preliminary results suggest that MMIP may help alleviate depressive symptoms in elderly patients. EEG data revealed more stable and coordinated brainwave patterns during the music and exercise phases, indicating improvements in emotional states. During the exercise phase, ECG data demonstrated more regular and stable heart rate variability. In the debriefing phase, no significant physiological changes were observed.Subjective feedback from participants indicated they felt more relaxed, less anxious, and had improved mood and energy levels after the therapy.

CONCLUSION: This study provides preliminary evidence that MMIP can effectively improve mood and alleviate depressive symptoms in elderly patients. These findings offer a promising alternative treatment for elderly depression, but further research is needed to validate the long-term benefits of this combined approach.

**THOSE WHO WEIGHT TRAIN AND RUN EXHIBIT LOWER ANXIETY THAN THOSE WHO PARTICIPATE IN GROUP FITNESS OR DO NOT EXERCISE.**

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INTRODUCTION: A regular exercise routine can be an effective way to reduce anxiety, yet, exercise rates are lower in those with anxiety. This suggests anxiety may act as a barrier to exercising without regard to specific exercise modality. The purpose of this study was to evaluate whether college students who participate in different exercise modalities exhibit the same lower levels of anxiety and exercise-specific anxiety, than those who do not exercise.

METHODS: The present study included 333 students from a private liberal arts institution (263 females; 66 males; 1 nonbinary/third gender). On average, participants were 19.5 years old (SD=1.55; Range=18-34). Participants completed a survey that measured their exercise habits and exercise-based and general anxiety. Exercise anxiety was measured using the Social Exercise and Anxiety Measure, which yields three subscales: Self-Efficacy (SES), one's belief in their ability to complete exercises, Gym Avoidance (GA), hesitancy to attend a gym, and Exercise Importance (EI), personal significance of physical activity. They also completed the Generalized Anxiety Disorder 7 to measure overall anxiety.

RESULTS: Participants were categorized into four groups: "resistance trainers" consisted of those who reported lifting weights at the gym within the past week (n=178), "yogis" those who had participated in yoga in the past week (n=77), "runners" who reported running in the past week (n=152), "interval trainers" who participated in a group fitness class within the past week (n=111) and "non-exercisers" those who had not exercised in the past week (n=121). Non-exercisers exhibited less confidence in their ability to perform exercise-related tasks (M=64.15, SD=19.20) than resistance trainers (M= 80.35, SD= 17.3; t(326)= 7.53, p <.001) and runners (M=77.93, SD=19.77; t(326)=4.043, p<.001) but not yogis (M=74.24, SD= 18.24; t(326)= .545, p=.586) or interval trainers (M= 76.56, SD= 17.52; t(326)=1.474, p=.142 ). In addition, non-exercisers considered exercise less important to their day-to-day lives (M=4.64, SD=1.98) compared to all exercise modalities; runners (M=5.76, SD=1.00; t(330)=4.55, p<0.001) , weight lifters ( M=5.81, SD=.99; t(330)=6.33, p<0.001), yogis (M=5.86, SD= 1.02; t(330)=3.52, p<0.001), and interval trainers (M=5.84, SD= 1.27; t(330)=4.37, p<0.001). Interestingly, the yogis and interval trainers exercised despite having higher anxiety levels.

CONCLUSION: Overall, the results indicate exercise modality matters in regards to anxiety levels. Group exercisers showed the same anxiety levels as those who do not exercise but they valued the importance of exercise more. Group exercise, like yoga and interval training, may serve to mediate the exercise-specific anxiety while fulfilling the desire to exercise. Further studies are needed to understand if exercise-specific anxiety can be improved through coaching by a fitness professional.

**THE MECHANISM OF IRRATIONAL BELIEFS ON COMPETITIVE ANXIETY IN HUNGARIAN ATHLETES**

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INTRODUCTION: Rational Emotive Behavior Therapy (REBT), particularly its core concept of irrational beliefs, has gained increasing attention in both scientific research and applied sport psychology. The primary objective of this study is to investigate the impact of irrational beliefs—demandingness, awfulizing, frustration intolerance, and depreciation—on competitive anxiety, including cognitive anxiety, somatic anxiety, and self-confidence.

METHODS: A total of 407 Hungarian athletes participated in the study and completed the Hungarian-adapted version of the Irrational Performance Beliefs Inventory (iPBI-HUN) and the Competitive State Anxiety Inventory (CSAI-2HR). To explore the effects of irrational beliefs on competitive anxiety, confirmatory factor analysis (CFA) and structural equation modeling (SEM) were conducted using SPSS AMOS software.

RESULTS: The confirmatory factor analysis supported the original factor structure of the iPBI-HUN, while a two-factor model (anxiety and self-confidence) demonstrated better fit indices for the CSAI-2HR. Therefore, subsequent analyses were based on this model. SEM results indicated that the REBT-I model (direct and indirect effects of irrational beliefs on CSAI subscales) and the REBT-III model (indirect effect of demandingness on competitive anxiety through secondary irrational beliefs, without direct effects of demandingness) provided the strongest predictions for anxiety and self-confidence. In contrast, the REBT-II model (direct relationships between all irrational beliefs and CSAI subscales) failed to show acceptable model fit regarding competitive anxiety.

Discussion: Findings suggest that the primary irrational belief, demandingness, predicts increased anxiety and decreased self-confidence through secondary irrational beliefs (awfulizing, frustration intolerance, and depreciation). These results underscore the importance of identifying and restructuring secondary irrational beliefs in Hungarian athletes to effectively regulate anxiety and self-confidence levels. The study highlights the necessity of integrating REBT principles into sport psychological interventions to enhance athletes mental health and optimize performance under competitive conditions.

## Sociology

### RESEARCH ON HAND DRAWN MENTAL MAPS OF SPORTS CITY SPATIAL IMAGE

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In the context of the emergence and rapid development of sports cities, current research primarily focuses on two main aspects: the role of sports activities in shaping urban brands, revitalizing the economy, improving peoples livelihood, and the study of evaluation index system models and internal factors influencing the formation of urban field patterns. However, this field faces challenges due to insufficient micro-level analysis, empirical studies of citizens as subjects, and in-depth investigations, particularly regarding the "image" perception of sports participants personal experiences. This study employed literature review and hand-drawn cognitive mapping methods to analyze and summarize the cognitive maps drawn by sports activity participants. The research revealed that sports participants formed sequential and spatial images, as well as some singular sports facility images, which were represented in their cognitive maps. Cognitive factors such as participants gender, environmental familiarity, personal preferences, types of sports activities, and educational background influenced the formation of spatial images in their cognitive maps. Regarding the composition of cognitive map images of urban sports venues, females demonstrated more diverse and rich overall images compared to males. Male spatial images were predominantly composed of districts, while female images were mainly constructed through paths and landmarks. Additionally, female respondents showed greater deviation in their drawn routes compared to geographic map routes than their male counterparts. Cities are fundamentally human-centered, representing the embodiment of human spirit, and sports venues are not merely objective exercise spaces; their true scale derives from the projection of human subjects bodies. Emphasizing human perspective and scale in sports city research is essential for providing better recommendations and strategies for future spatial planning and construction.

## Sport Management and law

### PREDICTING VOLUNTEER RETENTION: THE 2023 COLOMBIAN NATIONAL SPORTS GAMES

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INTRODUCTION: Volunteering is often driven by a complex interplay of personal and societal motivations. Traditional factors associated with volunteerism include patriotism, personal growth, and a love for the relevant cause or activity (e.g., sports; Bang et al., 2019). However, emerging sociocultural factors, such as environmental concerns, gender equality, and trust in the organizing body, may also play a significant role in shaping volunteers' intentions to continue their engagement.

This study investigates the motivations influencing volunteers' future intentions in the context of the 2023 Colombian National Sports Games. Specifically, we examine the predictive power of both traditional motivational factors related to sport events and emerging sociocultural factors on volunteers' intentions to continue their service.

METHODS: A total of 191 Colombian volunteers (Mean age = 27.94 years, SD = 10.49), including 130 men, participated in this study. Participants voluntarily completed questionnaires assessing their motivation for volunteering in sporting events. The questionnaire evaluated factors such as expression of values, patriotism, interpersonal contacts, career orientation, personal growth, extrinsic rewards, and love of sports. Additionally, the survey measured participants' perceptions of environmental sustainability, gender equality, and trust in the organizing body.

RESULTS: Multiple regression analyses revealed that trust in the organization ($b = .23$, $p < .01$), perception of gender equality ($b = .16$, $p < .05$), and overall motivation ($b = .38$, $p < .00$) were significant predictors of volunteers' intentions to continue their service ($R2 = .45$). Notably, the perception of environmental sustainability was not a significant predictor ($b = -.003$, $p > .05$).

Further analysis focusing on the individual factors within the motivation scale showed that only personal growth ($b = .22$, $p < .01$), extrinsic rewards ($b = -.15$, $p < .05$), and love of sports ($b = .19$, $p < .01$) were significantly associated with the intention to volunteer again ($R2 = .45$).

Conclusions

Our findings highlight the importance of both traditional and emerging factors in shaping volunteers' intentions to continue their engagement. Trust in the organization and the perception of gender equality within the event emerged as key factors associated with future volunteering intentions. Interestingly, the negative association of extrinsic rewards suggests that these volunteers may be primarily driven by intrinsic motivations such as personal growth and a love for sports, rather than tangible benefits.

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**EXPLORING THE IMPACT OF BRAND PERSONALITY, ATTITUDE, AND EMOTIONAL VALUE ON UNIVERSITY EVENT: A CASE STUDY OF THE 2024 INTERNATIONAL SOOCHOW ULTRA MARATHON**

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Introduction:

The current study is to examine the impact of brand personality of Soochow University Ultra Marathon on key related variables in students' behavior. Students' association with the university plays a serious part for the university brand. A strong brand personality fosters identification and loyalty for the university, especially a place for education, interdisciplinary learning. Knowing students' attitude on the event hosted by the university can be a key aspect for students' behavior, surrounding students to cognitive and emotional evaluations, which can directly impact the student's behavior, such as word-of-mouth promotion, and long-term support of the university. Emotional values are characterized by feelings and emotions experienced by students when there is Soochow University Ultra Marathon which takes an affective student experiences derived from the event and has been shown to be a powerful determinant of satisfaction and engagement in university.

METHODS: The study distributed 450 questionnaires among Soochow University in Taiwan, the sample for the purpose of this study after elimination consists of a 351 valid questionnaire. A 5-point Likert scale was used in this study, with 5 being the highest agreeable scale and 1 being the least agreeable. SPSS for windows was used for basic descriptive analysis, and the study used Smart PLS 4 to analyze structural equation modeling with CFA to test for reliability and validity and to test the relationship among the variables.

Results:

The collected survey consists of 177 (48.9) male and 204 (58.1%) female with age 19.08 ≤ The analysis showed that the measurement model has a good fitness indicator where the SRMR was at .0.053 which met the criteria. This study showed that the factor loading range was at 0.713-0.933 and NFI had the value of 0.885 which met the required value of NFI>0.9 . Additionally, the Brand personality had the exploratory power of attitude R2 was .25 giving an exploratory power of 25% and toward emotional value of R2 was.56 with an exploratory power of 56%

Discussion:

Understanding the relationships between these variables is essential to enhance Soochow University name and build lasting connections with its students and alumni. This study investigates brand personality effects on attitude and emotional value, and how these, in turn, affect overall experience with the event and the university. This research not only contributes to the academic discourse on sports branding but also offers practical implications for improving the emotional and attitudinal dimensions and also understand the importance of hosting an international event for the university, ensuring sustained growth and global recognition for the Soochow University.

**LEVERAGING UNIVERSITY SPORTS EVENTS: EXAMINING FUNCTIONAL CONGRUITY, ENGAGEMENT, AND BRAND LOYALTY THROUGH THE INTERNATIONAL SOOCHOW ULTRA MARATHON**

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INTRODUCTION: Sporting events are not only athletic showcases but also a platform for fostering brand loyalty and the enhancement of institutional reputation, to reflect the alignment between students' expectations and their perception of the university's offerings or values. In the context of the International Soochow Ultra Marathon, this could include the events quality. Students' positive perception of the university makes it a critical factor in institutional branding. Moreover, engagement captures the level of emotional, cognitive, and behavioral involvement of students. Engaged students are more likely to form strong, memorable connections with the university through the event. Brand loyalty examines the commitment of individuals either alumni students, or external audience to the Soochow University brand. Loyal supporters of the university will not only advocate for the university but also sustain its reputation and influence.

METHODS: The study consists of 430 university students, after elimination of invalid response a total of 380 students of Taiwan Soochow university questionaires were used in the study. This study consists of 161 male and 219 female participants, with an average age of 19.17. The study used 5-point Likert scale from least agreeable with 1 being least to 5 being the most agreed on, which shows that the higher the agreement the higher the level of construct.± .90.The current research recruited to participate in the study, with the use of structural equation modeling with the confirmatory factor analysis (CFA), and the test for reliability to examine consistency and validity including the test of association between the variables.

RESULTS: The analysis showed that Structural equation modeling was implemented to verify the model fit with SRMR 0.064 which met the required value of < 0.08. Functional congruity, engagement and brand loyalty. The study model validated that functional congruity was positively related to engagement (β = 0.652 ***); and was positively related to brand loyalty (β =0.338***) and engagement was also positively related to brand loyalty (β=0.414***). Discussion: This study provides data-driven insights from variables of functional congruity, engagement and brand loyalty, showed how Soochow University can leverage tthrough International Soochow Ultra Marathon which align its branding efforts with the experiences of students, alumni and external audience. The findings aim to contribute to both academic research in sports branding and

practical applications for enhancing institutional visibility and loyalty through sport event to bring more support from students and alumni.

**EXPLORING THE IMPACT OF COGNITIVE AND SOCIAL VALUES ON ATTITUDE AND BRAND IMAGE: A CASE STUDY OF THE INTERNATIONAL SOOCHOW ULTRA MARATHON**

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Introduction :

The 24-hour International Soochow Ultra Marathon event has garnered significant attention showcasing athletic excellence and participation of students and alumni. Understanding how students and alumni feel about the university is utmost important for the institution branding. Sporting events often transcend mere competition, hoping to offer rich opportunities to explore the interplay of values, attitudes, and brand perceptions among participants. This study aims to delve into the nuanced relationships between cognitive value, social value, attitude, and brand image within the context of the International Soochow Ultra Marathon.

Method :

A total of 420 questionnaires were distributed among university students, with 32 invalid responses and a total of 388 valid questionnaires were analyzed using SPSS 23.0 for basic descriptive analysis. For the validity and reliability of the questionnaire the study used Smart PLS, a statistical tool to perform the Structural Equation Modeling (SEM). Furthermore, to analyze the fitness of good and the relationship among the variables of cognitive value, social value, attitude and brand image.

Results :

This study a total of 168 males and 220 females participants which found positive relationship of cognitive value on attitude (β=.427***) and social value (β=.388***) and attitude on brand image was (β=.591***) in which attitude variance of latent variable was R2 = .614 which made up 61.4% meanwhile brand image R2 was .350 which made up 35 % of variance in the latent variable.

Discussion :

The findings of this study showed cognitive value as an intellectual or functional benefit derived from the event, service, or experience, this plays a pivotal role in shaping participants and spectators attitudes toward the event. Furthermore, social values connect to the benefits that is associated with social recognition, such as belonging, and the identity that individuals derive from participating in or the connections with the marathon. Positive attitudes is not only an indicative of satisfaction of the event but also serve as a bridge inducing the perceived brand image of Soochow University. By using SEM, this study seeks to discover the direct and indirect pathways through which these constructs interact, which provides insights for event organizers, marketers, and the university administrators. Ultimately, highlighting the strategic importance of leveraging sports events as platforms for enhancing the university brand image.

**ENHANCING UNIVERSITY BRAND EQUITY: HEDONIC AND UTILITARIAN VALUE IN THE SOOCHOW ULTRA MARATHON**

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INTRODUCTION: University-hosted sports events are powerful platforms for enhancing university branding and fostering meaningful connections with students and alumni. The International Soochow Ultra Marathon, a prestigious ultra marathon running event, provides an ideal context to explore how hedonic value, utilitarian value, and brand equity interact to shape the universitys overall brand perception. Hedonic value represents emotional and experiential enjoyment, derived from attending events, and the counterpart of hedonic the utilitarian value which plays an important part in efficient organization, which benefits practical outcomes which contributes to the audience perception. The collective value of a brand derived from audience perceptions brand equity is the ultimate outcome of hedonic and utilitarian value in ultra marathon

Method:

A total of 362 questionnaires were distributed, with basic descriptive analysis using SPSS 23.0. The study used Smart PLS, a statistical tool to perform the Structural Equation Modeling (SEM) to analyze the relationships among hedonic, utilitarian values and their collective impact on Soochow University's brand equity. Confirmatory factor analysis was tested to ensure the validity and reliability of items.

RESULTS: The model showed good fitness with SRMR 0.042 below 0.08 and NFI 0.878 which is above the required value. Furthermore, we could see that the value for hedonic on brand equity was β= 0.477*** and Utilitarian on brand equity was β=.227**. The R2 for brand equity was 0.463 which indicated 46.3% for variance in latent variables.

Discussion:

The findings of this study reveal a positive relationship between hedonic value and brand equity. The hedonic value aspects of the International Soochow Ultra Marathon, for example the excitement of the race, the vibrant event environment, and fulfillment experienced by participants, contribute to a deeper connection with Soochow University. While Factors for utilitarian value such as efficiency in event inorganization, accessibility of facilities, create a sense of reliability and trust-

worthiness of the university. These positive experiences enhance positive associations, encourage advocacy, and extend loyalty among, ultimately enhancing its brand equity.

**MEGA VERSUS NON-MEGA SPORTING EVENTS. THE COMPARISON OF SOCIAL IMPACTS VALUATION BETWEEN DIFFERNTLY SIZED SPORTING EVENTS IN GDANSK, POLAND.**

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Introduction.

The study examines the impact of large sporting events on the host communities, with a focus on intangible social effects. In recent years, researchers have explored these impacts not only for mega sporting events (MSEs), but also for smaller, albeit still large, sporting events, so called non-mega sporting events (NMSEs). The primary aim of this research is to provide a monetary valuation of the intangible social benefits generated by sporting events of varying sizes hosted in two arenas in Gdansk, Poland, using the contingent valuation method (CVM). An additional objective is to compare the valuation of these social impacts to the expenditures incurred for the construction of the two sporting arenas in Gdansk.

Material and methods.

The study examined four sporting events, consisting of one MSE (Euro 2012) and three NMSEs (the 2016 European Men's Handball Championship, the 2017 Men's European Volleyball Championship and the 2023 World Men's Handball Championship) , which were held in Gdansk over a twelve-year period. To ensure comparability, all the obtained values were adjusted to the year 2023, which was the most recent event analyzed. The interview and sampling methods varied across the events, but the hypothetical scenario and payment vehicle remained consistent. To ensure the representativeness of the test sample, the distribution of basic socio-economic parameters in the population of Gdansk was considered. For each event, the Willingness-to-Pay (WTP) elicitation method involved a single question about the exact value of WTP using a payment card. At the outset of the survey, the social effects of the sporting events were clearly defined and explained. Given the expectation of WTP as a non-negative figure and the potential for a large number of zero offers, the Tobit model was applied, which accommodates left-censorship.

Results. Research has shown that sporting events of all sizes influence the social impacts experienced by residents in host cities. Although the combined effects of non-mega sporting events may have lower individual values, the cumulative impact of these events can comprise a greater proportion of the actual public funds invested in the construction of sporting facilities.

Conclusions. By acknowledging the intangible benefits, it may be feasible, to some extent, to justify the use of public resources in hosting large sporting events. Furthermore, NMSEs have greater potential to positively impact host city residents compared to MSEs.

**MAJOR SPORT EVENTS - OLYMPIC GAMES: HOW HOSTING AND SPORTING SUCCESS AFFECT NET MIGRATION**

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This thesis investigates the relationship between hosting the Olympics, sporting success, and net migration by addressing two research questions: (1) How does hosting the Olympic Games impact net migration in the respective country? and (2) How does sporting success in the Olympic Games influence net migration in the respective country? To answer these questions, the most important migration theories were reviewed and the most important push-and pull factors of migration were analysed in detail to formulate a theoretical model. With separate data from the Summer and Winter Olympics and difference-in-difference models focusing on hosting this study, migration trends are examined before and after the events. Linear regression models analysing sporting success focus on answering the second research question. The findings reveal nuanced effects: hosting the Winter Olympics significantly increases net migration during the combined pre- and post-event periods, however turns negative for the interaction coefficient analysing the combined effect of hosting and post-event cases. For sporting success, achieving a higher number of gold medal is positively related with higher net migration. However, no similar effect was observed for silver and bronze medals. The findings hold practical implications for policymakers and event organisers, suggesting the use of a framework to anticipate and leverage migration dynamics through hosting the Olympics and achieving sporting success by winning gold medals.

**RESEARCH ON THE GUIDING ROLE OF GENERATIVE AI CONTENT RECOMMENDATION ON SPORTS FANS CONSUMPTION BEHAVIOR**

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With generative AI tools, media can provide real-time event interpretation and data analysis with higher efficiency and lower cost. However, problems of false information and bias have gradually emerged. These problems may not only have a negative impact on sports fans cognition, but also undermine users trust in AI content. Although existing research has focused on the technical capabilities and application scenarios of generative AI, empirical research on users ethical risk perception and trust mechanism of AI-generated content is still scarce. In view of this, this study aims to explore sports fans perception of false information and bias in AI-generated content through a questionnaire survey, and analyze its

influence mechanism on trust. The study revolves around two core objectives: one is to evaluate the perceived characteristics of false information and bias in AI-generated content by sports fans, and the other is to analyze how the perception of false information and bias affects the level of trust. This study focuses on the subjective experience of sports fans when they are exposed to AI-generated content and explores the differences in ethical risk perception among different types of sports fans. The study distributed questionnaires to fan groups in China, covering sports fans of different ages, genders and sports focus areas. The questionnaire design includes four modules: false information perception score, bias perception score, trust score and user background information. The questionnaire will be distributed through social media platforms (such as Weibo, Douyin) and sports communities. After collection, the analysis uses a combination of correlation analysis and regression analysis to reveal the preliminary relationship between false information perception, bias perception and trust through correlation analysis, and explore the basic interaction pattern. The study found that sports fans perception of false information and bias in AI-generated content significantly affects their level of trust in the content. Content inaccuracy is considered to be the main factor that undermines trust, while perception of bias shows a stronger negative effect in specific user groups. Further analysis shows that there are significant differences in the perception of bias between the audiences of mainstream sports and niche sports. Users who follow niche sports are more sensitive to the unfairness reflected in the content, and are more inclined to have negative comments on biased content, which further reduces their acceptance of AI-generated content. The study further found that the improvement of trust can be achieved by reducing false information and bias, and transparent content annotation and fairness design are important optimization directions. Study expands the research scope of generative AI in user behavior and psychological mechanisms and provides AI developers and media with content optimization strategies for sports fans.

**THE IMPACT OF THE EUROPEAN BICYCLE MARKET ON THE DEVELOPMENT OF CHINAS BICYCLE INDUSTRY IN THE CONTEXT OF ECONOMIC GLOBALIZATION**

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I.Background/Purpose:Transformation demand of Chinas bicycle industry; Dual drive of policy and market demand in recent years; Demonstration effect of european competitions

This study endeavors to conduct an analysis of the multi-dimensional impact of European cycling events on Chinas bicycle industry.

II.Research Methods: 1.Select representative cases of Chinese enterprises in the European market. Analyze the correlation between these cases and competitive dynamics within Europe. 2.Utilize data from the Chinese bicycle industry report alongside European E-bike market growth data to validate the demand-side impact of relevant events. 3.Analysis Examine policy differences between China and Europe. Evaluate the role of Chinese enterprises through supply chain research.

III.Research Results: European cycling events have facilitated the transformation of Chinas bicycle industry towards higher-end and international markets.

1.Market Expansion and Technology Upgrade: European events have stimulated demand for high-performance bicycles, allowing Chinese E-bikes to rapidly capture market share due to their cost advantages and comprehensive industry chain capabilities. The technical requirements of these events have driven Chinese manufacturers to break through core technologies.

2.Brand Internationalization and Industrial Chain Integration: By sponsoring prestigious European races or teams (such as Giants sponsorship of the Tour de France), Chinese brands have significantly increased their international visibility, gradually shedding the "contract manufacturing" label. The integration capabilities of the industrial chain have been enhanced, and Chinas technological advancements in key components like motors and batteries have reduced E-bike production costs and fostered global competitiveness.

3.Synergistic Effects between Domestic Competitions and Industry: The European model has inspired China to develop local events, tourism, infrastructure development, and consumer demand, thereby forming a closed loop of "events-manufacturing-service".

IV. Conclusion/Discussion: 1.Coexist of Opportunities and Challenges: European competitions provide Chinese enterprises with technology bench-marking windows and market entry points, particularly in the field of E-bike technology where the spillover effect is significant; Core sensor technology remains dependent on imports, and brand premium capability is insufficient; European trade barriers, such as carbon tariffs, could increase export costs. 2.Strategic Direction Recommendations: Strengthen Technology Research and Development; Deepen International Cooperation; Coordinate with Policy. 3.From a sustainable development perspective, European markets highlight the importance of environmental protection. China can leverage this emphasis to promote green manufacturing standards, integrate the bicycle industry into its "dual carbon" strategic framework.

**EDUCATIONAL TECHNOLOGY ADOPTION: AN INTEGRATION OF UTAUT2 AND TECHNOLOGY READINESS AMONG SECONDARY SCHOOL STUDENTS**

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INTRODUCTION: This study examines the factors influencing the adoption of a new educational technology (using a LiDAR sensor) among secondary school students in the United States. The primary aim of this study is to investigate the formation of intention to use of the new educational technology product by empirically testing its key antecedents. Grounded in the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) and the Technology Readiness Index (TRI) 2.0, the research investigates how constructs such as Performance Expectancy, Hedonic Motivation, Habit, and Technology Readiness predict students' Intention to Use the product.

METHODS: Data were collected from 200 secondary school students using a convenience sampling approach. Structural equation modelling with Partial Least Squares (PLS) was employed to test the proposed model, and the Importance–Performance Map Analysis (IPMA) provided additional insights into areas for improvement. Given that the product is still in its pre-market stage, carefully designed stimuli were employed to simulate a realistic user experience. These stimuli includes video demonstrations, brochures with detailed product information, and comprehensive usage instructions.

RESULTS: Overall, the PLS-SEM results indicate that Performance Expectancy, Hedonic Motivation, Habit, and Technology Readiness significantly predict students' Intention to Use the product, with Facilitating Conditions notably enhancing Technology Readiness. Specifically, the results reveal that Performance Expectancy ($\beta = 0.20$, $p < .05$), Hedonic Motivation ($\beta = 0.18$, $p < .05$), Habit ($\beta = 0.42$, $p < .001$), and Technology Readiness ($\beta = 0.14$, $p < .05$) significantly influence Intention to Use. Furthermore, Facilitating Conditions significantly predict Technology Readiness ($\beta = 0.34$, $p < .001$). These findings suggest that while performance and enjoyment drive adoption, habitual use and technological predispositions also play crucial roles.

Discussion

The study concludes by discussing practical implications, including the potential benefits of gamification and targeted marketing strategies for technology-ready segments. The IPMA results offer additional insights beyond the standard structural analysis by comparing each construct's relative importance with its performance. Based on the results, we provided practical implications. For instance, both Performance Expectancy and Hedonic Motivation exhibit high importance yet only moderate performance, placing them in the "Keep Up the Good Work" category.This suggests that while users recognise the benefits of JUST ON STUDY in enhancing their study performance and enjoy its features, there remains potential to further refine these aspects. For instance, developers might enhance features that directly improve study outcomes or integrate additional gamification elements (e.g., point systems, progress badges, and leaderboards) to boost engagement and motivation.

**A STUDY ON LEGAL OVERSIGHT FOR SPORT COACHES WORKING WITH CHILDREN AND YOUTH**

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In Taiwan, anyone with a coaching certificate issued by a sports association can teach children and youth sports. However, these coaching certificates usually only assess the coachs sports skills and do not evaluate their educational ability to handle special or emergency situations. This has led to a lot of cases of excessive training or sexual crimes happening. Legislators have called for administrative agencies to more systematically oversee sports coaches to protect the rights of children participating in sports. Therefore, this study aims to address the following questions: 1. What items should be included in the vetting process for coaches of children? 2. What level of government oversight should be implemented?

This study adopts a comparative legal research approach, examining Australias Worker Screening Act 2020, the UKs Safeguarding Vulnerable Groups Act 2006, the Protection of Freedoms Act 2012, and the Police Act 1997, as well as Germanys Federal Child Protection Act and the Act on Cooperation and Information in Child Protection. It also looks into Australias Child Safe Code of Conduct, and UK's Code of Practice for Sports Coaches, attempting to summarize the aforementioned research questions and offer recommendations.

It shows that, compared to the UK and Australia, which tend to focus on verifying information about workers dealing with children, Germany places greater emphasis on quality development for child protection. However, Australias Working with Children Check system requires workers to complete child safety training before obtaining a work permit. Additionally, most countries use measures like safe codes to remind people of the necessary ethical behavior.

This study points out that the screening of coaches can be divided into two aspects. One is to prevent coaches with high-risk records from interacting with children and teenagers, such as those with records of sexual abuse or violent crimes, which may limit their ability to coach youth sports. The second aspect requires coaches to have the professional knowledge, such as being able to identify children with autism or ADHD and handling them appropriately. It's also important to understand relevant laws and to train in compliance with regulated teaching methods. The requirements for the above abilities or qualifications can be enforced with varying levels of strictness through licenses, certificates, or simple proof. In Taiwan, administrative units are moving toward legislation for licenses, and they hope to set comprehensive requirements for coaches' abilities from physiological, psychological, and legal perspectives. This approach aims to protect the rights and interests of young athletes.

Sport Technology

**CONSTRUCTION AND VALIDATION OF A TRAINING SUPPORT SYSTEM USING REAL-TIME FEEDBACK OF SENSOR MEASUREMENT INFORMATION IN ROWING.**

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INTRODUCTION: In this study, we constructed a system that comprehensively captures the movement of a boat by combining a high-precision GNSS（Global Satellite Navigation System） positioning system with a 9-axis IMU (Inertial Measurement Unit) sensor. This system simultaneously measures acceleration and angular velocity for each stroke, in addition to the boats position and velocity. The system was then used to measure and collect rowing data, and a comparative analysis between athletes was conducted to evaluate its effectiveness.

METHODS: The system consists of a GNSS receiver mounted on the boat, a small Arduino-compatible board computer (Sony Spresense), and a GNSS Add-on board. By integrating these components, high-precision positioning was achieved. An LTE extension board was also installed to enable data transmission via LTE-M communication. Additionally, the boat was equipped with an IMU sensor, allowing real-time measurement of the boats position, velocity, acceleration, and angular velocity (longitudinal and lateral oscillations) during rowing. For data visualization, Soracoms cloud service Harvest Data was used. The measured data (sampling frequency: 10 Hz) was transmitted via LTE-M communication every 5 seconds.

The experiment was conducted on athletes who regularly train in single sculls. The subjects were instructed to row at maximum speed with 20 strokes fixed in a stroke rate 24. The subjects were categorized as novice rowers, with less than one year of rowing experience, and advanced rowers, with more than three years of experience.

RESULTS: In this study, the maximum velocity recorded for novice rowers was 4.02 m/s, while that for advanced rowers was 4.63 m/s, indicating that advanced rowers achieved higher velocities. The maximum acceleration for novice rowers in the direction of travel was 4.26 deg/s, while in the backward direction, it was 6.45 deg/s, showing a tendency for greater acceleration in the backward direction. In contrast, the maximum acceleration for advanced rowers in the direction of travel was 5.48 deg/s, and in the backward direction, it was 6.04 deg/s, indicating a smaller difference in acceleration between the forward and backward directions. Furthermore, a comparison of accelerations in the lateral direction of the boat (rolling) showed that the maximum values for novice and advanced rowers were 35.7 deg/s and 31.5 deg/s, respectively, confirming that the rolling amplitude was greater for novice rowers. Regarding the boats longitudinal (pitching) acceleration, the maximum value for novice rowers was 8.60 deg/s, while for advanced rowers, it was 16.9 deg/s, indicating that pitching acceleration was greater for advanced rowers.

CONCLUSION: These results show that the use of this system has made it possible to understand rowing characteristics. In the future, in order to improve the technical level of beginners, the development of a system that enables them to compare their own movements with those of advanced rowers will promoted.

**ANALYSIS OF PLANTAR LOAD DISTRIBUTION OF SPRINT SPIKES EQUIPPED WITH CARBON PLATES FOR TRACK AND FIELD**

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INTRODUCTION: In recent years, trends in track and field sprint spikes have changed dramatically with advances in technology. Traditional spikes are made of synthetic resin with a thin sole and are designed to provide a good sense of contact with the ground. On the other hand, many of the spikes that are becoming mainstream today have built-in carbon fiber plates and thick soles. Therefore, the purpose of this study was to compare the difference in how the plantar forces are received during sprinting between conventional thin spikes made of synthetic resin (SRS) and thick-soled spikes equipped with carbon plates (CPS).

METHODS: The subjects were 10 male sprint athletes belonging to a university track and field team (age 20.6±1.0years, height 169.6±4.5cm, weight 63.6±4.1kg). The measurement was performed in a 50m sprint in an all-weather athletics stadium. After warming up, the subjects ran 50m once each in spikes SRS and CPS. The analysis items were sprint time for the 30m section from 20m to 50m, and the plantar load force for three steps within a randomly selected section. The plantar loading force was measured using Pedar-X in-shoe pressure measurement system (Novel, USA) , and defined in areas toes (area 1), forefoot most front (area 2), forefoot next front (area 3), forefoot middle (area 4), forefoot rear (area 5), midfoot front (area 6), midfoot (area 7) and rearfoot (area 8) , in order from the toe to the heel.

Statistics were compared between SRS and CPS for sprint time, plantar load /body weight during the period of contact with the ground at 60N or more, and plantar load distribution at highest point, and a paired t-test was used ($p<0.05$).

RESULTS: The sprint time of CPS (3.25±0.1sec) was significantly faster than that of SRS (3.35±0.1sec) ($p=0.004$). The plantar load pressure/body weight of CPS was significantly lower in area 3 (SRS 3.76±0.70N/kg, CPS 2.54±0.88N/kg) ($p=0.002$), and significantly higher in area 5 (SRS 2.49±0.89N/kg, CPS 3.23±0.87N/kg) ($p=0.003$), area 6 (SRS 1.09±0.46N/kg, CPS 2.33±0.89N/kg) ($p=0.001$), area 7 (SRS 1.28±0.51N/kg, CPS 2.12±1.02N/kg) ($p=0.009$), and total value of all areas (SRS 19.32±2.16N/kg, CPS 20.82±2.67N/kg) ($p=0.014$). A similar trend was seen for total workload. Plantar load distribution at highest point of CPS was significantly lower in area 3 (SRS 4.79±1.18N/kg, CPS 3.30±1.42N/kg) ($p=0.001$) and area 4 (SRS 5.27±1.03N/kg, CPS 4.51±1.18N/kg)($p=0.037$), and significantly higher in area 6 (SRS 2.61±0.67N/kg, CPS 3.69±0.96N/kg)

(p=0.001). The contact area receiving the force was significantly larger for CPS (SRS 106.30±11.08cm2, CPS 112.32±9.58cm2) (p=0.024).

CONCLUSION: The plantar load force distribution of CPS was slightly further back than in SRS, the contact area was wider, and the force was greater. These differences were thought to be due to differences in the hardness and resilience of the materials.

**EFFECTS OF COMPRESSION STOCKINGS ON RECOVERY FROM EXERCISE-INDUCED MUSCLE SORENESS, STRENGTH, AND RANGE OF MOTION**

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INTRODUCTION: Exercise-Induced Muscle Damage (EIMD) is a well-documented physiological response to eccentric contraction exercises, which has been shown to result in a reduction in muscle force production, an increase in muscle soreness, and elevated inflammatory responses [1]. The use of compression stockings (CS) as a recovery aid has been proposed, with the hypothesis that they enhance blood circulation, thereby reducing muscle fatigue and soreness. However, the effectiveness of CS in reducing muscle damage markers and enhancing functional recovery remains to be fully clarified. The present study aims to examine the effects of wearing compression stockings on muscle soreness, limb circumference, range of motion (ROM), and manual muscle strength (MMT) in healthy males.

METHODS: Fifteen healthy male participants were divided into two groups: the compression stockings group (CSG, n=7) and the control group (CON, n=8). Assessments included body composition analysis, muscle soreness using the Visual Analogue Scale (VAS), calf circumference (CIR), ROM, and MMT. Participants performed a 30-minute bench step exercise to induce EIMD, and measurements were taken pre-exercise, immediately post-exercise, and at 12, 24-, 48-, 72-, and 96-hours post-exercise.

RESULTS: Repeated measures ANOVA revealed significant main effects for group and time ($p < .05$) on VAS scores, indicating that the CSG group experienced a significantly greater reduction in post-exercise muscle soreness than the CON group. Post-hoc analysis showed that VAS scores were significantly lower in the CSG group at 12-, 24-, and 48-hours post-exercise ($p < .05$, respectively). MMT and ROM also demonstrated significantly faster recovery trends in the CSG group, particularly after 48 hours ($p < .05$, respectively). However, no significant differences were found in calf and thigh circumference changes between groups ($p > .05$).

CONCLUSION: These findings indicate that wearing compression stockings effectively reduces post-exercise muscle soreness and accelerates muscle strength recovery. The results suggest that compression stockings may enhance blood circulation and facilitate metabolic waste removal, leading to faster functional recovery. However, their effect on reducing swelling was not significant. Given the growing interest in recovery interventions among athletes, these findings align with previous research demonstrating that external compression garments can aid in muscle recovery and performance enhancement [2]. Future research should explore the long-term impact of compression stockings on various exercise modalities and athletic populations.

**TECHNOLOGICAL ADVANCEMENTS IN FOOTWEAR AND THEIR IMPACT/INFLUENCE ON ELITE RUNNING PERFORMANCE: INNOVATION OR TRAINING?**

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INTRODUCTION: The past decade has seen a surge in record-breaking performances in elite distance running, often attributed to advances in footwear technology (Ortega et al., 2021). High-performance shoes with carbon-fiber plates and responsive foams have raised debates about whether these performances stem from improved training or technological innovation. Addressing this issue is essential for maintaining fairness in the sport.

METHODS: This study examined trends in elite running over the past ten years, correlating technological milestones with athlete performance. Data from performance, biomechanical, physiological, and psychological research were synthesized. Athlete-specific trials and comparative studies assessed key factors such as energy return, running economy, stride efficiency, and ground reaction forces.

RESULTS: Technological innovations have been shown to significantly enhance performance by improving running economy through reduced oxygen consumption and delayed muscle fatigue (Muniz-Pardos et al., 2021; Barnes & Kilding, 2019). Carbon-fiber plate-equipped shoes demonstrated superior energy return and stride optimization, with reduced muscular impact on the lower limbs (Hoogkamer et al., 2018; Wang et al., 2012). Psychological assessments also indicated a placebo effect, where athletes perceived performance gains due to the footwear's reputation (Dierickx et al., 2003).

CONCLUSION: Although rigorous training remains a cornerstone of athletic success, advanced footwear technology plays a significant role in modern performance gains. This has prompted regulations from governing bodies such as World Athletics, but existing measures may be inadequate in addressing inequalities. Athletes from economically disadvantaged regions face challenges in accessing these technologies (Muniz-Pardos et al., 2021). To safeguard fairness, stricter policies are needed, potentially limiting stack height or energy return thresholds to maintain equal opportunities for all athletes while preserving the sport's integrity.

**CHARACTERISTICS OF GPS DATA BY OFFICIAL MATCH RESULTS AND PLAYER POSITIONS IN WOMEN'S FOOTBALL**

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INTRODUCTION: The aim of this study was to advanced the development of womens football in Korea by providing foundational information on the GPS data of female football players in the 2024 WK-League season. The study analyzes the correlation between GPS characteristics and match results (win, draw, loss) as well as the influence player positions (attack, midfield, defense).

METHODS: This study examined twenty-too female players from Team S who participated in the 2024 WK-League season. Movement data was collected using GPS devices (Catapult Optimeye S5, Catapult sports, Melbourne, Australia) during all official league matches, and this data was analyzed to examined characteristics based on match outcomes and player positions. Data collection covered 28 regular-season games. A One-way ANOVA was conducted to analyze GPS characteristics according to player positions and match outcomes, with post-hoc analysis performed using the Bonferroni's method.

RESULTS: Firstly, the total distance covered and average distance per minute were significantly greater for forwards and midfielders compared to defenders. Secondly, in terms of positional analysis, Zone 1 were significantly greater for both forwards and defenders than for midfielders, whereas Zone 2 and Zone 3 were the highest for midfielders. For Zone 4, Zone 5, high-intensity distance, number of sprints, and maximum speed, forwards exhibited the highest values. Thirdly, acceleration and deceleration were significantly the highest for midfielders based on their positions. Lastly, regarding match results, metrics for Zone 5, high-intensity distance, maximum speed, and acceleration were significantly higher in matches that resulted in a victory.

CONCLUSION: The results of this study demonstrated differences in GPS characteristics based on player positions and match results. Specifically, when the team won, Zone 5, high-intensity running distance, maximum speed, and acceleration records were higher compared to when the team drew or lost. Based on these findings, it is believed that developing training plans, tactics, and strategies while managing and monitoring fitness, may help enhance the performance of women's football players.

**INTEGRATING ARTIFICIAL INTELLIGENCE AND BLOCKCHAIN IN SPORTS: CHALLENGES AND OPPORTUNITIES IN DATA MANAGEMENT, SECURITY, AND REGULATORY COMPLIANCE**

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INTRODUCTION: AI is playing an increasingly significant role in sports, extending beyond team performance analysis and game strategy development. The application of advanced machine learning and deep learning techniques enables the optimization of athletic preparation, injury recovery, and injury risk prediction through pattern analysis. Additionally, its implementation may also impact fan engagement. However, both the adoption of AI and blockchain pose regulatory and data protection challenges, particularly in contexts governed by strict standards such as the AI Act and GDPR in Europe and HIPAA in the United States. In this scenario, blockchain emerges as a potential solution to ensure transparency, security, and traceability in data management, reducing the risk of unauthorized access and data manipulation.

METHODS: This study is based on a systematic analysis of the academic literature on AI, its application in sports, the related regulations, and its integration with blockchain, with a specific focus on personal data management. In parallel, the main applicable regulations, including the AI Act, GDPR, and HIPAA, were analyzed to assess the regulatory implications of data management.

RESULTS: Preliminary analysis confirms that AI can provide significant advantages in sports management. However, critical issues related to data quality, information security, and regulatory compliance have emerged. Poor data sampling and/or negligent data handling could compromise the reliability of predictive models, potentially affecting athletes health and careers. The analysis suggests that blockchain could serve as an effective solution to ensure transparency, security, and traceability in data processing. Its decentralized architecture could mitigate the risk of unauthorized access and simplify anonymization, but its application within a complex regulatory framework raises further compatibility issues with existing regulations.

CONCLUSION: The integration of AI and blockchain in sports represents an opportunity to enhance data management and security, yet it requires a careful balance between technological innovation and regulatory compliance. Data are strategic assets, as AI models improve through continuous training. GDPR and HIPAA impose limitations on data decentralization and immutable storage, making it necessary to adopt blockchain protocols with adaptable governance mechanisms. The implementation of such solutions must consider the evolution of the regulatory framework and the adoption of technological frameworks capable of balancing efficiency, privacy, and compliance. Future research should focus on identifying purpose-specific blockchain protocols that comply with these requirements. The Sports Industry could once again act as a testing ground for emerging technological innovations.

**IS IT TIME TO RE-EVALUATE POSTURAL ASSESSMENT TOOLS? TEST-RETEST AND INTER-RATER RELIABILITY OF WEARABLE 3D INERTIAL SENSOR VS. FORCE PLATFORM OVER DIFFERENT POSTURAL CONDITIONS**

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INTRODUCTION: In posturography, wearable inertial measurement units (IMUs) are commonly used due to their cost and portability advantages. However, their validity, if compared with the gold standard (force platform, P), has rarely been investigated. In detail, among several studies performed on IMUs for the evaluation of static balance, 10/47 validated the result against a P, and only 4/47 performed a retest test (1).

This study aimed to evaluate the inter-rater reliability in assessing the absolute agreement between the GYKO (G) IMUs and P within different foot positions and stable/unstable conditions through the time-domain outputs. The secondary aim was to quantify the test-retest reliability to state the consistency between repeated trials (2).

METHODS: Thirty-eight healthy subjects (19M and 19F; 25±3 years;1.71±0.09 m; 65.7±10.2 kg) visited the laboratory twice, one week apart. Participants were asked to perform postural stability tests (open eyes) in three foot positions (bipedal, tandem, single standing) over two different surfaces (stable on the floor; unstable on the BOSU).

All the tests were carried out on a force plate (AMTI; Watertown, MA; 500 Hz) wearing G sensor (Microgate, Bolzano, Italy; 500 Hz) positioned at the lumbar level.

The variables analysed were: medio-lateral (ML) length, antero-posterior (AP) length, length, ML mean velocity, AP mean velocity, mean velocity, ML mean distance, AP mean distance, mean distance, ML RMS distance, AP RMS distance, RMS distance, area (3).

The reliability was assessed through the intraclass correlation coefficient (ICC) that was used to evaluate: i) the consistency of the same device between sessions; ii) the absolute agreement among devices within the same trials. The standard error of measurement (SEM, SEM%) and the minimal detectable change (MDC, MDC95%) were calculated for G and P as well as RMSE and Mean Difference.

RESULTS: For P, 42/78 parameters result moderate,30/78 good, with an ICC mean equal to 0.683 (i.e. it can be considered as moderate reliability). For G, 49/78 conditions result moderate, 24/78 good, with an ICC mean equal to 0.687, indicating moderate reliability. SEM% for P ranged from 7 to 41%; for G, ranged from 11 to 47%. MDC95% for P ranged from 21% to 114%; for G, from 30% to 132%. The inter-rater reliability assessment showed poor reliability for 57/78 parameters, and moderate for 18/78. Only 3/78 reached good reliability, with a mean equal to 0.338, which states poor reliability.

RMSE showed a grand mean equal to 342.5, and the Mean Difference showed a grand mean equal to 100.2.

CONCLUSION: G appears to be a convenient tool because of its good reliability across multiple measurements. However, its results are quite different from those of a force plate. This finding recommends that it can be used with safe awareness especially in pathological populations.

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**EXPLAINABLE AI-BASED APPROACH FOR THE EVALUATION OF THROWING MOTION SKILLS**

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INTRODUCTION: The evaluation of throwing motion is conducted even in elementary education; however, such evaluations require specialized knowledge and experience. Utilizing AI-based approach can provide a simplified and objective assessment method applicable in educational settings. This study aimed to develop a technique for evaluating throwing skills using machine learning.

METHODS: Participants included 24 male university students who were members of a baseball team and were assumed to possess high throwing skills (Baseball Group) and 29 male and female university students without any baseball experience, assumed to have low throwing skills (General Group). The participants were tasked with throwing a softball 10 times at a target located 7 meters away. All participants were right-handed, and the throws were executed with the right hand. They were instructed to throw naturally towards the target, with no restrictions on speed or force. The throwing motions were recorded from the sagittal plane using a video camera. For machine learning, the training data comprised 16 participants from the Baseball Group and 20 from the General Group, while the test data included 8 from the Baseball Group and 9 from the General Group. The ResNet-152 model was employed for machine learning. After training the model with the training data, it was tested to classify the groups using the test data. Additionally, Grad-CAM was utilized to visualize the areas of the images that contributed to the model's decision-making during the image recognition task.

RESULTS: The results showed that the developed model achieved a discrimination rate of 1.00 for the Baseball Group and 0.95 for the General Group. The model's performance, based on the confusion matrix, was as follows: Accuracy: 0.95, Precision: 0.99, Recall: 0.91, and F1 score: 0.95, indicating generally favorable outcomes. The heatmaps generated by Grad-CAM suggested that the model visually focused on the trunk region for the Baseball Group. Furthermore, the eval-

uation points identified by Grad-CAM indicated that the model focused on the right knee, trunk, left hip, and right shoulder when distinguishing the Baseball Group.

CONCLUSION: Some previous studies have pointed out that the presence of a windup motion during the preparatory phase is associated with the development of throwing skills. In this study, the step foot contact phase, classified as a preparatory phase, was analyzed, revealing the presence of windup motion in the Baseball Group. The heatmaps of Grad-CAM demonstrated that the model concentrated on the trunk and shoulder joint areas. These findings suggest that the learning model accurately recognized the critical features for distinguishing throwing skills, highlighting essential aspects for skill evaluation in throwing motions.

**EVALUATING SWIMMING TRAINING APPLICATIONS: SENTIMENT ANALYSIS AND USER FEEDBACK ON KEY FEATURES AND ISSUES**

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INTRODUCTION: Swimming is a widely practiced sport and exercise activity that has experienced increasing popularity in recent years. With advancements in technology, numerous swimming training applications have been developed to support both professional swimmers and recreational enthusiasts in skill development and performance monitoring. These applications offer various features, including personalized training programs, performance tracking, and integration with wearable devices, to enhance the overall swimming experience. This study aims to analyze user reviews of several prominent swimming training applications to gain insights into user satisfaction, preferences, and areas for improvement. By examining feedback from actual users, this research seeks to identify key features that users find valuable and to pinpoint common issues they encounter.

METHODS: User review data were collected using two primary Python libraries: app_store_scraper and google_play_scraper. These tools facilitated the retrieval of user reviews, ratings, and other relevant information from the Apple App Store and Google Play Store for five widely used swimming training applications: Duoswim, Swim.com, SwimUp, Form Swim, and MySwimPro. Standard data preprocessing techniques were applied to clean and refine the dataset. A combination of analytical methods, including keyword analysis, sentiment and subjectivity analysis, similarity analysis, and qualitative analysis using MAXQDA, was employed to extract meaningful insights from user feedback.

RESULTS: The analysis indicated that users particularly value personalized and customizable training plans, real-time feedback, and the integration of wearable devices for precise tracking of swimming metrics. However, common concerns included dissatisfaction with subscription models and technical stability issues. While applications such as Duoswim and Form Swim received predominantly positive feedback, MySwimPro exhibited significant divergence in user opinions.

CONCLUSION: Understanding user feedback is essential for the continuous improvement of swimming training applications. This study highlights both the strengths and limitations of different applications, providing developers with guidance on enhancing functionality and user experience. By addressing common user concerns and incorporating features deemed valuable by users, developers can create more effective and user-centric swimming training applications.

**EXPERIMENTAL VERIFICATION OF BOLT TYPE FORCE SENSOR IN SPEED CLIMBING**

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INTRODUCTION: Speed climbing is one of the disciplines of sport climbing. In this sport, athletes climb the artificially constructed wall and compete in terms of speed. Athletes climb the wall by gripping and stepping on climbing holds attached to the wall. In motion analysis of sport climbing, several studies have focused on the forces applied to climbing holds. However, most of these methods require dedicated walls and holds, making it difficult to apply them to existing facilities.

Two types of holds, hand holds and foot holds, are used in speed climbing, and their shape and position are determined. In this study, we develop a system to measure the force applied to the holds in speed climbing. In particular, it is more challenging to develop a system that can be installed on the walls of existing facilities since foot holds are smaller than hand holds and it is difficult to build in a force sensor.

METHODS: To measure the forces applied to the foot holds, strain gages are mounted on a bolt to fix the hold and measure the force. This sensorized bolt is called a bolt-type force sensor. This sensor can measure 3-axis forces applied to the hold. The sensor consists of a steel bolt and four strain gauges, and the strain gauges are mounted on the shaft of the sensor. The wiring of strain gauges is designed to pass through the shaft and exit from the threaded side of the bolt. So, when the sensor is installed on climbing walls, the wiring comes out from behind the wall. This wiring method does not distract the competitor or interfere with the competitors movements.

The transformation from strain to force uses a conversion equation obtained by prior calibration. The calibration device consists of a bolt type force sensor and a 6-axis force sensor. The 6-axis force sensor gives true values. In calibration, the transformation is calculated by using particle filter. Particle filter is used to sample from a normal distribution around the measured strain values. Particle filter is effective in minimizing the effect of noise on the measured strain values.

RESULTS: Force measurement experiments were conducted in a real environment to verify the usefulness of the system. Two bolt type force sensors are attached to the wall to measure forces applied to two foot holds. The subject is one of the Japanese national team players. The proposed system measured the forces applied to the foot holds appropriately.

CONCLUSION: In this study, the bolt type force sensor was proposed to measure the forces applied to the foot holds in speed climbing. In the experiment, the usefulness of the proposed system is verified. The improvement of the accuracy is a future work.

**EXPLORING PHYSICAL ACTIVITY LEVEL OF INDIVIDUALS WITH COPD: A COMPARISON OF WEARABLE DEVICE USER AND NONUSER**

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INTRODUCTION: Wearable devices have been used to promote physical activity (PA) among the general public [1]. Previous studies have examined the PA levels of people with a noncommunicable disease using wearable devices [2], but limited literature has examined individuals with chronic obstructive pulmonary disease (COPD). Participating in PA could be beneficial to people with COPD [3]. This study aimed to compare PA levels between wearable device users with COPD and non-wearable device users with COPD.

METHODS: Using the free-living data from the 2017 Behavioral Risk Factors Surveillance System, 259 individuals with COPD were included in this cross-sectional secondary data analysis. Respondents self-reported their weekly PA levels in minutes. Participants were classified as utilizing wearable devices and not using wearable devices. A T test was used to compare PA level between wearable device users and nonuser. Unadjusted and adjusted linear regression was used to examine the association between PA level and wearable device usage. The adjusted model was built upon on the unadjusted model with PA level regressing into wearable device usage with the addition of demographic factor serving as a covariant. Sampling weights were accounted for during the analysis due to the data being complex survey data.

RESULTS: Among the participants, 15.29% (95% CI [9.00, 23.43]) used wearable devices and 84.71% (95% CI [76.57, 91.00]) were nonusers. The average weekly PA level among the participants was 469.66 (95% CI [331.20, 608.12]) minutes. There was no statistical difference between weekly PA levels between users (505.68, 95% CI [302.20, 703.16]) and nonusers (463.16, 95% CI [304.71, 621.61])(t=0.33, p=.74). Both the adjusted and unadjusted linear regression found no statistically significant association between weekly PA level and wearable device (β=42.52, p=.74; adjusted β=-26,46, p=.80).

CONCLUSION: The current study shows that wearable device users with COPD might not necessarily show higher levels of PA when compared to nonusers with COPD. Further research is needed to examine appropriate approaches in using wearable devices to promote PA levels in people with COPD. Promotion of PA remains crucial to individuals with COPD, as PA can lead to improvement of wellbeing and symptom management.

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**SELF-REPORT MENSTRUATION AND SLEEP DURING AN NCAA DIVISION I WOMEN'S SOCCER SEASON**

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INTRODUCTION: There is an underwhelming amount of research dedicated to how the female body responds to the stresses of sports competition. More specifically, examining how the menstrual cycle impacts sleep. Two studies reported that the menstrual cycle was associated with sleep disturbances and poorer quality sleep (Kullik, et al., 2024; Michelekaki, et al. 2023). While both studies included athletes, more research should examine the impact of menstruation and sleep. Therefore, this study aimed to add to the existing research by surveying an NCAA Division I women's soccer team over their season.

METHODS: One NCAA Division I women's soccer team (n = 24) completed daily subjective wellness surveys throughout the Fall 2023 NCAA Championship Season. We examined two items from the survey: Are you on your menstrual cycle? How many hours of sleep did you get last night? We used Wilcoxon Signed Rank Test to compare sleep hours from days a participant recorded being on their menstrual cycle versus not.

RESULTS: The participants reported 1646 days when not menstruating and 288 days when they were throughout the season. There was a significant statistical difference between self-reported sleep hours when participants indicated menstruation versus not ($Z = -2.87$; $p > .01$).

CONCLUSION: The results of our project found that throughout the season, participants who indicated they were menstruating had less sleep noted than when participants indicated they were not. A qualitative study by Read et al. (2022) held interviews with professional women's soccer players and noted 100% of the participants had negative symptoms during menstruation, which could be a reason for the decreased sleep hours we found in our study.

Coaches and support staff of women's teams should be aware that menstruation can influence sport participation via poor sleep. Planning for these situations with their participants can optimize their training stimulus without over-taxing their body and allowing for continued high-level performance.

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**THE RECOVERY-ENHANCING EFFECT OF ICING WITH MICROBUBBLE CARBOHYDRATE WATER ON THE DISTAL LATENCY OF THE ULNAR NERVE**

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INTRODUCTION: In sports field, icing is widely used to reduce acute inflammation and to elevate the pain threshold. The risk of injury after icing increases for about 30 minutes due to the loss of muscle strength and joint position sense caused by reducing peripheral nerve function. Therefore, returning to sports immediately after icing should be avoided even in the case of light injury (Auley, 2001) . Then, we focused on the carbon dioxide which has vasodilating effect. Icing with cold carbonated water (CCW) might have the effective recovery of nerve function due to the promotion of peripheral nerve blood flow after icing. This study aimed to evaluate that icing with CCW would promote the early normalization of peripheral nerve conduction velocity, which is reduced by cooling.

METHODS: Six healthy female university students with BMI below 25 participated in this study. Ulnar nerve conduction recovery after elbow joint icing was compared with 5°C water (control condition) and 5°C carbonated water. Both conditions consisted of 15 minutes of icing (WI1-15) followed by 30 minutes of rest (R1-30). Recovery of ulnar nerve conduction after icing was evaluated by measuring the distal latency. It was measured before icing (BI) and every minute from the start of icing (WI1) to the end of rest (R30). Skin temperature was measured before icing (BI), end of icing (R1) and at the end of rest (R30).

RESULTS: Significant elongation of the distal latency was detected in CCW compared to cold water at WI1, WI4 to WI8, WI10, and R12 to R30 ($p < 0.05$). No significant difference was observed in skin temperature between the two conditions at any point.

CONCLUSION: The significant elongation of distal latency before WI10 may be due to the vasodilation caused by the carbon dioxide, which had suppressed the decrease in peripheral nerve blood flow and minimized the loss of nerve function. However, no significant difference in distal latency was observed after WI11. This result could be explained by the possibility that cold induced vasoconstriction is stronger than the vasodilation caused by carbon dioxide. The significant rapid recovery of distal latency in the CCW from R12 to R30 could be promoted by the vasodilation effect of carbon dioxide gas and the gradual increase in body temperature.

These results concluded that CCW icing could be one of the effective methods for athletes who require a quick return to play.

**SELF-EFFICACY FOR WORKOUT INFLUENCES SPORTS INJURY PREVENTION?**

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INTRODUCTION: Some studies have demonstrated a connection between psychological factors and an athlete's return to play following a sports injury. While interventions, such as positive self-talk and goal setting, have been found to promote recovery after a sports injury 1), it is unclear whether psychological factors can also affect injury prevention. This study aimed to determine whether freshmen's self-efficacy in workouts influences sports injury prevention.

METHODS: A total of 573 freshmen at a medical university completed a self-efficacy questionnaire about workouts upon entering the university. They also completed a self-administered questionnaire about sports injuries at the end of the semester. Of the 573 freshmen, 181 (100 males, 81 females; mean age: 18.3 ± 1.5) participated in sports. The relationship between their self-efficacy at enrollment and sports injuries was investigated.

The self-efficacy questions included 4 negative items (e.g., "If I work out a lot, I will be at a higher risk of injury.") and 4 positive items (e.g., "If I practice a lot, I will be able to win games."). Participants responded on a 5-point scale (1: not at all, 2: not really, 3: either, 4: somewhat, 5: very much).

Each score for 4 negative and 4 positive self-efficacy items was summed and analyzed. Using the Mann-Whitney test, comparisons between injury and non-injury groups for both negative and positive self-efficacy were made at the 5% level. Height and body mass were compared using the unpaired t-test.

RESULTS: Twenty-three students (16 males and 7 females) sustained injuries over a period of 9 months, resulting in an injury rate of 12.7%. The demographics of the injured athletes were similar to those of the uninjured athletes (height: 170.1 ± 8.4 cm vs 165.3 ± 8.7 cm, weight: 64.1 ± 12.6 kg vs 57.8 ± 10.7 kg, respectively). However, the body mass of the injured female group was higher than that of the uninjured female group (55.6 ± 6.7 kg vs 50.6 ± 5.5 kg, $p < 0.05$). Positive self-efficacy scores were lower for the injured group than the uninjured group (3.76 ± 1.12 vs 4.14 ± 1.00, $p < 0.01$). No significant differences were found in negative self-efficacy scores between the injured and uninjured groups (3.03 ± 1.38 vs 3.01 ± 1.19).

CONCLUSION: Patients who have experienced sports-related injuries often face reduced self-efficacy. High-quality evidence supports the use of goal setting to improve patient self-efficacy 2). Although it was unclear whether psychological factors could affect the prevention of sports injuries, this survey demonstrated that athletes with lower positive self-efficacy, such as believing "If I practice a lot, I will be able to win games," were more likely to get injured than those with higher positive self-efficacy. Additionally, preventive measures should be taken to control female body mass, as the body mass of the injured female group was higher than that of the uninjured group.

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**OVERUSE INJURIES IN YOUTH COMPETITIVE CRICKET- A DESCRIPTIVE EPIDEMIOLOGICAL STUDY**

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INTRODUCTION: Overuse injuries (OUI) are a significant concern in youth competitive sports. Cricket, as a sport is rising in popularity among youth worldwide. The roles of fast bowlers and all-rounders in cricket places unique biomechanical stresses on athletes, leading to a high risk of OUI. Despite this, limited research exists on the epidemiology of OUI among youth cricket players, particularly in Singapore. This study investigated the prevalence, severity, and associated risk factors of OUI in youth competitive cricket players in Singapore.

METHODS: A cross-sectional study was conducted involving 272 youth competitive cricketers (227 males, 45 females) aged 12–18 years, recruited from various clubs and academies in Singapore. A validated questionnaire for overuse injuries in youth sport was used. Players recalled OUI over the past three months period. Players were either at the end of pre-season or in-season at the time of the study. Data on demographics, playing role, training load, injury history, and anatomical regions were obtained. Descriptive statistics, chi-square tests and logistic regression were used to identify significant associations between age, training load, playing roles, and OUI.

RESULTS: OUI prevalence was 56.6%, with the lower back (27.6%) and knees (27.9%) being the most affected anatomical regions. Shoulder injuries (21.3%) and elbow injuries (5.9%) were also reported. Male participants accounted for 86.4% of all OUI, while females accounted for 13.6%, largely reflecting the gender distribution in the sample. Fast bowlers were particularly vulnerable, showing higher risk of lower back and shoulder injuries. Training frequency exceeding four sessions per week and session durations over three hours were associated with a significantly higher injury prevalence ($p < .05$). Additionally, older participants (16–18 years) had a higher risk of OUI compared to younger players (12–15 years).

CONCLUSION: The findings show a high prevalence of OUI among youth competitive cricketers in Singapore, with fast bowlers and players exposed to high training loads being at greater risk. Key risk factors include excessive training frequency, prolonged session durations, and biomechanical demands specific to playing roles. The study underscores the importance of implementing evidence-based prevention strategies, such as individualized training programs, age-appropriate workload management, and injury surveillance systems. Coaches, physiotherapists, and stakeholders must collaborate to create structured training regimens that balance intensity, duration, and recovery to ensure the safe and sustainable participation of youth in cricket. Future research should focus on longitudinal studies to better understand the causative pathways of OUI and evaluate the effectiveness of preventive interventions.

**CORRELATION OF SAGITTAL AND CORONAL ANTERIOR CRUCIATE LIGAMENT GRAFT ANGLE IN MRI WITH KNEE FUNCTION IN PATIENTS WITH ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION: A SHORT-TERM FOLLOW-UP STUDY**

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INTRODUCTION: To analyze whether there is a correlation between graft angles in the sagittal and coronal planes and short-term follow-up knee stability and functional outcomes in patients undergoing single-bundle ACL reconstruction with hamstring tendon autograft.

METHODS: Through a 3-year follow-up of 46 patients who underwent single-bundle ACL reconstruction with hamstring tendon autograft, and graft angles were measured using MRI. Combined with objective knee static stability tests (Lachman Test, KT2000, and Pivot Shift Test) and dynamic functional tests (single-leg hop test, single-leg triple hop test, single-leg crossover hop test, Y balance test, isokinetic strength test, and proprioception assessment), the study analyzed whether there is a correlation between graft angles in the sagittal and coronal planes and short-term follow-up knee stability and functional outcomes.

RESULTS: The sagittal graft angle was found to have a moderate positive correlation with the Lachman test (r = 0.305, P = 0.039) and the peak torque of knee flexion during concentric isokinetic muscle strength testing at 180°/s (r = 0.392, P = 0.007). The coronal plane angle showed no correlation with any of the test results.

CONCLUSION: More vertical graft placement in the sagittal plane is associated with poorer anterior-posterior stability (Lachman test) and higher knee flexor strength output during dynamic testing (180°/s concentric isokinetic testing).This may reflect compensatory muscle activation to enhance stability, similar to the "quadriceps-avoidance gait" observed in ACL-injured patients,and may potentially affecting long-term outcomes.

No correlation was found between coronal graft angle and any static stability or dynamic function tests.The lack of correlation between coronal graft angle and any test results may be related to the fact that the coronal angles measured in this study were closer to the native ACL angles compared to previous studies. Additionally, this finding is significantly associated with the testing methods employed and the specific outcomes included in the analysis. If pivot shift testing under anesthesia, dynamic tasks involving knee pivoting, and direct measurements of kinematic parameters such as tibial rotation were incorporated, more ideal results might be achieved.

Recommendations:

Aim for graft placement angles closer to the native ACL to optimize knee biomechanics and reduce long-term degenerative changes.

Emphasize postoperative rehabilitation to minimize abnormal kinematics and reduce secondary degenerative changes.

**CHARACTERISTICS OF FALLS AMONG WHEELCHAIR BASKETBALL WOMEN PLAYERS IN THE TOKYO 2020 SUMMER PARALYMPIC GAMES: A VIDEO ANALYSIS**

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INTRODUCTION: Wheelchair sports, while offering numerous physical and psychosocial benefits, are associated with a heightened risk of falls [1]. Understanding the mechanisms and characteristics of these falls is crucial for developing effective injury prevention strategies. However, research specifically addressing falls in wheelchair basketball, particularly among women athletes, remains limited. This study aimed to investigate the specific characteristics of falls among wheelchair basketball women athletes at the Tokyo 2020 Summer Paralympic Games (the Tokyo games).

METHODS: We obtained video footage from the International Paralympic Committee of the Tokyo games that included 10 women's teams from each of the 31 wheelchair basketball games. A quantitative analysis was performed to examine the incidence of falls, class-based differences (low vs. high pointers), temporal patterns of falls within games, and biomechanical characteristics of falls, including contact events, fall trajectories, and impact sites. The Pearson's $X^2$ test or the Fisher's exact test was used to compare each categorical variable in each group; the Fisher's exact test was conducted when the expected number was 5%.

RESULTS: Overall, 325 falls (womens basketball, Low; 168, High; 157) occurred (average per game: 9.3). The Tokyo games were characterized by an increase in falls among women's wheelchair basketball players, particularly those classified as low pointers. Statistical analysis revealed significant differences between low pointer and high pointer in several aspects of falls, including the direction of the fall, site of fall, whether the fall occurred during foul play, and the specific game situation in which the fall occurred.

CONCLUSION: The findings of this study highlight higher number of falls experienced by low pointer women wheelchair basketball players at the Tokyo games compared to their high pointer. This result may be attributed to several factors, such as low pointers, who often fulfill more defensive roles, being involved in more collisions and challenging maneuvers, thus increasing their risk of losing balance and falling. Their greater physical limitations of low pointer may also contribute to a reduced ability to recover from destabilizing events. Furthermore, the specific rules and close physical contact and rapid changes in direction might differentially affect players with varying levels of physical function. Future research should explore these potential contributing factors in more detail.

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**POST AND LONG-COVID-19 SYNDROME AND EXERCISE INTERVENTION ROLES IN TERMS OF ACE2**

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INTRODUCTION: The large number of Post and Long-COVID survivors has drawn attention to the management of Post and Long-COVID-19 condition, known as Post and Long COVID-19. Dyspnea, chronic cough, and fatigue are the most commonly reported symptoms in the first 4week to 6 months after infection, but cognitive impairment and psychological symptoms may persist beyond this time. Other persistent symptoms such as cognitive and mental impairments, chest and joint pains, palpitations, myalgia, smell and taste dysfunctions, cough, headache, and gastrointestinal and cardiac issues were reported. The purpose of this comprehensive review is to evaluate Post and Long-COVID-19 syndrome from a biological perspective and also discuss about physical exercise intervention roles in terms of ACE2. It is thus imperative to

analyze Post and Long-COVID-19 effects, specifically as local and systemic pathophysiological outcomes of other coronavirus-related diseases with the exercise interventions.

METHODS: Medline, Embase, Global Health (Ovid), CINAHL (EBSCO), PubMed, Scopus, Web of Science and Google Scholar search engines were used to identify the definition, mechanism, pathophysiology of Post and Long post-COVID and also to find out rehabilitation and exercise-intervention benefits in terms of ACE2.

RESULTS: Medical treatments for COVID-19 (anticoagulants, corticosteroids, anti-inflammatory drugs, oxygenation therapy and ventilation) and vaccination have improved patient outcomes. The majority of patients will recover spontaneously or after acute-phase management, but clinicians are now faced with long-term complications of COVID-19 including a large variety of symptoms, defined as "Post-acute COVID-19 syndrome". Since the lungs are the most involved organs and the Post and Long-COVID prolonged and persistent effects are mainly related to the pulmonary system, it is crucial to define and predict the outcome and to determine the individuals that can progress to fibrosis and loss of function of lungs. The findings from our review indicated that there were four pathophysiological categories involved: virus-specific pathophysiological variations, oxidative stress, immunologic abnormalities, and inflammatory damage with physical exercise.

CONCLUSION: Although studies examining the pathophysiology of Post and Long-COVID-19 syndrome are still relatively few, there is growing evidence that this is a complex and multifactorial syndrome involving virus-specific pathophysiological variations that affect many mechanisms but specifically oxidative stress, immune function, and inflammation. Rehabilitation and Multicomponent exercise-intervention program (4-5 days per weeks, 35-60% HRR, 100-250 minutes aerobic exercise) considered especially for the Post and Long-COVID-19 syndrome patients were recommended with all forms of psychological support such as meditation and MBI. Adopting life style changes and tailorized dietary interventions will be helpful to reduce Post-COVID-19 syndromes in terms of ACE2.

**EPIDEMIOLOGICAL STUDY OF HAMSTRING STRAIN INJURIES IN UNIVERSITY ATHLETICS ATHLETES: MRI-BASED ANALYSIS OF INJURY SITES AND SEVERITY**

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INTRODUCTION: Hamstring strain injury (HSI) is one of the most common injuries in sprint-based sports, particularly in competitive athletes. Moreover, it has a high recurrence rate, particularly within one year after the initial injury. However, few studies have utilized early post-injury MRI assessments to examine injury sites, severity, and their progression over time. This study aimed to investigate the incidence of HSI in university athletes by analyzing injury sites and severity using MRI.

METHODS: A prospective observational study was conducted from April 2023 to March 2024, including 133 university athletes specializing in sprints and jumps. Athletes reporting pain or soreness in the posterior thigh first underwent clinical examination, and those with suspected HSI subsequently underwent MRI assessment. HSI presence, injury site, and severity were classified according to the British Athletics Muscle Injury Classification (BAMIC).

RESULTS: During the observation period, 51 athletes (69 cases) reported symptoms, and MRI was performed on average 4.0 ± 3.1 days after symptom onset. HSI classified as grade 1 or higher according to the BAMIC classification was identified in 34 athletes (41 cases), with 30 cases involving the biceps femoris, 8 cases in the semitendinosus, and 3 cases in the semimembranosus. The severity classifications were as follows: 10 cases of grade 1a, 9 cases of grade 1b, 5 cases of grade 2a, 14 cases of grade 2b, 1 case of grade 2c, 1 case of grade 3b, and 1 case of grade 3c. Multiple injuries were observed in six cases during the observation period, including five athletes with ipsilateral injuries and one athlete with a contralateral injury, with four cases being recurrent injuries in the long head of the biceps femoris.

CONCLUSION: HSI in university athletes most commonly occurred in the biceps femoris, with a high recurrence rate in its long head. Future studies should conduct longitudinal investigations of injured athletes to identify risk factors for recurrence and to develop targeted rehabilitation strategies.

**DIFFERENCES OF DYNAMIC POSTURAL CONTROL PERFORMANCE AND MOTOR CONTROL ABILITY OF ANKLE BETWEEN JAPANESE JUNIOR HIGH SCHOOL AND COLLEGIATE BASKETBALL PLAYERS**

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INTRODUCTION: Ankle injury is the most common cause of ankle sprains in Japanese basketball players, because the rate of ankle sprains is higher in Japan than in NCAA players [1]. However, the differences in dynamic postural control performance and motor control ability between age groups remain unclear. Therefore, this study aimed to examine cross-sectional differences in dynamic postural control performance and motor control ability in young Japanese basketball players.

METHODS: The participants were 69 junior high school (12–15 years) and 57 collegiate (18–22 years) Japanese basketball players. Hip abduction isometric strength (ABD), Y-balance test (YBT) to the anterior (Ant), post-lateral (PL), post-medial (PM), and side hop test (SHT) were measured. The ABD and YBT scores were normalized to body mass, femur length, and lower limb length (from the anterosuperior iliac spine to the medial malleolus). The analysis used data from the superior value side. To evaluate the differences between groups, independent t-tests or Mann–Whitney U tests were performed after assessment of normality using the Shapiro–Wilk test.

RESULTS: The collegiate group had higher YBT-PM and SHT performances than those in the junior high school group (YBT-PM; p<0.001, d=0.77, SHT; p<0.001, r=0.39). However, the YBT-Ant in the collegiate group was significantly lower than that in the junior high school group (p<0.001, d=0.95). No significant differences were observed between the ABD and YBT-PL.

CONCLUSION: The SHT and YBT-PM scores may be influenced by increased motor control ability associated with growth. However, lower YBT-Ant scores, which have been reported as a feature of chronic ankle instability [2], were found in the collegiate group, in which higher athletic performance was expected. As suggested in previous research, lower YBT-Ant scores in the collegiate group may be affected by ankle dorsiflexion range of motion as the limiting factor [3]. Our results showed a difference in dynamic postural control performance between different age categories.

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**TEN-YEAR NATIONWIDE REVIEW OF YOUTH FIELD HOCKEY LOWER EXTREMITY INJURIES IN NEW ZEALAND**

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INTRODUCTION: Field hockey (hockey) is a popular team sport worldwide. Its physiological demands pose injury risks which may vary by demographics such as sex, age, and competition level. Research indicates the lower extremity (LE) is the most common injury site in hockey [1]. According to national insurance (Accident Compensation Corporation [ACC]) data in New Zealand (NZ), hockey ranks fifth for team sport injury claims [2]. National, multi-year reviews to understand injury epidemiology and inform injury prevention programmes (IPPs) have been conducted in other popular sports including netball, football, and rugby [3, 4, 5]. Given hockey's popularity in NZ and the significant ACC injury claims, similar initiatives are warranted. An understanding of injury types, rates, costs and trends will help inform future injury prevention strategies. Therefore, this study aimed to review ACC LE injury claims in youth hockey players from 2013-2023.

METHODS: Youth hockey injury data was extracted from ACC and reported by injury site and monthly injury count for the top three LE body sites per year to determine seasonal patterns over the 10-year period between 2013/14-2022/23. Age groups were defined as intermediate school age (10-14yrs) and high-school age (15-19yrs), representing the different schooling levels of play. Monthly injury counts and participation data from Hockey NZ were used to calculate monthly injury rates per 1000 affiliated players. Injury costs per year are also reported. A Shewhart control chart was used to identify seasonal changes and patterns within each year.

RESULTS: The highest average injury rate was for hip/upper leg/thigh injuries in females (15-19yr, 35.8/1000; 10-14yr, 26.2/1000), followed by knee injuries in females (15-19yr, 31.3/1000; 10-14yr, 25.9/1000). In both male age groups, the highest injury rate was also for hip/upper leg/thigh injuries (15-19yr, 29.13/1000; 10-14yr, 17.13/1000), followed by ankle injuries in the 15-19yr group (22.18/1000) and knee injuries in the 10-14yr group (15.95/1000). The highest mean cost/year was for knee injuries in females (15-19yr NZ$343,885; 10-14yr NZ$120,042). Most injury counts decreased over the 10-year period (15-19yr range -35.9% to +0.6%; 10-14yr range -45.6% to -27.0%). Consistent injury peaks were seen in May/June near the start of the season, and August/September around annual tournaments, except for 2020 and 2021 during the Covid-19 pandemic.

CONCLUSION: The most common injuries in youth hockey involve the hip/upper leg/thigh and knee. Injuries were more common in females than males and in 15-19yr compared to 10-14yr age groups. The majority of hockey LE injuries decreased between 2013-2023. Seasonal data across both age groups shows that high intensity periods can lead to higher injury rates. These findings could inform future IPP design to help reduce LE injuries in youth hockey.

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3) Belcher et al., 2020

4) King et al., 2024

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**SPORTS INJURIES AT THE SPECIAL OLYMPICS NIPPON NATIONAL WINTER GAMES 2024**

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INTRODUCTION: Studying sports injuries and illness are crucial to their prevention and plays a vital role in the continuation and promotion of sports activities. However, few studies of sports injury have been conducted at sporting events for parasports athletes, especially those with intellectual disabilities. A clear understanding of the difference between sports injuries and illness in athletes with intellectual disabilities and those without is important for prevention and medical sup-

port of injuries and illness in these athletes. The objective of this study was to clarify the incidence and characteristics of sports injuries and illness during the Special Olympics Nippon National Winter Games 2024.

METHODS: Four hundred and eighty-five athletes with intellectual disabilities (male: 378 [77.3%], female: 107 [22.7%]) and 26 unified partners, who are teammates without intellectual disability, (male: 17 [65.4%], female: 9 [34.6%]) who participated in the Special Olympics Nippon National Winter Games 2024 were included in the study. The sports included alpine skiing, snowboarding, cross-country skiing, figure skating, short track skating, floorball, and floor hockey. The number of injuries and illnesses and incidence (injuries/1000 athlete exposure [AE]) were investigated over the period. Additionally, location, mode of onset, mechanism, etc. were classified according to the definitions recommended by the International Olympic Committee. These analyses were categorized according to athletes and unified partners.

RESULTS: A total of 10 injuries occurred during the games period (6 days), there were no illnesses. All injuries occurred in athletes with intellectual disabilities, not in unified partners. The incidence in athletes with intellectual disabilities was 10.6/1000 AEs. In terms of the location and mechanism of injury, 70% of the injuries occurred in the lower extremity and were non-contact injuries. There were two time-loss injuries, both of which were serious and required surgery. On the other hand, the majority of injuries did not involve time loss and included complaints where the mechanism of injury or clinical findings were unclear.

CONCLUSION: At the Special Olympics Nippon National Winter Games 2024, sports injuries occurred only among athletes with intellectual disabilities. The characteristics of winter sports injuries in athletes with intellectual disabilities showed a high incidence in the lower extremities. Injuries ranged from severe to minor or unspecified complaints, requiring medical support to meet a wide range of needs.

**GAIT CHARACTERISATIONS IN ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS WITH RIGO A**

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INTRODUCTION: Adolescent idiopathic scoliosis (AIS) is one of the most common spinal deformities, with a prevalence of 1% to 3%. AIS disrupts the biomechanics of the lower limbs, leading to altered gait patterns. These abnormal gait characteristics may, in turn, increase asymmetric loading on the spine, potentially contributing to the progression of AIS. Previous studies have demonstrated that patients with Rigo type A scoliosis exhibit significant imbalances in spinal coronal parameters. However, the specific gait characteristics associated with this condition have rarely been reported.This study aimed to compare the gait characteristics and trunk stress patterns between Rigo type A AIS patients and healthy controls. The findings may provide valuable insights for clinical interventions.

METHODS: A cross-sectional design was employed in this study. The study protocol was registered with the Chinese Clinical Trial Registry (Registration Number: ChCTR1800018310) and approved by the Human Subject Committee of Guangzhou Sport University (Approval Number: 2023LCLL-10).

Ten AIS patients (aged 10–16 years) and an equal number of age- and sex-matched healthy adolescents (control group) were recruited. A 3D motion capture system was used to analyze the spatiotemporal parameters of gait in both groups. First, the German Zebris FDM gait analysis system was utilized to collect gait parameters at normal walking speed. Second, the Vicon motion capture system, combined with an AMTI force platform, was employed to analyze dynamic gait parameters at a constant speed and calculate trunk forces using inverse dynamics. Each participant was measured three times, and the average values were used for statistical analysis.

All experimental data were processed and analyzed using SPSS 26.0 software. Independent samples t-tests were applied to data conforming to a normal distribution, while non-parametric rank-sum tests were used for data that did not meet normality assumptions. Statistical results are presented as mean ± standard deviation.

RESULTS: Compared to the control group, AIS patients exhibited a longer double stance phase (25.43 ± 1.77% vs. 22.98 ± 2.90%). Additionally, in AIS patients, the vertical force on the trunk reached its maximum during the early phase of the right stance in the gait cycle.

CONCLUSION: Compared to healthy controls, AIS patients in this study demonstrated a greater proportion of double stance phases during gait cycles, suggesting that they may compensate for reduced stability by increasing double stance time. Furthermore, the maximum vertical force on the trunk occurred during the early phase of the right stance, which may be associated with the right-sided coronal imbalance typically observed in right thoracic curves. These findings highlight the potential relationship between gait adaptations and spinal asymmetry in AIS patients.

**SURVEILLANCE OF UNIVERSITY AMERICAN FOOTBALL TEAM INJURIES OVER THREE YEARS**

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INTRODUCTION: The purpose of this study was to conduct an injury survey of a total of 317 male university students enrolled in American football clubs at universities in one of the two major leagues in Japan from 2021 to 2023.

METHODS: Method of recording injury investigation records. All injuries were diagnosed by the team physician and reported by the student trainer using an electronic medical record. Injury incidence was calculated using units of 1000 Athlete-Exposures (1000 AE) and 95% confidence intervals (95% CI) were obtained. Other factors such as the cause of the injury, the location of the injury, the type of injury, and the severity of the injury were also tabulated.

RESULTS: In 2021, the club had 111 members, 9 games, 156 practices, and an injury rate of 5.2/1000AE [3.6-7.6]; in 2022, the club had 102 members, 13 games, 152 practices, and an injury rate of 5.8/1000AE [4.4-7.3]. In 2023, there were 104 members, 12 games, 176 practices, and 4.8/1000AE [3.5-6.1]; in 2021, contusion and meniscus tears were the most common, both at 16.5/1000AE; in 2022, dislocation was the In 2023, cartilage injury was the most common with 36.9/1000AE, followed by dislocation with 10.3/1000AE.

CONCLUSION: Although the number of injuries and disabilities has increased over the three-year period 2021-2023, the injury rate has decreased; the injury rate is higher in Contact than in No contact. Injuries to the upper and lower limbs have remained constant. On the other hand, injuries and disabilities in the head and neck and trunk/back areas varied from year to year. In terms of injury type, the incidence of injuries occurring in games was high, with bruises, dislocations, meniscus tears, cartilage injuries, and arthritis being the most common types of injuries

**EVALUATING THE PRECISION AND UTILITY OF HRMAX PREDICTION FORMULAS: A SYSTEMATIC REVIEW AND META-ANALYSIS**

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INTRODUCTION: Accurate estimation of maximum heart rate (HRmax) is essential for safe exercise prescriptions and cardiovascular risk assessment [1]. Widely adopted formulas (e.g., Fox [220–age], Tanaka [208–0.7×age]) may over- or underestimate true HRmax, especially in older or clinical populations [2]. This review and meta-analysis aimed to clarify potential bias in these formulas among both healthy and special cohorts (e.g., older adults, athletes, cardiac patients) and to examine subgroups (e.g., age, fitness, medication) that could influence HRmax prediction accuracy.

METHODS: This review was registered in PROSPERO (CRD42024607429). A comprehensive literature search was conducted in PubMed, Web of Science, Scopus, SPORTDiscus, Medline up to March 2024. Search terms for maximal heart rate ("HRmax," "maximum heart rate"), prediction equations ("heart rate prediction," "HRmax equation," "220−age," "Tanaka formula"), and populations ("adults," "elderly") were combined using Boolean operators ("AND"/"OR") and database-specific indexing. Only cross-sectional studies enrolling adults (≥18 y) or older adults (≥60/65 y), examining commonly used HRmax formulas (e.g., Fox, Tanaka, Gellish) and directly measuring HRmax (e.g., treadmill, ergometer) were included. Three reviewers independently screened records, extracted data, and assessed methodological quality (Newcastle–Ottawa Scale). A random-effects meta-analysis estimated the pooled mean difference (predicted vs. measured HRmax) with 95% confidence intervals, and subgroup analyses addressed age group, sex, cardiac status, athletic status, and formula type.

RESULTS: A total of 60 cross-sectional studies met the inclusion criteria, of which 23 provided mean ± SD ± n data for meta-analysis, and 37 were assessed narratively. Among these 60, 3 developed new HRmax equations, 47 validated existing models, and 10 incremented established formulas. Methodological quality was moderate in most studies, often due to limited confounder control (e.g., training status, β-blocker use). The meta-analysis indicated a systematic overestimation of measured HRmax in adults (18–59 y) (MD: +4.85 bpm, 95% CI: 2.96–6.74) and older adults (≥60/65 y) (+10.89 bpm, 7.84–13.94), with Fox showing greater bias (+7.43 bpm) than Tanaka (+1.94 bpm). Despite high heterogeneity ($I^2 > 75\%$), excluding lower-quality studies still yielded similar outcomes. Qualitatively assessed articles, especially involving athletes or older participants with comorbidities, reinforced overestimation trends, underscoring the need for population-specific refinements.

CONCLUSION: Commonly used HRmax prediction formulas systematically overestimate measured HRmax, particularly in older or specialized populations. Developing refined or population-specific models may enhance exercise prescription accuracy and cardiovascular risk stratification. Further research should validate adjustments for age, sex, and fitness level, thereby optimizing HRmax prediction across diverse populations.

**IMPACT OF PATIENT POSITIONING HEIGHTS ON RESCUER MUSCLE FATIGUE DURING CHEST COMPRESSIONS IN CARDIOPULMONARY RESUSCITATION: PRELIMINARY RESULTS**

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INTRODUCTION: Current adult cardiopulmonary resuscitation guidelines do not provide specific recommendations regarding the patient positioning height (e.g., ground level or elevated surfaces).1-2 However, previous research suggests the patient positioning height may impact rescuer muscle fatigue and, consequently, the quality of chest compressions (CC).3 Moreover, biomechanical advantages have been observed when rescuers are allowed to select the patient positioning height.4 Despite these findings, further investigation is required to address this topic comprehensively. The median frequency (MDF) is a parameter commonly used in electromyography (EMG) analysis, especially for studying muscle fatigue (its value tends to decrease when a muscle is fatigued).5-6 Thus, this preliminary study aimed to compare rescuer muscle fatigue across different patient positioning heights.

METHODS: In this randomized crossover trial (one week between different scenarios), 7 participants (mean age: 46.6 ± 9.0 years; 2 men) with a minimum of 5 years of experience in cardiopulmonary resuscitation were recruited. Each participant performed CC under four different patient positioning heights (scenarios): 1) on the ground; 2) on a bed at 75 cm (like the most common hospital bed height); 3) on a bed at 42 cm (the lowest height of electronic hospital beds); 4) on a bed at self-selected height (mean: 60 cm). CC were performed on the manikin's left side, with the rescuers right hand on its ster-

num, following 5 cycles of 2-minute CC (each separated by a 2-minute pause). The MDF values for both left and right portions of the trapezius superior (TS) and lumbar erector spinae (ES) were obtained from surface EMG (Biosignalplux; 1000 Hz), according to literature.6 Wilcoxon test was used to compare the four different scenarios, during 5 CC cycles.

RESULTS: In most cycles, CC performed on the ground yielded higher MDF values of the ES compared to self-selected and 42 cm heights ($p<0.05$). In some cycles, CC performed standing at 80 cm also yielded higher MDF values compared to the other two CC standing scenarios ($p<0.05$). Regarding TS, the CC performed on the ground also yielded higher MDF values compared to the other three CC standing scenarios ($p<0.05$).

CONCLUSION: Performing CC on the ground appears to result in lower TS fatigue. In contrast, performing CC in a standing position, with the patient positioned at lower heights, appears to induce higher ES fatigue. Given the small sample size, further research is necessary to validate these findings. These findings will be crucial for refining future cardiopulmonary resuscitation guidelines and optimizing exercise programs aimed at enhancing CC performance.

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**ASSOCIATIONS BETWEEN HAMSTRING STRAIN INJURY AND EXCENTRIC HAMSTRING MUSCLE STRENGTH IN ELITE MALE SOCCER PLAYERS**

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INTRODUCTION: Hamstring strain injuries (HSI) are a common problem in football, accounting for 12% of all injuries in high-level professional players, and recurrence rates have not decreased in recent years. These data suggest that our understanding of HSI and the risk of re-injury is incomplete. Many risk factors for HSI have been reported, such as older age, previous HSI and muscle fatigue. In recent years, eccentric hamstring imbalances, low eccentric strength and torque have been highlighted as new risk factors for HSI in many athletes. However, it has remained unclear whether eccentric hamstring imbalances, low eccentric strength and torque are associated with a previous occurrence of HSI in football players. The aim of this study was to investigate the relationship between the occurrence of HSI and eccentric hamstring strength in Japanese male soccer players.

METHODS: A total of 119 elite male football players (mean age 25.5± 3.5 years) from one team underwent eccentric strength testing during the preseason (2020-2024). Players with a history of HSI were assigned to group H (mean age 25.8± 3.3 years) and those without a history of HSI to group NH (mean age 25.5± 3.5 years). Eccentric hamstring strength was measured using the NordBord (VALD Performance, Albion, Australia). From these measurements, maximum force (N), torque (N･m), and imbalances for each leg (%) were calculated. All data were analyzed using SPSS Statistics software version 21.0 (IBM, Armonk, NY). p-value <0.05 was considered statistically significant.

RESULTS: The number of players with a history of HSI was thirty-six (30.3%: group H) and those without a history of HSI was eighty-three (69.7%: group NH). There were no significant differences in baseline characteristics such as age, weight, height and body mass index (BMI) between the two groups. No significant differences were observed between group H (dominant leg: 309± 64 N, non-dominant leg: 299± 63 N) and group NH (dominant leg: 308± 61 N, non-dominant leg: 291± 60 N) in the maximum force of eccentric hamstring strength ($p=0.821$, $p=0.821$) and torque between group H (dominant leg: 134±27 N･m, non-dominant leg: 130±26 N･m) and group NH (dominant leg: 137±28 N･m, non-dominant leg: 130±28 N･m), respectively ($p=0.810$, $p=0.958$). In addition, the eccentric hamstring force imbalances for each leg were not significantly different between the two groups (group H: 6.2± 6.4, group NH: 7.4± 7.7) ($p=0.387$).

CONCLUSION: The history of HSI among elite male soccer players in Japan was approximately thirty percent. There was no association between a history of HSI and eccentric hamstring strength.

**PREVALENCE OF LOW ENERGY AVAILABILITY AND NUTRITIONAL INTAKE DURING OFF-SEASON IN JAPANESE ADOLESCENT WATER POLO PLAYERS**

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INTRODUCTION: The International Olympic Committee (2014, 2023) introduced the concept of relative energy deficiency in sports (RED-S), a clinical syndrome resulting from low energy availability (EA). Insufficient energy intake can lead to issues with growth and development, metabolism, mental health, cardiovascular health, and bone health, ultimately impairing athletic performance.

The Japan Sports Association (2021) issued the "Guidelines for Sports Activities in the Developmental Period," highlighting the importance of psychological and social factors, adequate nutrition, and sports injury prevention.

Nutritional guidelines emphasise that sufficient energy intake and a well-balanced diet are essential for physical growth. Additionally, studies suggest that adequate daily energy intake is essential for preventing RED-S in adolescent athletes. However, research on energy availability in this population remains limited.

This study evaluates nutritional intake, training volume, and the occurrence of low EA (<30 kcal/kg FFM) in Japanese adolescent water polo players. The findings aim to contribute to the promotion of a healthy sporting life during early growth and development.

METHODS: Twenty-five elementary and junior high school water polo players (aged 8-15years) from clubs in Kyoto Prefecture, Japan, participated in this study. This study was conducted during the off-season to assess nutritional intake and energy availability when training demands may differ from the competitive season. The primary measurements included nutritional intake, training volume, body composition, and bone density. Nutritional intake was assessed using the brief-type self-administered diet history questionnaire for 15-year-olds (BDHQ-15y), and dairy energy intake was calculated. Exercise energy expenditure (EEE) was determined from a 7-day training record.

Participants were categorised into three groups for comparison: low, sub-optimal, and optimal EA according to the established definition of EA.

RESULTS: The mean EA was 64.8 ± 36.9 kcal/kg FFM. The prevalence of low, sub-optimal, and optimal EA was observed in 29.1%, 16.7%, and 62.5% of the players.

The corresponding EA values for these groups were 23.5 ± 3.9, 40.6 ± 5.2, and 87.3 ± 27.4 kcal/kg FFM, respectively. The low and sub-optimal EA groups had lower EA than the optimal EA group ($F(2) = 38.1$, $p = 0.006$, $p < 0.001$ and $p = 0.03$). Similarly, energy intake in the low EA and sub-optimal EA groups was lower compared to the optimal EA group ($F(2) = 15.5$, $p = 0.01$, $p < 0.001$ and $p = 0.04$). EEE also tended to be higher in the low EA group.

CONCLUSION: These findings indicate that 29% of the players had low energy availability and low energy intake. This group also tended to have a higher training volume.

In conclusion, these results highlight the need for a dietary intake improvement plan, particularly to enhance energy and nutrient intake during the developmental period.

**THE STUDY OF INJURIES AND INITIAL FIRST AID FOR BASKETBALL ATHLETES IN THE 3 × 3 BASKETBALL CHAMPIONSHIP OF THAILAND 2024**

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INTRODUCTION: The objectives of this study are to investigate the causes of injuries, the body parts that affected, and the nature of injuries sustained by 3x3 basketball athletes of Thailand.

METHODS: The sample group used in this study comprised 272 basketball athletes who participated in the 3 × 3 Basketball Championship of Thailand in 2024. The Taro Yamane (1973) formula was used to determine the sample size. The research instrument employed in this study was a questionnaire on the study of injuries and initial first aid. Content validity was assessed by calculating the Item-Objective Congruence (IOC) index, which ranged from 0.67 to 1.00. ,(R=1.0)). The statistical methods used for data analysis included frequency, percentage, mean, and standard deviation.

RESULTS: 1) Causes of Injuries, and Nature of Injuries of Basketball Athletes – the most common causes of injuries due to external factors. Substandard shoes and poor playing surface conditions were the leading causes, accounting for 28.60% of cases. Causes of injuries due to internal factors primarily involved a lack of warm-up, which contributed to 28.10% of injuries. Regarding Body Parts affected, head injuries were the most commonly found at the eyebrow (30.59%), while lower back injuries were the most frequent for the trunk (43.57%). Injuries to the upper limbs predominantly affected the fingers (35.75%), whereas the lower limbs were most commonly injured at the ankle (41.88%). In terms of the Nature of Injuries, skin injuries were mostly abrasions (47.81%), while muscle injuries were primarily cramps (57.10%). Joint and ligament injuries were mostly sprains 96.81%), and fractures were the most common type of bone injury (70%). The severity of injuries was mostly minor, allowing athletes to continue training and competing the next day 65.07%). The ongoing injuries due to training were mostly reported by athletes (90.44%). 2) Survey of Initial First Aid Approaches for Basketball Athletes – regarding first aid approaches within the first 24 hours after injury Providers of first aid were mostly the athletes themselves (44.05%). First aid method used was predominantly with cold compresses (48.84%

CONCLUSION: The study concluded that the most common cause of injuries among basketball athletes in the 3 × 3 Basketball Championship of Thailand was the lack of warm-up. The most frequently injured body part was the ankle, followed by the knee. The most common type of injury was cramps, while the severity of injuries was mostly classified as minor, allowing athletes to continue their training and competition. The predominant first aid method within 24 hours after injury was rest. Most athletes self-administering treatment with cold compresses was the most common method. The majority of treatment durations to recovery ranged from 7 to 13 days. The main source of first aid knowledge was from sports coaches. The findings of this study will serve as a guideline for coaches and athletes to plan injury prevention strategies in future competitions.

**LOW AWARENESS AMONG COACHES AS A RISK FACTOR FOR THE WIDESPREAD PREVALENCE OF RED-S AMONG ELITE ENDURANCE ATHLETES**

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INTRODUCTION: The widespread prevalence of Relative Energy Deficiency in Sport (RED-S) represents one of the most pressing challenges in global sports, negatively impacting multiple dimensions of athletic performance. These include elevated injury rates, detrimental impacts on reproductive health, and compromised mental well-being. Consequently, it is imperative to ensure sufficient awareness and understanding of RED-S among professionals who work directly with athletes, particularly coaches and sports physicians. Prior research has indicated that coaches knowledge regarding the prevalence and implications of this syndrome is inadequate, highlighting a potential significant concern [1]. The objective of this study was to assess the level of awareness of RED-S among coaches who train elite athletes in short-track speed skating and track and field.

METHODS: The study involved a total of 100 coaches (mean age 43.41±12.68 years, mean coaching experience 18.65±12.58 years) from track and field (n=73) and short-track speed skating (n=27). 19% coaches were currently working with high-level athletes (including medalists and participants of Olympic Games and medalists of European Championships) at the time of the survey, while 81% coaches worked with lower level athletes. All participants completed an online questionnaire in real time, based on the questionnaire used in the study by Kroshus et al. [2].

RESULTS: Among all participants, 61% of coaches answered "no" to the question "Have you heard of Relative Energy Deficiency in Sport (RED-S)?", while only 39% answered "yes." There was no statistically significant difference in RED-S awareness between speed skating and track and field coaches (40.7% and 38.4%, respectively; $p > 0.05$), indicating similarly low levels of awareness across both disciplines. Additionally, coaches currently working with elite athletes demonstrated higher awareness than those working with lower-level athletes (47.4% vs. 37%; $p < 0.05$). Among the coaches who were aware of RED-S, 51.3% considered their knowledge insufficient (low and very low), and all of them believed it was extremely important to implement educational initiatives on RED-S syndrome.

CONCLUSION: The study revealed extremely low awareness of RED-S among both coaches working with elite athletes and those working with lower-level athletes. This highlights the need for the implementation of educational programs detailing the diagnosis, treatment, and prevention of RED-S syndrome in practice.

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**ANALYSIS OF THE IMPACT OF MUSCLE DEFICIENCY ON BALANCE ABILITY AND WALKING IN THE ELDERLY**

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INTRODUCTION: Muscle deficiency, a condition commonly associated with aging, is characterized by the progressive loss of muscle mass, strength, and function, collectively referred to as sarcopenia. This degenerative process has been shown to substantially impair postural stability and locomotor ability in older adults, thereby increasing the risk of falls, mobility limitations, and loss of independence. Given that ambulation is a fundamental component of daily living in the elderly population, any decline in walking ability can have profound implications for overall health and quality of life. Falls, often resulting in a cascade of medical interventions, represent a major concern for aging individuals. Since balance dysfunction is a key contributor to fall risk, understanding the relationship between muscle deficiency, balance impairment, and gait alterations is of critical importance. Therefore, this study aims to analyze the effects of muscle deficiency on balance control and walking performance in the elderly.

METHODS: This study recruited elderly individuals diagnosed with sarcopenia (n = 16) as the sarcopenia group and age-matched healthy elderly individuals (n = 17) as the control group, all of whom participated voluntarily. Static balance and gait performance were assessed using plantar pressure measurement systems. Descriptive statistical analysis was conducted to summarize the characteristics of both groups. An independent sample t-test was employed to evaluate differences in balance capacity and gait parameters between the sarcopenia and control groups. Additionally, a paired sample t-test was used to examine intra-group differences in balance performance under open-eye versus closed-eye conditions, as well as gait parameters under self-selected comfortable versus maximum walking speeds.

RESULTS: Regarding balance, the sarcopenia group exhibited a significantly larger COP sway area (4.95 ± 1.82 cm2 vs. 2.84 ± 1.12 cm2 , $p < .05$) and higher COP movement speed of the center of pressure during open-eye standing balance compared to the control group (1.64 ± 0.66 cm/sec vs. 1.27 ± 0.35 cm/sec , $p < .05$). However, no significant differences were observed between the two groups in closed-eye standing balance performance. Regarding gait, no significant differences were found between the sarcopenia and control groups in gait parameters during self-selected comfortable walking. However, during maximum-speed walking, the sarcopenia group demonstrated significantly shorter stride length ( 99.48 ± 14.30 cm vs. 116.31 ± 14.17 cm , $p < .05$), lower cadence ( 114.63 ± 12.61 step/min vs. 126.58 ± 16.63 step/min , $p < .05$), and reduced gait speed ( 0.95 ± 0.18 m/sec vs. 1.22 ± 0.15 m/sec , $p < .05$), compared to the control group ($p < .05$), while foot angles and step width did not differ significantly between the groups.

CONCLUSION: Elderly individuals with sarcopenia exhibit significantly impaired open-eye balance and maximal-speed gait performance compared to their healthy counterparts. To effectively distinguish between sarcopenic and healthy elderly individuals, open-eye standing balance assessment and maximum-speed walking tests are recommended as more sensitive detection methods.

**RUNNING OFF THE BEATEN PATH: A REVIEW OF INJURIES IN TRAIL RUNNING**

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INTRODUCTION: Trail running events take place in natural environments, mostly off-road, and vary in distance as well as vertical gain. Considering its increasing popularity, evidence-based information on trail running related injury (RRI) epidemiology is fundamental in identifying risk factors and hence suggesting preventive strategies for safer practice. Thus, the aim of this study was to summarize the existing literature on injury frequency, characteristics, and risk factors in trail running.

METHODS: A literature search was performed electronically in PubMed from inception to February 12th, 2025, using the terms "(injury OR epidemiol*) AND (trail running OR mountain running)" or running-related terms. From 576 identified records (including duplicates), 12 fulfilled the inclusion criteria for the current review.

RESULTS: Frequency of injury. The incidence of RRIs, including illnesses, during training in the year before a race varies between 28.2% and 71.7% [1,2,3], probably influenced by recall bias. Reported RRIs during single races range from 25% to 56.5% [4,5], according to different definitions of injury.

Injury type. Musculoskeletal trauma is the most commonly reported injury type (17.4%-56%) [2,4,5,6], and usually occurs in training. During races, a higher incidence of dermatologic injuries, such as blisters or lacerations (33%), has been reported [5].

Injury location. The lower leg (15.3%-94%), especially the knee (9.1%-33.2%) and ankle, is the most common location of RRIs [3,5,7,8].

Risk factors. Viljoen et al. [1] reported that being male and having a history of RRIs increased the odds for RRI, while a higher number of running sessions or increasing distance covered lowered the odds of RRIs. However, there is no general consensus on the latter relationships so that protective factors are still not well defined. On the other hand, bone stress injuries are more frequent among older women [9].

CONCLUSION: This review presents the latest knowledge on RRIs. These vary considerably in incidence, mostly affect the musculoskeletal system followed by the skin, are typically localized at the lower leg, and are overall more common among men as well as athletes with injury history.

These results could be the basis for the implementation of evidence-based preventative measures, which are crucial for injury management and performance enhancement. The present findings highlight the need for a deeper understanding of injury mechanisms and potential protective factors as well as the importance of tailoring training plans to reduce injury risks [1,6,8]. Additionally, injury prevention efforts should be reinforced through educational programs for athletes and coaches, providing evidence-based guidance on risk factors, prevention strategies, and early treatment options for RRIs.

References

1 Viljoen et al. 2021a

2 Viljoen et al. 2021b

3 Hoffman & Fogard 2011

4 Mauvieux et al. 2020

5 Scheer & Murray 2011

6 Viljoen et al. 2024

7 Viljoen et al. 2021c

8 Gajardo-Burgos et al. 2021

9 Stennett et al. 2025

## Statistics and Analyses

**INTERPLAY OF PHYSICAL ACTIVITY, SLEEP QUALITY, AND CHRONOTYPE IN UNIVERSITY STUDENTS' ACADEMIC PERFORMANCE**

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INTRODUCTION: Physical activity, sleep quality, and chronotype are critical factors that influence cognitive function and academic performance. While physical activity is widely recognized for its physical health benefits, its role in enhancing academic outcomes, particularly in physically active student populations, remains underexplored. This study aims to assess the combined effects of physical activity, sleep quality, and chronotype on academic performance in a cohort of

university physical education students, offering new insights into how these factors contribute to success in physically demanding academic programs.

METHODS: A total of 58 undergraduate students from the Department of Physical Education at Qatar University participated in this study. Participants completed the International Physical Activity Questionnaire (IPAQ) to assess physical activity levels, the Pittsburgh Sleep Quality Index (PSQI) to evaluate sleep quality, and the Morningness-Eveningness Questionnaire (MEQ) to determine chronotype. Academic performance was measured through participants' GPA. Statistical analyses were conducted using IBM SPSS Statistics, Version 29, including Pearson's correlation and multiple regression analyses. Normality was assessed using the Shapiro-Wilk and Kolmogorov-Smirnov tests.

RESULTS: The analysis revealed significant interactions between sleep quality, physical activity, chronotype, and academic performance. A moderate negative correlation was found between sleep quality (PSQI) and GPA ($r = -0.37$), with students experiencing poorer sleep quality (PSQI > 5) showing a lower average GPA (2.90) compared to those with better sleep quality (PSQI $\leq$ 5), who had a higher GPA (3.26). Although no significant direct correlation was observed between total physical activity (MET-minutes/week) and GPA, students with moderately evening chronotypes reported the highest levels of physical activity (3792 MET-minutes/week). Regarding academic performance, definitely evening-type students had the highest GPA (3.57), while moderately morning-type students had the lowest GPA (2.71). Additionally, sleep quality was associated with chronotype, as evening-type students reported the best sleep quality (PSQI = 5.00), further highlighting the role of chronotype and sleep in academic success.

CONCLUSION: This study underscores the importance of chronotype and sleep quality in shaping academic performance, with evening-type students demonstrating both higher physical activity levels and better academic outcomes. Although physical activity did not directly predict GPA, the interaction between physical activity and circadian preferences suggests that aligning physical activity with one's natural chronotype may have beneficial effects on both cognitive and physical performance. These findings highlight the need to consider the combined effects of physical activity, sleep, and chronotype in promoting academic success among students in physically demanding programs.

**ANALYSIS OF THE TECHNICAL ELEMENTS OF THE ESTONIAN MENS VOLLEYBALL TEAM AT THE 2023 EUROPEAN CHAMPIONSHIP FINALS.**

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INTRODUCTION: Analysing teams' proficiency about different technical elements at competitions leads to valuable information, which allows coaches to understand the weak and strong sides of the players and change the training plans and methods, which ultimately contributes to the advancement of the team. (Drikos et al., 2022)

The aim of the thesis was to compare the performance indicators of different technical elements in matches won and lost, and to determine their effect on the games result. The specific aims were compare serving indicators, serving reception indicators, attack indicators and blocking indicators in won and lost sets. The study involved the Estonian men´s volleyball team. Five matches were analysed from the 2023 final tournament, comprising eighteen sets, of which four were won and fourteen were lost.

METHODS: Data were collected through video observations, where the author recorded serving, serving reception, attack and blocking performances, which were evaluated based on the Data Volley 4. For data processing was used Microsoft Excel. Students t-test in Jamovi was used for comparing data and evaluating relationships.

RESULTS: No significant differences were found between losing sets and winning sets in serving and serve reception performance. Differences were found in attack performance ratings and effectiveness averages between winning and losing sets. Differences were also found in blocking performance rating and effectiveness averages between winning and losing sets.

CONCLUSION: In conclusion one can say that the games what we lost were lost mainly because of our weaker block and attack because these elements were performed statistically significantly weaker in lost sets than in the sets that estonians won. The conclusions drawn from the study could be helpful for coaches in improving the technical elements of the game, helping them understand which technical aspects may be crucial from the perspective of match outcomes and how to improve or optimize them.

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**HAS COVID-19 INFLUENCED THE PERFORMANCE OF TOP-CLASS ATHLETES IN THE OLYMPIC DISTANCE OF THE ITU WORLD TRIATHLON CHAMPIONSHIP?**

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INTRODUCTION: World Championships are attractive to the scientific community and have been investigated in a wide range of sports. The World Triathlon Series (WTS) is the top championship for triathlon in Olympic distance (OD). Sex differences in triathlon performance have been found to depend on discipline and distance, as previous studies have shown (Lepers, 2019). Lepers & Stapley (2010) have asserted that the sex performance gap is narrower in the Olympic distance

when compared to other larger distances. The influence of COVID-pandemic on triathlon is not yet clear. The aim of the present study is to provide a comprehensive analysis of the effect of COVID-19 pandemic on performance in the WTS focusing on male and female categories.

METHODS: The dataset for this study was obtained from the ITU World Triathlon Series (WTS) website (http://wts.triathlon.org/). Individual discipline times and overall times from 2018 and 2022 were collected for analysis, excluding 2020 due to the COVID-19 outbreak. The total number included athletes in this study was 1,628 subjects (874 males and 754 females). The mean age of subjects overall was 27.00 for males and 27.59 for females. The Students t-test for independent samples comparing sex was used for normal variables, whereas the Mann-Whitney U-test was used for non-normal variables.

RESULTS: The analysis displayed several significant changes in performance after the COVID-19 pandemic. For men, all the variables changed with a p value lower than 0.001. All variables except for swimming and first transition performance showed better performance values. For women, all variables significantly changed after the COVID-19 pandemic. Swimming, cycling and final performance improved (p values 0.033; <0.001; <0.001 respectively) whereas the running performance decreased (p value 0.003). When examining the relative changes between sexes, four out of six studied variables showed significant differences, being the cycling and the final performance the most significant (p values <0.001). Additionally, the two other variables (swimming and first transition performance), showed a smaller difference (p values <0.05).

CONCLUSION: These results suggest that triathletes from both sexes participating in the Olympic Distance of the WTS were able to not only maintain but also improve their final performance level despite the COVID-19 pandemic, except for the swimming performance. The reason may be because access to swimming pools during the lockdown may have been more complicated than cycling or running training. These findings also highlight the importance of considering specific variables, distances, and sex when assessing the impact of the pandemic on multi-sport performance.

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**QUANTIFYING MOTOR MOVEMENT DIFFICULTY USING ITEM RESPONSE THEORY: A CASE STUDY OF STRADDLE VAULTING IN THIRD- AND FOURTH-GRADE ELEMENTARY SCHOOL STUDENTS**

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INTRODUCTION: In motor learning, setting appropriate tasks based on an individuals ability is crucial. Overly difficult tasks may lead to a sense of powerlessness and increase the risk of unexpected injuries, while overly easy tasks may decrease motivation. Quantifying motor movement difficulty provides valuable information for designing progressive movement tasks tailored to individual abilities. This study aimed to quantify the difficulty of individual movements that constitute the straddle vault in third- and fourth-grade elementary school students.

METHODS: This study involved 538 children (263 boys and 275 girls) from five elementary schools in Japan. Their straddle vault movements were recorded from both the left and front sides. The movements were evaluated and scored using the observational evaluation criterion (30 items) [1]. After confirming item unidimensionality through factor analysis, item difficulty values (b) were estimated using item response theory (IRT). Additionally, differential item functioning (DIF) was analyzed to assess whether difficulty levels varied by grade.

RESULTS: The IRT analysis revealed that item difficulty values for taking off from a stable run-up (b=-4.952 to -1.833) and shifting weight forward (b=-0.610 to -0.048) indicated that these were low-difficulty movements. The movements required for a bouncy take-off (b=0.131 to 0.360) and stable landing (b=0.012 to 0.816) were of medium difficulty. DIF analysis revealed that third graders found four landing movements—looking at the landing position, closing the legs, flexing the lower limbs, and stopping firmly—more difficult than fourth graders. The movements of turning rotation (b=1.026 to 1.309) and aggressive landing (b=1.152 to 1.806) were highly difficult. The dynamic take-off movements were extremely difficult (b=2.432 to 3.824). Based on this information, a sequence diagram of movements was created, considering both movement timing and difficulty levels.

CONCLUSION: The movements for a stable run-up and weight shift are of low difficulty, making them suitable for early learning stages. The bouncy take-off and stable landing are of medium difficulty, with landing being harder for third graders than for fourth graders. Turning back and aggressive landing are high-difficulty movements that should be learned as skill levels progress. The dynamic take-off is highly difficult and may not need to be mastered by third or fourth graders. Developing a teaching program that considers movement difficulty and verifying its effectiveness will be essential.

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**DECLARATIVE KNOWLEDGE TEST ON RIGGING IN SAILING COMPETITIONS: CREATING TESTS BY KNOWLEDGE LEVEL**

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INTRODUCTION: In sailing, the ability to make decisions in various situations is essential. Decision-making is not simply based on that alone but is also based on a wealth of declarative knowledge. Therefore, the possession of declarative

knowledge is also important as a basis for decision-making. So, we created a knowledge test that asked about the importance of rigging in sailing competitions. However, if there were to be a large number of questions, then for those with a lot of knowledge, the easy questions would be tedious and redundant, while for those with less knowledge, the difficult questions would be too difficult and stressful. Therefore, it was desirable to create a test with a small number of items of varying difficulty that are appropriate to each persons ability.

METHODS: A test consisting of 40 questions on the names of ship riggings was given to 174 people who had participated in a nationwide competition for the general public and a nationwide competition for high school students in Japan. Obtained data were applied to the one-, two- and three-parameter item response models, and we then obtained the item parameters, individual ability parameters θ, and information functions that indicated the accuracy of θ corresponding to the models.

RESULTS: After calculating the BIC for each model, we found that the BIC for the 1-parameter model was 5827; that for the 2-parameter model was 5736; and that for the 3-parameter model was 5747, i.e., that for the 2-parameter model was the lowest, so we adopted the 2-parameter model. The difficulty parameters obtained were mostly around -0.5, gradually decreasing in the negative direction, and the positive parameters were fewer than the negative ones. The discrimination parameter was mostly around 2.0, and while the shape was unimodal, it was relatively even. θ, which indicates the amount of knowledge an individual has, was symmetrically distributed around 0, ranging from -2 to 2. The relatively difficult test items included "Catamaran (difficulty = 3.406, discrimination = 0.221);" "Stern (0.740, 0.843);" "Transom (0.557, 2.030);" and "Halyard (0.099, 1.615), the moderately difficult test items, "Rudder (-1.387, 3.623);" "Bow (-1.449, 2.983);" and "Reach Ribbon (-1.464, 2.636)," and the less difficult test items, "Beam (-4.307, 0.542);" "Abeam (-4.307, 0.542;" "Centerboard (-4.226, 0.362);" and "Raffing (-3.012, 1.087)." Taking into account the difficulty parameter(b), we considered the high ability range to be θ=0.0 to -1.0, the moderate one to be -1.0 to -2.0, and the low one to be -2.0 to -3.0 and set the amount of information to I=9.0, which corresponds to a reliability coefficient of 0.9 in classical test theory.

CONCLUSION: As a result, in the high range, 15 items with b of -0.915 or more were required, and in the medium range, 11 items with b of -1.618 to -1.106 were required. However, even when using the 23 items with a low range of b=-0.971 or less, it was not possible to cover the lowest part of the range.

**ASSESSMENT OF THE DEFENSIVE TRIANGULAR FORMATION IN FOOTBALL**

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INTRODUCTION: Advancements in information technology have facilitated real-time data acquisition during soccer matches and its application in tactical analysis. Measurement of the defensive triangular area can aid in quantifying the probability of scoring and conceding goals. However, data on the defensive triangular area near the penalty area (PA) are limited. Therefore, in this study, we aimed to investigate the defensive triangular areas under different attacking patterns near PA.

METHODS: Twenty matches from the 2023 J-League Division 2 were analyzed and only those without any player dismissal were selected. Match footage was reviewed to identify the instances of defensive success and failure near PA. Attacking patterns were classified into five categories: (A) Passes within PA, (B) passes from outside to inside PA, (C) dribbling within PA, (D) dribbling from outside PA, and (E) shots taken within PA.

Defensive triangle was defined as the area formed by the three nearest defensive players in front of the ball holder at the final moment. Positional coordinates of the defensive players were extracted using a semi-automatic tracking system (Iseyama et al., 2015). Defensive triangular areas were calculated from the XY coordinates and classified based on the attacking patterns (A-E).

RESULTS: Defensive triangular areas were analyzed and classified according to the attacking patterns. In all attacking patterns, the defensive triangular area was significantly smaller during successful defense than during failure ($p<0.05$). Notably, the defensive triangular area during successful defense was the smallest in C (16.8±9.6m2). No significant difference in the defensive triangular area was observed between C and A (21.2±5.7m2); however, the defensive triangular area was significantly smaller in C than in B (35.8±4.6m2), D (26.3±5.9m2), and E (20.9±5.7m2). The defensive triangular area was the largest in B, being significantly larger than those in the other attacking patterns. These findings suggest that defensive players position themselves widely when defending crosses.

During defensive failures, the defensive triangular area was the smallest in A (37.2±3.1m2). No significant difference in the defensive triangular area was observed between A and E (39.2±16.2m2); however, the defensive triangular area was significantly smaller in A than in B (57.2±12.4m2), C (50.9±8.0m2), and D (43.5±5.8m2) ($p<0.05$). These findings highlight the importance of defensive compactness in preventing goal-scoring opportunities.

CONCLUSION: This study analyzed the defensive triangular areas under different attacking patterns near PA and showed that successful defense is associated with a significantly small triangular defensive area. Our findings suggest the defensive triangular area as a valuable metric to determine the defensive effectiveness near PA.

**A TEST OF DECLARATIVE KNOWLEDGE OF SAILING THEORY IN SAILING COMPETITIONS**

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INTRODUCTION: In sailing, the ability to make decisions and judgments that should be performed in a split second under various conditions is required, but these judgments are not made based solely on this ability, and a wealth of declarative and procedural knowledge is needed as a foundation. Therefore, in this study, we created a knowledge test that asked about important sailing theory in sailing competitions. We used the item response theory to estimate ability because the number of correct answers and ability are not necessarily linear. In particular, we proposed a simple method with a correspondence table with the number of correct answers, in which complex calculations were not required.

METHODS: A test consisting of 28 questions about sailing theory was conducted on 174 people who had participated in prefectural and nationwide tournaments in Japan and who had agreed to the aims of this research. We applied one-, two-, and three-parameter models in the item response theory to the data, which had been converted so that the correct answers were scored 1 and the incorrect ones 0, and we selected the model with the best fit using BIC and then obtained the item parameters and individual ability parameters corresponding to that model.

RESULTS: After calculating the BIC for each model, the BIC for the one-parameter model was the lowest, at 4674, while that for the two-parameter model was 4691, and that for the three-parameter model was 4685. These results allowed us to select the three-parameter model. The values of the individual ability θ obtained were generally within the range of ±2.0 and were symmetrical around 0, with the most distribution of values mainly between θ=-0.3 and θ=0.7. The difficulty parameter, which indicates the difficulty of the test items, was the lowest for "Close-hauled angle" at -5.543 (standard error = 1.012), followed by "Heel" at -3.115 (0.347); "Tacking" at -2.726 (0.302); and "Jibing" at -2.643 (0.294), which were relatively low in difficulty. On the other hand, "Sail shape wrinkle" was the most difficult, with a difficulty parameter of 2.805 (0.311), followed by "Outhaul" with 1.621 (0.222), then "St. bend wrinkle" with 1.302 (0.209), and subsequently "Cunningham" with 0.951 (0.198), and "Side-jibe instructions" with 0.822 (0.195), which were relatively difficult items. These difficulty parameters were the most frequent between θ=-1 and θ=0 and were almost evenly distributed, but there was a slight skew towards lower difficulty. In addition, the information function, which indicates the accuracy of the θ estimation, showed a maximum value of 4.8 around θ=-0.7, indicating that the θ value in this area was estimated to have the highest accuracy. This corresponded to a reliability coefficient of 0.83 in classical test theory.

CONCLUSION: Finally, we proposed a converting table corresponding to the number of correct answers and θ values one-to-one by having calculated it in advance, which should allow us to calculate θ values conveniently.

**VENTILATORY THRESHOLD POWER PREDICTION MODEL FOR FUNCTIONAL THRESHOLD POWER TESTING IN RECREATIONAL TRIATHLETES**

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INTRODUCTION: Previous studies often use training zones to develop training prescriptions, with the three-zone, two-threshold model based on ventilatory thresholds (VT1 and VT2) being the gold standard for setting exercise intensity[1-3]. However, measuring ventilatory thresholds requires expensive equipment and trained personnel[4]. Therefore, this study aims to develop a pedaling power prediction model for ventilatory thresholds using the more accessible Functional Threshold Power (FTP) test, providing a simple and fast method for recreational triathletes in Taiwan to adjust their training prescriptions.

METHODS: This study recruited 22 recreational triathletes (13 males, 9 females) who completed an FTP and cycling-graded exercise tests on separate days. Physiological parameters (e.g., heart rate, power, core temperature) were measured during the FTP test, while ventilatory threshold (VT) and their corresponding power outputs were determined from the graded exercise test. Stepwise multiple linear regression was used to develop pedaling power prediction models for different VT.

RESULTS: The results showed that in the prediction model for VT1 power, the maximum heart rate reserve (MaxHRR) during the 20-minute FTP stage was the primary predictor, explaining 90.8% of the total variance in VT1_Power (W), with an adjusted $R^2$ of 89.6%, indicating a high predictive ability. The prediction equation was VT1_Power (W) = 993.192 − 8.956 × MaxHRR. For the VT2 power prediction model, FTP value and the average core temperature (AvgCoretemp) during the 20-minute FTP stage were the key predictors, explaining 93.5% of the total variance in VT2_Power (W), with an adjusted $R^2$ of 91.6%, demonstrating an excellent predictive ability. The prediction equation was VT2_Power (W) = 2931.049 + 0.772 × FTP − 74.519 × AvgCoretemp. However, previous studies on ventilatory threshold prediction using multiple linear regression models incorporating multiple indicators remain limited, with most research relying on single-variable correlation models[5].

CONCLUSION: Indicators from the widely used FTP test can accurately predict ventilatory threshold power. The high accuracy of the prediction models suggests that FTP testing can effectively replace traditional cycling-graded exercise tests, providing valuable guidance for athlete training. This offers a practical alternative for recreational triathletes and supports using FTP testing in sports science.

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**THE VALIDITY OF THE ITALIAN TALK TEST FOR MEASURING EXERCISE INTENSITY IN HEALTHY ADULTS**

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INTRODUCTION: Talk Test (TT) is a simple method for measuring exercise intensity and estimating the ventilatory threshold (VT). It has been validated and used in several languages, such as Spanish and English, but no validation is available in Italian. Therefore, this study aimed to validate the Italian version of the TT (ITT) as a method for exercise prescription in the adult population.

METHODS: 14 healthy participants (24.6±2.9yrs) performed two testing sessions: one submaximal incremental treadmill exercise test (SITE) during which each individuals' ventilatory threshold (VT) was assessed via respiratory gas analysis, and one ITT following the same protocol. The SITE involved 3-min warm-up at 1% slope, followed by a 1 km/h speed increase every 2 minutes. In the last 30s of each stage, heart rate (HR), Rating of Perceived Exertion (RPE, Borg CR10 scale), and speed (km/h) were recorded. In the ITT, participants read aloud the Italian version of the Olympic Oath and were asked, "Can you speak comfortably?" with three possible responses: yes, not sure, or no. The last "yes" stage was considered the last positive (LP), the first "not sure" stage the equivocal (EQ), and the first "no" stage the negative (NEG). To investigate concurrent validity, Pearson's correlation coefficient (r) was used to assess ($p<0.05$) the relationship between HR, RPE, and speed at LP, EQ, and NEG during the ITT and the corresponding variables at VT recorded during SITE. Bland-Altman plots and 95% limits of agreement (LoA) were used to evaluate the level of agreement between HR, RPE, and speed variables from the ITT and SITE.

RESULTS: EQ (HR=167.6±11.6bpm; Speed=8.9±2km/h; RPE=3.6±0.9AU) and VT (HR=166.5±9.6bpm; Speed=9.2±2.4km/h; RPE=2.8±0.9AU) showed a very good to excellent correlation, with significant relationships for HR ($r=0.78$, $p<0.001$) and speed ($r=0.97$, $p<0.001$).

For RPE, a moderate correlation ($r=0.55$, $p=0.040$) was observed between LP (2.5±0.9AU) and VT. Bland-Altman plots indicated good agreement between EQ and VT, with mean bias of 1.14bpm for HR (LoA ranging from –12.97 to 15.25bpm), and –0.29km/h for speed (LoA ranging from –1.48 to 0.91km/h) values. Bland-Altman plots supported the significant relationship between LP and VT, where the mean bias was of –0.25 AU for RPE (LoA ranging from –1.87 to 1.37AU) values.

CONCLUSION: The EQ stage of the ITT is a practical and valid surrogate for VT in exercise prescription for healthy Italian adults. When participants were unsure about speaking comfortably, they exercised at an intensity measured by HR and speed comparable to VT. The discrepancy in RPE results, where RPE at VT aligns more closely with LP intensity, may be due to a timing mismatch. While HR and speed increase at the start of each stage, RPE is recorded at the end, reflecting accumulated effort. This lag in perceived exertion may explain its misalignment with the other physiological variables.

**KINEMATIC ANALYSIS OF FOREHAND STROKES IN SENIOR ELEMENTARY TABLE TENNIS PLAYERS**

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INTRODUCTION: Table tennis is one of the ten most popular sports globally, ranking seventh with 850 million fans as reported by Sports Show in 2020. The forehand stroke is a fundamental skill in table tennis, critical for generating ball speed during impact with the racket. It is also a relatively simple technique for beginners to master in introductory training. By incorporating scientific methods, this study aims to enhance the quality and efficiency of training for table tennis players.

METHODS: Four senior elementary school table tennis players (mean age: 11.5 ± 0.25 years, mean height: 144.3 ± 3.03 cm) were engaged for evaluation. Each participant performed six forehand movements, divided into two stance types: (1) Standing with feet shoulder-width apart and straight, (2) Standing with knees bent and feet positioned forward and backward. For each stance, players executed three hitting methods: (1) Hand moving while the body remained still, (2) Body moving while the hand remained still, (3) Hand and body moving together. Each action involved hitting the ball 10 times, resulting in a total of 240 forehand hits.

We assessed various parameters, including swing time, racket horizontal displacement, bat face angle, elbow joint angle changes, and hitting accuracy. Kinematic measurements were conducted using Kinovea motion analysis software. Statis-

tical analysis was performed with SPSS 22.0, using Pearson correlation analysis to explore relationships among parameters such as ball speed, bat face angle, racket horizontal displacement, swing time, and elbow joint angle across different hitting movements. Statistical significance was set at $P < 0.05$.

RESULTS: The research demonstrates significant correlations between hand length, forearm length, shoulder width, and ball speed ($P < 0.05$). Additionally, when standing with knees bent and feet positioned in a forward-backward stance, participants exhibited a shorter racket swing time, greater horizontal displacement of the racket, faster ball speed, and higher hit scores.

CONCLUSION: This pilot study revealed that optimizing swing time, racket horizontal displacement, bat face angle, and elbow joint angle can improve the quality of forehand strokes in table tennis. These findings provide valuable insights for coaches and players, offering a scientific basis to enhance training methods.

**EXPLORING THE LINK BETWEEN LANDING TECHNIQUE AND INJURY RISK IN ADOLESCENT FEMALE SOCCER PLAYERS: A LESS SCORE ANALYSIS**

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INTRODUCTION: The Landing Error Scoring System (LESS) is a clinical assessment tool commonly used to evaluate landing techniques and movement patterns associated with injury risk. This study aimed to investigate the link between LESS score and injury occurrence in female adolescent soccer players.

METHODS: Seventeen adolescent female soccer players (age 15.47 ± 0.72 years, weight 57.81 ± 7.93 kg, height 159.99 ± 5.26 cm) participating in the girls U-18 Championship were recruited for the study. The landing technique of the players was evaluated using the LESS score (0-19 errors score), with video recordings captured from frontal and sagittal views using the KINOVEA software. The assessment was conducted prior to the pre-season preparation period, and the players were monitored throughout the season. During the season, the medical personnel were instructed to report any injuries sustained during official games or training sessions that resulted in the players' inability to continue participating. Only non-contact injuries that were clinically diagnosed and resulted in an absence from training or competition for at least seven days were included. For the statistical analysis, the players were divided into two groups for comparison: those who sustained injuries throughout the season and those who remained injury-free.

RESULTS: Results indicated that 35.29% of the players sustained a non-contact injury during the season. Furthermore, the independent samples t-test demonstrated that the injured players ($n = 6$) had significantly higher LESS score compared to the non-injured players ($n = 11$) (injured: 8.17 ± 1.17; non-injured: 5.36 ± 1.29, $p < 0.01$).

CONCLUSION: These findings indicate that injured female soccer players demonstrated pooper landing mechanics compared to the non-injured group, as reflected by higher LESS scores assessed prior to injury. Although the reliability of screening tests in identifying individuals at increased risk for sports injuries is debatable, these tests can still offer valuable insights. When used in combination, screening tools such as the LESS score could enhance the ability to identify high-risk female soccer players by detecting errors in landing mechanics and movement patterns.

**ASYMMETRY OF CHANGE OF DIRECTION PERFORMANCE IN SHUFFLE MOVEMENT AND 505 TEST AMONG COLLEGE BASKETBALL PLAYERS**

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INTRODUCTION: examine the difference and asymmetry in change of direction in shuffle movement (CoDS) performance among basketball players

METHODS: assess the correlation and directional agreement between asymmetry scores of CoDS, 505, and single leg jump tests. Forty-two college basketball players performed three trials of the CoDS , 505, single leg countermovement jumps, lateral jumps, broad jumps, and drop jumps tests for each leg, with the best performance used for the final analysis.

RESULTS: The dominant (D) limb was defined as the side that performs better, while the non-dominant (ND) limb is the opposite. Asymmetry scores were calculated using the formula: $(D - ND) / D \times 100\%$. Significant differences were found in CODS ($ES = 0.49$, $p < 0.01$) and 505 ($ES = 0.34$, $p < 0.01$) performance between D and ND limbs. There was no significant correlation between the asymmetry scores in CoDS and 505 ($p > 0.05$). The Kappa coefficients between CoDS, 505 and single leg jump tests showed poor to slight agreement (Kappa range from –0.07 to 0.22) regarding asymmetry direction.

CONCLUSION: These results suggest that practitioners should specialize in assessing CoD asymmetry in both forward-backward and lateral movement performance.

**THE DEVELOPMENT OF THE PSOAS MAJOR MUSCLE IN THREE POSITIONS OF CHEERLEADER**

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INTRODUCTION: In cheerleading, the technical demands of high performances increase the risk of injuries. To prevent injuries in cheerleading, proper posture and core stability are required (Goto. 2001) . Especially in top position (TP), main-

taining their posture in unstable conditions such as stunts and pyramids is needed. Therefore, top position requires greater core muscle strength than base (BP) and spot positions (SP) for balance during performances. Among the core muscles, the psoas major muscle is especially important, as it connects the torso to the lower limbs, playing a central role in stabilizing posture and enhancing performance (Andersson. 1997) . Also, it has been reported that there is a correlation indicating that a larger cross-sectional area of the psoas major muscle is associated with reduced anterior-posterior sway of the center of gravity (Ozawa. 2006) . From this, it can be inferred that TP, which particularly requires more postural stability in their performance than other positions, may have more developed psoas major muscle compared to other positions. The purpose of this study was to evaluate the differences in core muscle development among three positions in cheerleaders with cross-sectional area (CSA) of the psoas major muscles.

METHODS: The study involved 32 female cheerleaders aged 18 to 22 from a competitive university team (9 TP, 15 BP, and 8 SP). We measured height, weight, BMI, and muscle mass. MRI imaging at the L4-L5 intervertebral space was used to measure the psoas major muscle CSA and spinel CSA and calculate the psoas major muscle-to-spinel ratio (ps-R). An independent t-tests with Bonferroni correction were applied to compare the three positions: TP, BP and SP. Additionally, independent t-tests were applied to compare between two groups: TP and the others (BP and SP: BSP).

RESULTS: Height was significantly taller in SP than in TP and BP, and BSP was also significantly taller than in TP. Weight and BMI were significantly lighter and lower in TP than in BP and SP. Muscle mass was significantly greater in BP and SP than in TP. No significant differences in the ps-R were observed among the three positions. However, the ps-R was significantly higher in TP than in BSP.

CONCLUSION: Results of this study shows that TP is smaller in height, lighter in weight, and has higher ps-R than the other positions. The high ps-R in TP suggests that necessity of the psoas major muscle is higher in TP than the other positions for balance and stability, and the necessity induces the development of the psoas major muscle in TP which has high risk of serious injuries caused by falling.

This study highlights the importance of the psoas major muscle especially in TP, preventing injury and improving performance. Therefore, positive training of core muscle should be essential in TP.

**THE PROFILE OF HIP ROTATION RANGE OF MOTION AND BATTING PERFORMANCE IN COLLEGIATE BASEBALL PLAYERS**

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INTRODUCTION: A restricted hip rotational range of motion (ROM) may impede the efficient transfer of energy from the lower limbs to the trunk and upper extremities during throwing or hitting, thereby increasing the risk of hip, groin, or lower back injuries. Maintaining adequate hip joint mobility is crucial for baseball players to optimize performance and reduce injury risk. This study aimed to assess the bilateral hip rotational ROM, evaluate hitting performance, and analyze the correlation between hip rotational ROM and hitting performance among collegiate baseball players.

METHODS: Forty-three collegiate baseball players from Taiwan (mean height: 178.2 ± 5.7 cm, mean weight: 79.2 ± 9.5 kg, mean age: 17.3 ± 0.7 years) participated in this study. Hip internal and external rotation range of motion (ROM) for both the leading and axial legs was measured in a seated position using an electronic goniometer application integrated into a mobile phone. On the same day, hitting performance—specifically bat speed and peak hand speed—was assessed using a Blast baseball swing analyzer sensor attached to the butt end of the bat. Each player completed five repetitions of tee-batting. A non-parametric Wilcoxon signed-rank test was conducted to compare differences in hip internal and external rotation ROM between the leading and axial legs, while Spearman's rho correlation coefficient was used to examine the relationship between hip rotational ROM and hitting performance.

RESULTS: The hip internal rotation ROM of the players exhibited a trend of being slightly greater in the lead leg (31.8±9.8°) compared to the pivot leg (29.5±8.8°). However, the difference was not statistically significant ($p = .172$). Conversely, the hip external rotation ROM showed a trend of being slightly lower in the lead leg (27.0±8.7°) compared to the pivot leg (28.8±8.7°), with no statistically significant difference observed ($p = .288$). The bat speed was 65.7±5.7 km/hr, with a maximum hand speed of 19.1±1.9 km/hr. Further analysis revealed a moderate negative correlation between the external rotation ROM of both the lead and pivot legs and bat speed (rho = -0.427 and -0.401, $p < .05$).

CONCLUSION: In collegiate baseball players, the external rotation ROM of both the lead and pivot legs have a greater influence on bat speed during hitting.

**EFFECT OF CORE TRAINING ON STRIKING VELOCITY AND FUNCTIONAL PERFORMANCE IN TEENAGE TABLE TENNIS PLAYERS**

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INTRODUCTION: Table tennis is a sport that demands agility, coordination, reaction time and strength. Striking the ball relies on both lower and upper limb strength. Improving core muscle stability through targeted core training can significantly enhance various functional performances, which may further increase ball velocity and enhance table tennis performance. However, previous studies have not specifically examined the effects of a core training program on functional ability and striking velocity in youth table tennis players. Therefore, the aim of this study was to investigate the effects of a 5-week core training program on forehand stroke velocity and the functional performance of dynamic balance, agility, and core endurance in teenage table tennis players.

METHODS: Thirty teenage table tennis players (age range: 13–17 years) were recruited for the study. Participants underwent functional performance tests of the star excursion balance test (SEBT), agility T-test, and 1-minute sit-up. Additionally, their forehand stroke velocity in table tennis was measured. Participants were divided into experimental and control groups based on their forehand stroke velocity, with 15 players in each group. All participants completed 12 sessions of regular training over six days per week. After completing their morning specialized training, participants in the experimental group additionally performed a core training program lasting 30–40 minutes, three times per week for five weeks. Functional performance and striking velocity tests were conducted again two days after the five-week experimental period. Data were analyzed using a mixed-design two-way ANOVA to examine differences in dependent variables between the groups and time points.

RESULTS: Following five weeks of training, the 1-minute sit-up test performance in the experimental group improved significantly compared to the pre-training ($p < .05$) and was also significantly higher than that of the control group ($p < .05$). The agility T-test performance in the control group declined significantly post-training and was also significantly worse than that of the experimental group ($p < .05$). Moreover, the SEBT performance of the non-holding racket side support leg in the experimental group improved significantly after training compared to pre-training ($p < .05$),whereas no significant difference was observed in the control group. On the other hand, the SEBT performance of the holding racket side support leg and forehand stroke velocity in table tennis showed no significant difference between pre-training and post-training in both groups.

CONCLUSION: Engaging in a progressive core training program three times per week for five weeks enhances dynamic balance and abdominal muscular endurance in teenage table tennis players but has no significant effect on forehand stroke velocity.

**IS MUSCLE OXYGENATION ASSOCIATED WITH HAEMATOLOGICAL STATUS IN ELITE FEMALE SPEED SKATERS?**

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INTRODUCTION: Changes in the muscle tissue oxygenation, metabolism and haemodynamics in response to exercise remain understudied [1]. Additionally, the relationship between the bodys haematological status and tissue oxygenation remains relatively unexplored, with inconclusive findings [2,3]. The aim of this study was to analyze the relationship between the amount of haemoglobin in the body - assessed by blood count indices and by carbon monoxide (CO) rebreathing method - and near-infrared spectroscopy (NIRS) indices at rest, during a 2-minute time trial, and post-exercise recovery.

METHODS: Fourteen, healthy, elite female speed skaters (aged 20.5 ± 3.8 years) performed a 2-min time trial (TT) on Wattbike Air trainer, simulating a 1,500 m race effort on ice, during which the average and maximum power (Pmean, Pmax), as well as blood lactate concentration at 3 minute after exercise, were measured. Haematology status was assessed with two methods: blood morphology and total haemoglobin mass (tHbmass). Blood morphology parameters i.e haemoglobin concentration ([Hb]), hematocrit (Hct) and red blood cells (RBC) were assessed using haematology analyser (Sysmex 100X). tHbmass, plasma volume (PV), blood volume (BV) and red cell volume (RCV) were determined using CO rebreathing method. Local oxygenation (SmO2) was measured during exercise and recovery using NIRS with the Moxy device in the vastus lateralis. The following oxygenation parameters were measured: SmO2baseline, SmO2min, SmO2max, deltaSmO2, half-time of local muscle re-oxygenation and local haemoglobin concentration (tHblocal). Pearsons correlation was applied to explore the association between all variables.

RESULTS: The haematological status assessed both by blood morphology parameters ([Hb], Hct, RBC) and by parameters of CO rebreathing method's (tHbmass, EV, PV and BV) was not associated with any indicators of muscle oxygenation and with tHblocal during the entire observation period. tHbmass, RCV and BV ($p<0.001$) were positively associated only with relative value of Pmean achieved during 2-minute TT.

CONCLUSION: The results indicate that regardless of used assessment method, haematological indices do not affect muscle oxygenation at rest, during exercise and post-exercise recovery. This suggest that tHblocal may reflect local blood flow in the microvascular system rather than overall haematological status. When evaluating exercise capacity, total haemoglobin mass and intravascular volume indices appear to be more relevant than commonly used blood count parameters.

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**ANALYSIS OF PHYSICAL STRENGTH FACTORS THAT CAN PREDICT THE COMPETITIVE PERFORMANCE OF JAPANESE FEMALE TENNIS PLAYERS**

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INTRODUCTION: Technical skills are the predominant factors in tennis [1]; therefore, players spend significant time on the court for technical training with a racket. Notably, devoting exactly the same amount of time to on-court technical training

as to physical training without a racket is difficult. However, as the competition level increases, players often realize the importance of physical strength and fitness [1, 2, 3]. Because higher physical strength is required for a higher competition level, clarifying the extent of the difference between domestic and global levels would be practically useful as a developmental training indicator. Research on differences in physical strength depending on the competition level is still in the developmental stage; therefore, attempting to quantify these factors is important for designing training programs in tennis. Therefore, the aim of this study was to assess physical strength factors that serve as guidelines for competing in world-class tennis and examine the physical strength indicators in Japanese female tennis players. Male players have been assessed previously; therefore, differences between male and female players were assessed.

METHODS: In this study, 71 female tennis players performed six physical strength tests (5 m sprint, t-test, 505-agility test, vertical jump (VJ), medicine ball throw (MBT), and shuttle run [converted to VO2max]). The Japan Tennis Association ranking points per one tournament (JTA/1T) were used as indicators of tennis competition levels. Pearson's product-moment correlation coefficient was used to assess the association between ranking and physical strength. Principal component analysis (PCA) was performed on the physical strength variables and PCA1 was used as a comprehensive index of physical strength. Multiple regression analysis was performed with JTA/1T as the dependent variable and each physical strength test item as the independent variable to identify the physical strength items that affected the ranking. Based on these results, a regression formula was constructed to predict the rankings. Statistical significance was set at $P < 0.05$.

RESULTS: Multiple regression analysis was performed on 71 female tennis players, and a significant regression equation was observed using shuttle run (VO2max), the 505-agility test, and MBT as independent variables to predict rankings (Y=-7201.472-329.548x1+5024.562x2+527.064x3 (x1: VO2max, x2:505 agility test, x3: MBT), F=4.625, p=0.005). The contribution rate of this equation was 17.2% (r = 0.414); indicating that 17.2% of the rankings can be explained by the shuttle run (VO2max), the 505-agility test, and MBT.

CONCLUSION: The novel finding of this study was that in Japanese female tennis players aiming to become world-class players, physical strength factors are related to shuttle run (VO2max), the 505-agility test, and MBT. Furthermore, these indicators can be used to identify talent among junior players.

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**COMPARISON BETWEEN CROSS-SECTIONAL AND LONGITUDINAL DATA FOR CHANGES IN ANTHROPOMETRIC AND PERFORMANCE MEASURES FROM 11 TO 17 YEARS OLD IN JAPANESE MALE SPEED SKATERS**

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INTRODUCTION: Investigating longitudinal changes in physical fitness, motor skills, and athletic performance of children is important to understand whether they are positively responding to training, and achieving their goals (1). While longitudinal data can provide growth and developmental changes in individuals, obtaining such data takes time and effort, thus conducting longitudinal studies is a challenge. On the other hand, cross-sectional studies make it easier to collect large samples in a relatively short period of time, but the rate of change derived from the cross-sectional data may not represent longitudinal individual changes. In fact, it has been shown that differences in growth changes exist between the two types of data, suggesting that cross-sectional data may over- or underestimate growth and development, especially during adolescence (2). This may be due to how the two data sets are compared, and how the data were collected (3). The present study compared the cross-sectional (CS) and longitudinal (LT) data collected over the same period for junior speed skaters in the same region for their changes in anthropometric and performance measures.

METHODS: Male speed skaters aged from 11 to 17 years old, who had belonged to a same speed skating club in Japan were used in the present study. The CS data consisted of 404 male skaters of 11 (n=60), 12 (n=67), 13 (n=73), 14 (n=69), 15 (n=53), 16 (n=40) and 17 years (n=42) taken between 2004 and 2019. The LT data followed 11 male skaters for six consecutive years (11 to 17 y) in the period. Outcome measures included height, body mass, body mass index (BMI), lower limb circumference, lower limb muscle thicknesses (MT), peak power during 10-s maximal bicycle pedaling (MAnP), peak skating velocity on a sliding board (PSV), and average ice-skating speed in 500-m calculated from individual time in each year (SP500). Importantly, the same investigator took the measures of MT, MAnP and PSV. A two-way ANOVA was used to compare changes in the outcome measures over 6 years (11 to17 y) between the CS and LT data.

RESULTS: The average values of the outcome measures were not different (p=0.795-0.999) between the CS and LT data at any age (e.g., BMI: 21.7 ± 2.0 vs 22.3 ± 2.3 kg/m2; thigh anterior MT: 60.5 ± 5.1 vs 60.5 ± 4.5 mm; MAnP: 1022 ± 141 vs 1026 ± 164 W; PSV: 3.21 ± 0.25 vs 3.11 ± 0.21 m/s; SP500: 12.5 ± 0.4 vs 12.5 ± 0.4 m/s at 17 years). Changes in the measures from 11 to 17 years were not different (p=0.750-0.998) between the CS and LT data.

CONCLUSION: The results showed that changes in the anthropometric and performance measures over the 6 years were similar in the CS and LT data. This suggests that longitudinal development of individuals can be predicted well by cross-sectional data obtained for junior athletes.

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**IMPACT OF INTENSE GLYCOLYTIC EFFORTS ON ANAEROBIC POWER AND LACTATE LEVELS IN ELITE VS. SUB-ELITE 400-METER SPRINTERS**

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INTRODUCTION: To improve anaerobic performance, coaches and athletes focus on speed endurance training. Successful 400-m performance requires a fast start, followed by a relative decrease in velocity during the final 100 meters. Blood lactate (LA) levels are commonly used to evaluate anaerobic metabolism, exercise intensity, lactate threshold, and recovery, offering valuable insights into metabolic demands during various physical activities. Post-exercise lactate concentration is particularly informative about the workload and its impact on recovery. This study aims to investigate the differences in lactate concentration following maximal anaerobic efforts in a group of 400-m sprinters, further categorized based on performance levels.

METHODS: One hundred thirty male runners were divided into two groups: elite (n = 66, body mass = 73.4 ± 7.8 kg, height = 182.1 ± 6.2 cm, age = 20.8 ± 4.0 years) and sub-elite (n = 64, body mass = 72.0 ± 7.1 kg, height = 182.1 ± 5.2 cm, age = 20.8 ± 4.0 years). Elite athletes had a 400-m sprint time below 50 seconds, while sub-elite athletes had a personal best above 50 seconds. Power output during countermovement (CMJ) and sequential squat jumps (SSJ) was measured in two sets after a warm-up. This was followed by two intermittent 30-second Wingate tests. Lactate concentration was measured at eight time points.

RESULTS: Maximal power (Pmax) was significantly higher in the elite group for both Wingate and jump tests (CMJ, SSJ). Pmax in the second Wingate test was lower in both groups and not significantly different ($p = 0.140$). Elite sprinters had higher lactate (LA) concentrations at most time points, except at rest and post-warm-up. After the first Wingate test, LA accumulation was 9% higher in the elite group up to 6 minutes post-exercise. The sub-elite group showed higher LA clearance at 9 and 12 minutes. At 20 minutes, LA concentration in both groups was similar to the 1st minute. Peak lactate (LAmax) occurred at 3 minutes post-Wingate for 40% of both groups, while 32% of elite and 38% of sub-elite reached LAmax at 6 minutes. The timing of LAmax did not differ between groups. LA kinetics during accumulation (1-3 minutes) and clearance (9-20 minutes) were similar in both groups, with no significant differences between 3-9 minutes.

CONCLUSION: Elite athletes demonstrate higher maximum power and greater lactate concentration following Wingate tests, which can likely be attributed to their adaptation to anaerobic metabolism dominance and the recruitment of fast-twitch muscle fibers during prolonged sprints. This adaptation, along with a more aggressive running strategy, sets them apart from their less experienced sub-elite counterparts. Despite these differences, the kinetics of LA accumulation and clearance were comparable between the two groups. Furthermore, the 400-meter running time was significantly correlated with the rate of LA accumulation from the 1st to the 3rd minute post-effort, but showed no relationship with the rate of LA clearance.

**JUMPING ABILITY IN YOUTH AND PROFESSIONAL FOOTBALL PLAYERS**

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INTRODUCTION: This study aimed to compare jumping performance between youth and professional football players while investigating potential differences based on playing positions. A total of 96 male athletes participated: 52 professionals and 44 youth players. Jumping assessments included the squat jump (SJ), countermovement jump (CMJ), and eccentric utilization ratio (EUR).

METHODS: Jumping assessments included the squat jump (SJ), countermovement jump (CMJ), and eccentric utilisation ratio (EUR), measured using a Fusion Sport JumpMat (Fusion Sport®, Brisbane, Australia).

RESULTS: Demographic characteristics (mean ± SD) for professional and youth players respectively were as follows: body fat (7-site) 10.50 ± 3.88% vs 9.24 ± 3.28%; age 27.37 ± 5.57 years vs 16.20 ± 0.80 years; height 179.78 ± 6.72 cm vs 175.97 ± 5.84 cm; body mass 77.12 ± 6.54 kg vs 66.98 ± 6.19 kg. Professional players demonstrated significantly higher SJ (39.62 ± 3.83 cm) and CMJ (42.52 ± 3.85 cm) compared to youth players (SJ: 33.68 ± 4.72 cm; CMJ: 36.86 ± 4.73 cm; $p < 0.05$). Among professionals, wingers showed superior SJ and CMJ values compared to other positions, while no significant position-based differences were found in youth athletes.

CONCLUSION: Interestingly, the EUR was lower in professionals (1.07) than in youth players (1.10), indicating that youth players relied more on elastic energy during jumps. This observation aligns with prior findings suggesting that younger athletes often compensate for lower muscular strength by leveraging tendon elasticity during dynamic movements. These results underscore the importance of position-specific jump training for professional players and highlight the need to focus on strength development in youth players to enhance explosive performance.

**MODE-SPECIFIC RESPONSES DURING TRACK AND TREADMILL RUNNING IN ELITE DISTANCE RUNNERS**

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INTRODUCTION: The translation of laboratory-based assessments to field training prescription represents a critical challenge in endurance sports, particularly at intensities typical of contemporary high-level training. Previous research has

focused primarily on recreational runners at moderate intensities, leaving a significant knowledge gap regarding mode-specific responses in elite athletes training at substantially higher intensities. This study investigated the physiological and biomechanical differences between track and treadmill running using a protocol specifically designed to reflect contemporary training practices.

METHODS: Nine elite male distance runners (5000m season best: 13:47 +/- 0:12, 10,000m season best: 27:58 +/- 0:11) completed identical six-stage protocols on track (300m outdoor) and treadmill (0% gradient) in a randomized crossover design. Each stage comprised 1,200m at velocities progressing from 3:30 to 2:40 min/km, with standardized pacing for track trials. Blood lactate concentration, heart rate, and RPE were measured after each stage. Spatiotemporal parameters were analyzed using high-speed video at 240 Hz during the final 10s of each quarter of the stage. All testing was conducted under standardized environmental conditions with 48h between trials.

RESULTS: Track running elicited progressively higher blood lactate responses compared to treadmill running, with the difference becoming most pronounced at the highest intensity (stage 6: 12.1 +/- 0.6 vs. 8.4 +/- 0.8 mmol/L, $P < 0.001$). This metabolic divergence manifested in significantly lower running velocities at fixed blood lactate concentrations during track running (4 mmol/L: 316.2 +/- 8.4 vs. 328.5 +/- 7.8 m/min, $P = 0.008$; 6 mmol/L: 342.3 +/- 9.1 vs. 356.7 +/- 8.5 m/min, $P = 0.012$). Track running velocities at these thresholds showed remarkably strong correlations with 10,000m season best times (4 mmol/L: $r = -0.950$, $P < 0.001$; 6 mmol/L: $r = -0.973$, $P < 0.001$), while treadmill correlations were substantially weaker (4 mmol/L: $r = -0.703$, $P = 0.054$; 6 mmol/L: $r = -0.695$, $P = 0.061$). Biomechanically, track running exhibited consistently longer stride lengths ($P = 0.008$) and distinct ground contact time patterns at higher intensities ($P = 0.039$), despite similar step frequencies.

CONCLUSION: This study reveals systematic mode-specific differences in metabolic and mechanical responses at training-relevant intensities in elite runners. The strong correlation between track-based measurements and competition performance, coupled with the substantial underestimation of metabolic demand in laboratory assessments, suggests the need for mode-specific adjustments in training intensity prescriptions. These findings have direct implications for optimizing the precision of training prescription in high-performance endurance training.

**PHYSIOLOGICAL CHARACTERISTICS OF CROSSFIT TRAINING: COMPARISON WITH TRADITIONAL CIRCUIT TRAINING**

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INTRODUCTION: In sports coaching and physical education, the time available for improving physical fitness is limited due to the various tasks involved in learning sports skills and understanding tactics. Therefore, we focused on CrossFit training (CFT). CrossFit training is a high intensity training methodology where athletes perform a variety of training exercises without rest periods in between sets or exercises. In this study, we compared the physiological load of CFT with that of a traditional circuit training (TCT).

METHODS: High school and college age male students who regularly participated in recreational sports were included in this study. The exercise protocol consisted of 10 squats, 10 burpee jumps, 10 sit-ups, and 10 push-ups in which the subjects performed them in two variations: CFT-style (no rest between exercises and sets) and TCT (including a 15-second rest period). To be able to accurately quantify the training volume and necessary time spent performing these exercise modalities we examined and compared two conditions: test 1) a comparison with unified time (CFT vs. TCT, total volume in 4 min) and test 2) a comparison with unified number of sets to be performed (CFT vs. TCT, 3 total sets in both modalities). In the experiment, the cardiovascular system, metabolic system, and muscle activity levels were quantified using a heart rate monitor (H10, Polar), a blood lactate meter (Lactatepro2, Arkray), and electromyography (Free EMG, BTS). The muscles tested were the triceps brachii (TB), rectus abdominis (RA), and rectus femoris (RF).

RESULTS: In test 1, the mean heart rate during CFT was 88.9% HRmax, post-exercise blood lactate concentration was 15.0 mmol/L, and muscle activity level was 66.2% EMGmvc in the TB, 43.0% EMGmvc in the RA, and 45.6% EMGmvc in the RF. The mean heart rate during TCT was 77.9% HRmax, post-exercise blood lactate concentration was 10.7 mmol/L, and muscle activity levels were 74.9% EMGmvc for TB, 48.5% EMGmvc for RA, and 56.8% EMGmvc for RF. In test 2, mean heart rate during CFT was 91.4% HRmax, post-exercise blood lactate concentration was 15.2 mmol/L, and muscle activity levels were 55.9% EMGmvc for TB, 51.3% EMGmvc for RA, and 55.9% EMGmvc for RF. The mean heart rate during TCT was 87.4% HRmax, post-exercise blood lactate concentration was 16.7 mmol/L, and muscle activity levels were 60.8% EMGmvc for TB, 55.3% EMGmvc for RA, and 48.2% EMGmvc for RF.

CONCLUSION: The results of this study showed that CFT had a greater physiological load on the cardiovascular system than TCT when the time was standardized (Test 1), and CFT had a greater physiological load on the cardiovascular system than TCT when the number of sets was standardized (Test 2). These results suggest that CFT is a training method that can produce a higher physiological load in the cardiovascular system in less time than the TCT, which can potentially provide instructors with a variety of options to train their athletes more effectively in a shorter amount of time per session in the future.

**EXAMINING THE RELATIONSHIP BETWEEN TRUNK FLEXIBILITY AND ISOKINETIC HIP STRENGTH PARAMETERS USING WEARABLE TECHNOLOGICAL SYSTEMS**

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INTRODUCTION: The relationship between strength and flexibility is complex. Increased joint flexibility has been shown to enhance muscle power output [1]; however, an excessive focus on muscle strength without adequate flexibility training may elevate the risk of injury [2]. Therefore, the precise assessment of flexibility and strength parameters using reliable measurement systems is essential for injury prevention. This study investigates the relationships between isokinetic hip strength parameters—including force, power, and movement analysis metrics—and multidimensional trunk flexibility measures.

METHODS: This study involved 22 female subjects. Hip strength, peak torque (PT) attainment time, and angles were assessed using the Cybex (Humac Norm) isokinetic dynamometer (CSMI, Stoughton, MA).

Participants flexibility was evaluated using the MyoMotion system (Noraxon, USA). The system utilized five strategically placed sensors to measure lumbar flexion (LMB FLX), lumbar extension (LMB EXT), lumbar lateral (LMB LTR), and lumbar axial (LMB AXI) movements, as well as thoracic flexion (THR FLX), thoracic extension (THR EXT), thoracic lateral (THR LTR), thoracic axial (THR AXI), hip flexion (HFLX), and hip abduction (H ABD) range of motion.

RESULTS: A moderate and statistically significant relationship was observed between participants FLX PT and LMB EXT ($r=0.546$; $p<0.01$), LMB LTR ($r=0.535$; $p<0.05$), LMB AXI ($r=0.454$; $p<0.05$), and H ABD ($r=0.443$; $p<0.05$) flexibility levels.

Additionally, the PT attainment angle during HFLX movement exhibited a similarly significant correlation with LMB LTR ($r=0.438$; $p<0.05$) and H ABD ($r=0.448$; $p<0.05$) flexibility. A moderate significant relationship was also identified between the PT attainment time during HFLX movement and H ABD flexibility ($r=0.431$; $p<0.05$).

In contrast, no statistically significant relationships were found between HFLX strength and other flexibility parameters or between HEXT strength and any of the flexibility measures ($p>0.05$).

CONCLUSION: The findings indicate that increased flexibility does not negatively impact PT production in HFLX and EXT; rather, it supports FLX strength. However, LMB LTR and H ABD flexibility were found to increase the PT attainment angle, while H ABD flexibility also prolonged the time to reach PT. These results suggest that LMB LTR and H ABD flexibility levels should be carefully considered in training and performance assessments, particularly in sports requiring explosive strength.

**A BASIC STUDY ON THE IMPROVEMENT OF ATHLETIC PERFORMANCE OF FOOTBALL PLAYERS WITH CEREBRAL PALSY**

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INTRODUCTION: Cerebral palsy football (CP football) is a sport created for individuals with relatively mild cerebral palsy and was adopted as an official event at the Paralympic Games since 1984 in New York. Unfortunately, after the 2016 Rio de Janeiro Games, it was dropped as an official sport. However, attempts are being made to popularize it worldwide to make it an official Paralympic sport. Recently, parallel with the World Championships, regional international competitions, such as the European, National, and Asia-Oceania Championships, have been held. However, there is no information on objective accumulation of data by teams using scientific methods to strengthen and nurture their players. Therefore, there has been no continuous effort or handover for the strategic, medium- and long-term planning for strengthening. Therefore, the Japanese CP football community has called for strengthening cooperation with universities and other research institutions to enhance scientific support (Foofootball Science, 2023). Therefore, this study aimed to obtain basic data to help improve the competitiveness of CP football players. Here, we report the results of physical fitness tests conducted on male candidate national team players in CP football.

METHODS: The participants were 11 male Japanese national team 2024 CP football candidates (24.9 ± 4.93 years). The physical fitness test items were 30-m running (10- and 20-m transit time), 5-m x 3 shuttle run, vertical jump, standing broad jump, bounding, and Yo-Yo intermittent recovery test level 1 (YYIR1). Each measurement was performed in accordance with previous studies (Japan Football Association, 2005; Bangsbo and Mohr, 2015; MEXT, 1999; Ariga et al., 2016).

RESULTS: The mean and standard deviation of each fitness test result are as follows; 10-m transit time was 1.98±0.1 s, 20-m transit time was 3.4±0.17 s, 30-m transit time was 4.74±0.23 s, 5-m × 3 shuttle run was 4.46±0.21 s, vertical jump was 47.09±6.11 cm, standing broad jump was 1.88±0.25 m, bounding was 9.64±0.86 m, and YYIR1 was 956.36±361.53 m.

CONCLUSION: The study results revealed the physical fitness characteristics of male Japanese national football team candidates with CP, which remained unclear. Additionally , these results were compared with those of the U-20 Japan National Team (Japan Football Association, 2021) and All-Japan University Selected Team(Japan University Football Association, 2024), all of which showed low values. Therefore, improvement in the physical aspect (physical performance) required for soccer performance is an essential future enhancement measure for Japanese men's national team CP football players.

**LACTATE RESPONSE IN ACROBATIC ROCK AND ROLL: THE EFFECT OF AN 8-WEEK TRAINING PROGRAM**

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INTRODUCTION: Sport dances are high intensity, intermittent activities that alternate explosive and slow movements, requiring dancers to have specialized skills, a strong aerobic base, and high lactate tolerance [1-3]. Dance engages multiple energy systems with metabolic demands varying according to discipline, intensity, choreography, and length of the routine [4]. The study compares changes in blood lactate levels (La) after the modified competitive routine (CR) of acrobatic rock and roll (ARnR) dancers at the end of the preparatory phase (PP) and the beginning of the competitive phase (CP).

METHODS: The research sample included 8 ARnR dancers from the small formation ladies category (17.10±4.69 years; 54.73±6.61 kg; 162.50±4.28 cm). Dancers had to complete minimum 22 of 27 training units (80%). La was measured using a Lactate Scout device. Measurements were taken at four time points: at rest, immediately after the ARnR CR at 5, 10 and 20 minutes post-exercise. The first measurement (t0) was performed in the final of the PP, the second measurement (t1) after 4 weeks as an interim assessment, and the last measurement (t2) in the initial CP. Repeated measures ANOVA was used to detect changes between treatments, and partial eta-squared was calculated to express the practical effect size. Significant effects were followed by Bonferroni post hoc procedures with Cohens d effect size. Significance was established at $p<0.05$.

RESULTS: The dancers reached a maximum La of 12.69±2.65 mmol/l (t0), 13.36±1.90 mmol/l (t1) and 18.06±4.39 mmol/l (t2). The difference between all measurements (t0, t1, t2) was statistically significant with a large effect ($F(2)= 6.945$; $p= 0.028$; $\eta^2p=0.499$). A significant increase in maximum La was observed after the modified CR in CP vs. PP ($p=0.040$; $d=0.899$). The La gradient of dancers decreased by 2.69±2.65 mmol/l (t0), 4.83±2.13 mmol/l (t1) and 10.44±5.14 mmol/l (t2). Statistically significant differences with large effects were found between t0 and t2 ($p=0.005$; $d=1.411$). The difference between all measurements was statistically significant with a large effect ($F(2)=11.204$; $p=0.008$; $\eta^2p=0.615$).

CONCLUSION: The significant increase in maximum La during the CP indicates the effectiveness of specific training focused on resistance to La, with intensified training leading to beneficial adaptations in La tolerance. La gradient values showed a statistically significant difference with a large effect size between measurements. A decreased La gradient is crucial for maintaining performance during prolonged exercise and minimizing fatigue.These findings suggest that the dancers adapted to higher levels of La, enabling their organism to tolerate acidosis. Acknowledgements: This work was supported by the Scientific Grant Agency of the Ministry of Education, Research, Development and Youth of the Slovak Republic and the Slovak Academy of Sciences (Nos. 1/0712/24 and 1/0512/25).

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**COMPARISON OF FULL SQUAT MOVEMENT VELOCITY BETWEEN SMITH MACHINE AND FREE WEIGHTS ACROSS DIFFERENT LOADS IN WOMEN**

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INTRODUCTION: The load-velocity relationship is fundamental in velocity-based training for accurate and effective load determination [1]. Strength and conditioning coaches commonly utilize both free weights (FW) and Smith machine (SM) to enhance strength and power [2]. However, the mechanical constraints of each method differ, with FW requiring greater stabilization, whereas SM provides a guided bar path, potentially altering neuromuscular activation and movement velocity [3]. While previous studies have highlighted these biomechanical differences, it remains unclear whether velocity differences persist across various loads. This study compares movement velocity in the full squat exercise performed with FW and SM across various loads, assessing their agreement and interchangeability.

METHODS: Eleven women performed a one-RM maximum assessment in the full squat exercise under two conditions (FW and SM) in a randomized order one week apart. Mean velocity (MV) was recorded using a linear position encoder (Tendo Unit). The load-velocity relationships were modeled using linear regression, and velocity values were compared across conditions at eight relative loads (30%-100%). Statistical analyses included a two-way repeated measures ANOVA (2 conditions x 8 loads), Cohens' d effect sizes, Pearsons's correlations, typical error (TE) and Bland Altmann plots to assess agreement.

RESULTS: The two-way ANOVA (Condition x Load) showed a significant main effect for load ($p<0.01$; $\eta2=0.97$). Tukey's post hoc tests indicated that MV differed across all loads ($p<0.001$). No significant main effect was found between FW and SM ($p=0.35$; $\eta2=0.08$, pairwise Cohen's $d=0.03$-$0.12$). Pearson correlations of the individual data showed very strong agreement between FW and SM from 30% to 80% of 1-RM ($r=0.88$-$0.97$). However, at 90% and 100% of 1-RM, the correlations were moderate (0.74 and 0.63 respectively). The typical error of velocity differences was low (0.02-0.025 m/s) at moderate loads (50-80%) and slightly higher at the extremes of the load-velocity relationship (0.03-0.04 m/s). Finally, the Bland-Altman plots demonstrated that the differences in MV between FW and SM were within the 95% limits of agreement, with no values falling outside the limits, suggesting excellent agreement between the two conditions across all loads.

CONCLUSION: These findings indicate that both SM and FW yield comparable MV measurements during the full squat exercise in women making them interchangeable in velocity-based training. The consistency of the results across loads implies that either method can be used with confidence for training prescription, providing flexibility for strength and conditioning coaches in selecting the most appropriate equipment.

**KOTOV 1916: AN INSIGHT INTO THE ORIGIN OF TRAINING PERIODIZATION.**

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INTRODUCTION: The debate on the origins of the discipline of training periodization is still ongoing. The text "Olympic Sport", published by B. A. Kotov in 1916, was the first known book to focus on training methods and strategies for performance development. The manuscript is also considered the first to consider training organization and periodization. In addition, Kotov was the only author to cover these topics in Russia before the Soviet Bolshevik Revolution of October 1917.

METHODS: Recently, our research group had the opportunity to translate from russian language and work on the original text published in 1916 in Russian 1, 2, and on the manuscript published with the pseudonym of "Boko" in 1913 for the journal "Russky Sport"3.

RESULTS: The analysis of Kotov's manuscripts offers an insight into periodization and training at the beginning of the 20th century. The knowledge of the historical events and of the evolution of sport allow this manuscript to be contextualized and to understand the author's attempt to promote a different approach to athletic training. Relevant breakthroughs were included in this manuscript, such as the use of training programs to organize long training periods, the prescription of submaximal training loads based on perceived effort and the use of specific preparation phases. In addition, the text cointains one of the first notations of the concept of overtraining.

CONCLUSION: Considering its novelty, "Olympic Sport" represents a revolutionary book and the author can be considered as a fundamental contributor to the development of the discipline of the training theory and a starting point of modern periodization.

**THE ASSOCIATION BETWEEN WALKING PARAMETERS AND MAXIMAL OXYGEN UPTAKE DURING THE UKK WALK TEST IN JAPANESE ADULTS**

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INTRODUCTION: The UKK Walk Test (UKKWT) is an endurance test developed in Finland, but its validity for Japanese adults has not yet been established. This study aimed to investigate the relationship between walking parameters and maximal oxygen uptake ($VO_2$max) during the UKKWT in Japanese adults and to assess the influence of walking characteristics on $VO_2$max estimation.

METHODS: A total of 102 healthy adults (48 men, 54 women) aged 20–73 years participated in this study. $VO_2$max was measured using a treadmill protocol following the method of Laukkanen et al., with breath-by-breath gas analysis performed using the Aero Monitor AE-310S. Heart rate was continuously recorded using a Polar H10 and a Polar M430. The UKKWT was conducted at 80% of heart rate reserve (HRR) according to the UKK Walk Test Tester's Guide. Walking parameters, including stride length (SL), stride frequency (SF), and stride length as a percentage of height (%SL), were derived from cadence data obtained via the accelerometer in the Polar M430.

RESULTS: $VO_2$max was 41.99 ± 6.64 ml/kg/min in men and 32.38 ± 5.56 ml/kg/min in women. Walking speed was 120.9 ± 7.5 m/min in men and 108.9 ± 7.5 m/min in women. SL, SF, and %SL were 0.887 ± 0.048 m, 136.5 ± 6.3 steps/min, and 52.3 ± 2.8% in men, and 0.801 ± 0.052 m, 136.2 ± 6.7 steps/min, and 51.0 ± 2.7% in women, respectively.

Correlation analysis revealed significant positive correlations between $VO_2$max and all walking parameters in men ($r = 0.41–0.72$, $p < 0.01$). SF was not significantly correlated with $VO_2$max in women, whereas SL and %SL exhibited significant positive correlations ($r = 0.55, 0.61$, $p < 0.001$). Age was negatively correlated with $VO_2$max (men: $r = –0.56$, women: $r = –0.51$) and walking speed (men: $r = –0.59$, women: $r = –0.39$, $p < 0.01$).

CONCLUSION: The results of this study indicate that $VO_2$max is significantly associated with walking speed, SL, and %SL, with SL having the most significant effect on $VO_2$max. SF was also a significant determinant of $VO_2$max in men, whereas no significant association was observed in women. These findings suggest that men increase walking speed by adjusting both SL and SF, whereas women depend primarily on SL.

Additionally, the negative correlation between age and both $VO_2$max and walking speed suggests that age-related declines in walking ability may be due to reductions in SL.

The results of this study demonstrate that the UKKWTs walking parameters impact the estimation of $VO_2$max, with SL and %SL being critical parameters. Future development of a Japanese version of the UKK Walk Test should consider gender— and age-related differences in walking patterns.

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**VALIDITY OF SPORT-SPECIFIC AEROBIC AND ANAEROBIC TESTS IN PREDICTING THE TIME-MOTION PROFILE IN INTERNATIONAL TAEKWONDO MATCHES**

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INTRODUCTION: The Frequency Speed of Kick Test (FSKT) and the Progressive Specific Taekwondo Test (PSTT) are among the most used sport-specific tests in taekwondo. The FSKT is divided into two versions to assess anaerobic power (FSKT10s) and capacity (FSKTmult) in intermittent mode, while the PSTT allows the determination of both aerobic capacity and power indicators in continuous mode. Although these two tests are widely studied, the relationship between them needs further investigation and their criterion predictive validity has not been established, despite the fundamental importance of this tests' property in practice. Therefore, this study aimed to: i) investigate the relationship between sport-specific anaerobic (FSKT10s and FSKTmult) and aerobic (PSTT) performance; ii) evaluate the validity of the above sport-specific anaerobic and aerobic tests in predicting the time-motion profile in international matches.

METHODS: Sixteen taekwondo black belt athletes (8 males and 8 females; 17 ± 3 years; 12 ± 1 hours training/week) took part in this study. Athletes conducted three distinct experimental sessions. On the first day, the FSKT10s and FSKTmult were performed. After 24 hours, athletes executed the PSTT. Heart rate (HR) was measured, during the FSKTmult and the PSTT, using a HR monitor strap. In the following 1–3 weeks, athletes participated in an official international competition recognized by World Taekwondo. Videos of each athlete's first combat of the day were obtained for the time-motion analysis. All athletes were studied individually, using Kinovea software, and consequently thirty-two performance (tested athlete and respective opponent) were analyzed.

RESULTS: FSKT10s and FSKTmult performance were significantly correlated (Spearman's rho = 0.545–0.759, $p < 0.05$) with aerobic power indicators of the PSTT. Moreover, FSKTmult performance were significantly correlated (rho = -0.606–0.555, $p < 0.05$) with aerobic capacity indicators of the PSTT. No significant relationship emerged between anaerobic (rho = -0.442–0.396, $p > 0.05$) and aerobic (rho = -0.462–0.462, $p > 0.05$) physical fitness variables and time-motion indexes. All time-motion indexes were significantly correlated (rho = 0.756–1.000, $p < 0.001$) and they did not differ ($p = 0.498$–$1.000$) between the tested athletes and their opponents during international matches.

CONCLUSION: Our results support the assumption that the typical intermittent activity of taekwondo involves high demands on both anaerobic and aerobic metabolism. The specific rhythm of the first official combat of the day, generated by the technical-tactical dynamics between the two interacting opponents, could explain the inability to predict time and frequency spent in the different kinds of actions performed from the anaerobic and aerobic physical fitness variables. However, the athletes' conditioning level would play a key role in supporting the high attack/skipping ratio (~1:1.3) of the match.

**COMPARISON OF DIFFERENT METHODS FOR ASSESSING SKELETAL MUSCLE MASS: ACCURACY AND APPLICABILITY**

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INTRODUCTION: Skeletal muscle mass (SMM) is a key parameter in body composition assessment. Although it can be estimated with high accuracy through imaging techniques, simpler and more cost-effective alternative methods have been developed over the years. This study aimed to evaluate the agreement between anthropometric and bioelectrical-based procedures and Dual-Energy X-Ray Absorptiometry (DXA) in estimating SMM in male and female individuals.

METHODS: A total of 39 males and 27 females (age 34.4±17.9 years, BMI 24±3.1 kg/m2) underwent DXA scans, anthropometric measurements, and bioelectrical impedance analysis (BIA) using five different BIA devices (i.e., AKERN_BIVA_PRO, Tanita_MC780/980, Inbody_570, Technogym Health, Inbody 270). Anthropometric measurements were applied in the Lee equation, while only for the AKERN device that allowed the measurement of raw bioelectrical properties, the Janssen equation was utilized. For DXA-based SMM estimation, the McCarthy equation was used: SMM (kg) = appendicular lean soft mass x 1.12–0.63.

RESULTS: The analysis of variance for repeated measures showed a significant ($p<0.01$) effect within subjects measured by different devices for SMM prediction. Post-hoc tests identified significant differences ($p<0.05$ in all cases), with the lowest values obtained from DXA (25.6±7.3 kg). Bland-Altman analysis was performed comparing DXA with the alternative procedures, yielding the following results: (Anthropometry: mean difference of 1.3, 95% limits of agreement ranging from -6.6 to 9.3; AKERN: mean difference of 2.6, 95% limits of agreement ranging from -1.5 to 6.6; Technogym_Health: mean difference of 6.2, 95% limits of agreement ranging from -11.7 to 24.1; Inbody_570: mean difference of 6.3, 95% limits of agreement ranging from -11.8 to 24.3; Inbody_270: mean difference of 6.0, 95% limits of agreement ranging from -12.3 to 24.2).

CONCLUSION: A general lack of agreement has been identified among methods in the estimation of SMM. Considering the need to develop new predictive equations specific to different populations, only doubly indirect methods that allow the measurement of raw parameters can be used for the development of new regression models. Conversely, the updating of methods that directly provide body composition estimates without allowing the measurement of raw values will be limited for researchers and primarily the responsibility of manufacturers.

**DIVERGENT BLOOD LACTATE RESPONSES IN REPEATED SPRINTS VERSUS MAXIMAL AEROBIC SPEED TEST: A COMPARISON BETWEEN MIDDLE-DISTANCE RUNNERS AND SPRINTERS**

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INTRODUCTION: Blood lactate accumulation and clearance play a crucial role in repeated sprint performance, particularly in athletes with varying aerobic capacities. This study aimed to examine the effects of repeated sprints, aerobic capacity and anaerobic speed reserve (ASR) on blood lactate responses.

METHODS: Twelve athletes (Sprinters (SPR): 400 m sprint time: 50.46 ± 1.02 s and Middle-Distance runners (MDR): 800 m time: 114.00 ± 3.95 s) participated in the study. Maximum oxygen uptake (VO2max), velocity at VO2max (vVO2max) and velocity at respiratory threshold (vVT) were assessed on a treadmill using the Bruce Protocol, and ASR was calculated from vVO2max and peak running speed during a 40 m sprint. Two protocols were additionally used, one for lactate accumulation (LA) and one for lactate clearance (LC). In the LA protocol, athletes performed 10 X 60 m sprints with 30 s recovery, with lactate measured at baseline and after the 2nd, 4th, 6th, 8th, and (when possible) 10th sprint. In the LC protocol, athletes ran on a track at their vVO2max until volitional fatigue, after which they completed 4 X 60 m sprints, with 2 min recovery, with lactate assessments after each effort. Two-way repeated measures ANOVAs (group x time) were used to compare blood lactate responses, while a MANOVA followed by univariate analyses compared the aerobic variables between groups.

RESULTS: The MANOVA demonstrated a significant group effect (Pillai's trace =0.917, F (4,7) = 19.38, p <0. 001), with univariate analyses confirming that VO2max (F = 25.19, p <0. 001, MDR: 64.1 ± 3.9 vs. SPR: 54.6 ± 2.6 mL/kg/min), vVO2max (F (1,10) = 84.40, p < 0.001, MDR: 20.2 ± 0.9 vs. SPR: 16.4 ± 0.5 km/h), VT (F = 54.50, p < 0.001, MDR: 16.1 ± 1.0 vs. SPR: 12.7 ± 0.6), and ASR (F (1,10) = 48.71, p < 0.001, MDR: 13.54 ± 1.4 km/h vs. SPR: 19.04 ± 2.2) differed significantly between groups. For the LA protocol, ANOVA revealed a significant interaction (F (4,51) = 4.07, p =0.006), with pairwise comparisons indicating no group differences at baseline (p = 0.96, MDR: 1.15 ± 0.26 vs. SPR: 1.07 ± 0.24 mmol ) but significant differences from the 2nd (MDR: 3.87 ± 0.84 vs. SPR: 7.25 ± 2.46 mmol) through 8th (MDR: 10.6 ± 2.53 vs. SPR: 17.87 ± 4.32 mmol) sprints (p ranging from 0.0436 to 0.0001). In the LC protocol, a significant main effect on sprint number was observed (F (5,59) = 47.34, p < 0.001), yet neither the group effect (p =0.143) nor the interaction (p = 0.689) was significant, suggesting comparable lactate clearance between groups. Blood lactate values were similar in the two groups after the high-intensity aerobic running (MDR: 22.17 ± 2.32 vs. SPR: 22.2 ± 3.96 mmol), as well as after the last sprint (MDR: 11.45 ± 5.2 vs. SPR: 15.1 ± 5.83 mmol).

CONCLUSION: These findings indicate that while SPR and MDR display different responses with SPR accumulating more lactate during repeated sprints, their abilities to clear lactate following high-intensity aerobic exertion are comparable.

**THE IMPACT OF ATTENTIONAL FOCUS STRATEGIES ON BIOMECHANICAL AND NEUROMUSCULAR RESPONSES DURING ECCENTRIC FLYWHEEL SQUATS: A RANDOMIZED CROSSOVER STUDY**

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INTRODUCTION: Internal focus (IF) and external focus (EF) influences motor performance through distinct cognitive mechanisms. While EF generally enhances movement efficiency, IF can disrupt performance but may optimize muscle activation in certain contexts. Eccentric flywheel training, known for its high mechanical tension and neuromuscular adaptations, is widely used to enhance athletic performance. However, no study has explored how attentional focus strategies modulate biomechanical and neuromuscular responses during eccentric flywheel exercises. This study addresses this gap by examining the effects of IF and EF on ground reaction force and muscle activation during eccentric flywheel squats, providing new insights into optimizing performance and rehabilitation.

METHODS: 28 healthy males (aged 18–25) with over 1 year of resistance training experience participated in this randomized, counterbalanced crossover study. 3 AF conditions were tested during eccentric flywheel squats: EF, IF and Control (CO). Ground reaction force (GRF) and surface electromyography (sEMG) of 7 lower limb muscles were measured. GRF peak and mean values were recorded for eccentric and concentric phases, while sEMG signals were normalized to maximal voluntary contractions. Repeated measures ANOVA or Friedman tests were used for statistical analysis, with significance set at $p < 0.05$.

RESULTS: Average and peak amplitudes (A.A. and P.A.) of the gluteus maximus, rectus femoris, biceps femoris, semitendinosus, medial gastrocnemius, lateral gastrocnemius, and tibialis anterior were analyzed across conditions. EF resulted in the highest mean (M.) and peak (P.) concentric (C.) and M. eccentric (E.) forces (M.C.=107.65[102.13,115.64];M.E.=87.84[79.58,96.85]; P.C.=128.81[112.26,137.06]; P.E.=103.91[90.33,116.50]), followed by IF(M.C.=90.18[79.45,94.92];M.E.=78.66[70.36,84.11]; P.C.=106.53[94.00,112.14];P.E.=96.38[84.50,101.13]) and CO (M.C.=96.07[75.70,110.82]; M.E.=87.10[75.00,99.80];P.C.=111.06[87.05,112.57]; P.E.=106.93[90.75,120.02],p<0.001,p<0.001,p<0.001,p=0.008). EF also showed superior muscle activation efficiency, particularly in the gluteus maximus (PA.A.<0.001, PP.A.=0.002) and biceps femoris (PA.A.=0.01, PP.A.=0.025). In contrast, IF enhanced rectus femoris (PA.A.=0.019, PP.A.=0.36) and semitendinosus PA.A.=,0.004, PP.A.<0.001) activation compared to CO. These findings suggest EF optimizes force production and movement efficiency during eccentric flywheel squats.

CONCLUSION: EF enhances force production and movement efficiency during eccentric flywheel squats compared to IF and CO. IF demonstrates benefits for specific muscle activations, such as the rectus femoris and semitendinosus. These

findings suggest that EF is more effective for optimizing overall performance, while IF may be useful for targeted muscle engagement. Integrating attentional focus strategies with eccentric flywheel training could enhance athletic performance and rehabilitation outcomes.

**A COMPARISON OF THE RECOVERY RESPONSES FOLLOWING ISOMETRIC AND VARIABLE RESISTANCE EXERCISE IN TRAINED MEN**

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INTRODUCTION: Despite isometric exercise performed at long muscle length (LML), short muscle length (SML) and variable resistance exercise (VAR) represent effective methods to achieve neuromuscular and morphological adaptations [1,2], no studies to date investigated the recovery responses of the pectoral muscles following these training methods. Thus, the aim of the present study was to compare acute effects, muscle damage and the recovery responses following LML, SML and VAR exercise sessions involving the pectoral muscles in resistance trained men.

METHODS: Twelve trained men (age: 25.3 ± 4.1 years; height: 177.6 ± 7.3 cm; body mass: 81.6 ± 10.1; training experience: 6.7 ± 3.7; 1RM bench press: 108.5 ± 21.6 kg) performed a LML, SML and VAR exercise protocol in random order, with a 10-day washout between them. Participants were assessed prior to each protocol, 15 minutes (P-15min), 24 hours (P-24h) and 48 hours (P-48h) post-exercise for muscle architecture (muscle thickness [PECMT] and echo-intensity [PECEI]), and performance (peak isometric force [PF], power at bench press throw [BTP]) and muscle soreness. Blood samples were also collected at BL and at P-24h and Creatine Phosphokinase (CPK) was measured.

RESULTS: A longer time to recover the initial PECMT ($p = 0.003$) was registered in VAR, compared to LML and SML. This parameter returned to baseline at P-48h following VAR, and in correspondence of P-24h following LML and SML protocols. Similar recovery responses between the protocols were detected for PECEI ($p = 0.369$), PF ($p > 0.319$), BPT ($p = 0.614$) and muscle soreness ($p = 0.115$). The PECEI, PF and BPT parameters returned to BL within 24 h following all the protocols while muscle soreness was still present at P-48h without differences between the protocols. In addition, all the exercise protocols resulted in similar ($p = 0.727$) elevations of CPK (382.64 ± 172.95).

CONCLUSION: Results of the present investigation indicated that upper body isometric exercises performed at LML and SML and VAR exercise may result in muscle damage. The metabolic stimulus and the presence of eccentric phases in VAR protocol only, may have delayed the return to baseline registered for muscle architecture compared to both LML and SML protocols. A recovery period of 24-48h was required to dissipate performance reductions and partially muscle soreness following both isometric and VAR exercise protocols for the upper body muscles.

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**THE INFLUENCE OF MATURITY STATUS ON THE REACTIVE STRENGTH INDEX AND MAXIMAL SPRINTING SPEED IN YOUTH FEMALE VOLLEYBALL PLAYERS AGED 8–15 YEARS**

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INTRODUCTION: Understanding changes in physical fitness during maturation is essential for developing appropriate sport performance and injury management strategies [1]. Many researchers have characterized various physical fitness parameters of youth athletic and non-athletic populations depending on chronological age. Fewer studies have considered the influence of maturation on physical fitness and performance, and those have yielded ambiguous results [1,2,3]. This study investigated the influence of maturity status on the Reactive Strength Index (RSI) and sprinting speed in youth female volleyball players. The hypothesis of the study was that maturity status would influence the RSI and sprinting speed in youth female volleyball players.

METHODS: This observational cross-sectional study included 54 female volleyball players aged 8 to 15 years. The biological maturity of the players was predicted as the offset from peak height velocity (PHV) using the sex appropriate equation of Mirwald [4]. Subsequently, players were classified into three categories: pre-PHV (offset <–1 year), circa-PHV (offset in range –1 to +1 year) or post-PHV (offset >+1 year). The RSI was determined during a drop jump test using a height of 30 cm. In the 20 m sprint test, maximal speed was measured. Values between maturity offset categories were compared using one-way ANOVA with Fisher's post-hoc tests.

RESULTS: RSI in circa-PHV (0.91 ± 0.25 m/s) was significantly higher compared to pre-PHV (0.66 ± 0.17 m/s, $p = 0.012$) but not significantly different from post-PHV (1.03 ± 0.29 m/s, $p = 0.20$). Maximal sprinting speed in circa-PHV (6.27 ± 0.61 m/s) was significantly different from both pre-PHV (5.56 ± 0.38 m/s, $p < 0.001$) and post-PHV (6.76 ± 0.47 m/s, $p = 0.005$).

CONCLUSION: Our findings in female youth volleyball players support those studies research indicating gradual improvement in reactive strength and maximum speed in youth female athletes during maturation. Given that some studies have not confirmed this trend, there is a need for longitudinal research, including studies that consider the specificities of training load in individual sports.

**RELIABILITY AND VALIDITY OF THE RESPIRATORY THRESHOLD METHOD**

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INTRODUCTION: Traditional methods for determining exercise thresholds, such as the gas exchange threshold (GET) and the respiratory compensation point (RCP), have limitations, as they rely on identifying breakpoints in progressively increasing values along the x- and y-axis during an incremental exercise test (1). In 2021, a novel method was proposed that reinterprets these thresholds (RT1 and RT2) using the ratio of minute ventilation (VE) to end-tidal CO2 partial pressure (PETCO2) during incremental exercise (VE/PETCO2-W) (2). However, the reliability and validity of this method have not yet been fully established. The aim of this study was to assess the test-retest reliability and comprehensive validity of the VE/PETCO2-W method.

METHODS: Male participants who engaged in at least 150 minutes of exercise per week were recruited for both the reliability study (n = 42; age: 26 ± 7 years; height: 183 ± 8 cm; mass: 74 ± 13 kg; peak VO2 (VO2peak): 52 ± 10 mL·min$^{-1}$·kg$^{-1}$) and the validity study (n = 143; age: 26 ± 8 years; height: 182 ± 8 cm; mass: 73 ± 13 kg; VO2peak: 52 ± 10 mL·min$^{-1}$·kg$^{-1}$). All participants completed two ramp tests (30 W·min$^{-1}$) on separate days to assess reliability. For the validity analysis, participants were classified based on VO2peak as physically active (<45 mL·min$^{-1}$·kg$^{-1}$, n = 44), trained (45-55 mL·min$^{-1}$·kg$^{-1}$, n = 51), or well-trained (>55 mL·min$^{-1}$·kg$^{-1}$, n = 48). GET and RCP were identified using piecewise regression in the VCO2–VO2 and VE–VCO2 relationships, respectively, while RT1 and RT2 were derived from the VE/PETCO2-W relationship.

RESULTS: Results indicated that RT1 (3.0 ± 1.0 vs. 3.0 ± 1.0 W·kg$^{-1}$) and RT2 (3.8 ± 1.0 vs. 3.8 ± 1.0 W·kg$^{-1}$) demonstrated high reliability (intraclass correlation coefficient > 0.99; standard error of measurement < 3%; limits of agreement (LoA): −0.23 W·kg$^{-1}$ to 0.22 W·kg$^{-1}$). In terms of validity, RT1 and RT2 (2.9 ± 1.0 and 3.7 ± 1.1 W·kg$^{-1}$) showed strong agreement (Pearson r > 0.99; standard error of the estimate < 3%) with GET and RCP (2.9 ± 1.0 and 3.8 ± 1.1 W·kg$^{-1}$) and accurately predicted these thresholds (effect size (ES) < 0.16; LoA: −0.12 W·kg$^{-1}$ to 0.12 W·kg$^{-1}$). Furthermore, RT1 and RT2 effectively distinguished between the physically active (28 ± 3 and 37 ± 3 mL·min-1·kg-1), trained (34 ± 5 and 45 ± 4 mL·min-1·kg-1) and well-trained (41 ± 6 and 66 ± 12 mL·min-1·kg-1) groups (ES > 1.4).

CONCLUSION: In conclusion, the VE/PETCO2-W method is a reliable and valid tool for determining exercise thresholds and classifying aerobic endurance profiles. These findings highlight the potential of the VE/PETCO2-W method to enhance individualised exercise prescription and performance assessment.

**EFFECTS OF COMBINED STRENGTH TRAINING ON BODY COMPOSITION AND VERTICAL JUMP IN ADOLESCENT FEMALE VOLLEYBALL PLAYERS**

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INTRODUCTION: The skill of the vertical jump is vital to success in volleyball, it is used in serving, setting, spiking and blocking For this, it is necessary to have the ability to generate power in a short period (1). There are different types of training to increase the strength and power of the vertical jump, some of them are weight training (WT), plyometric training (PT), electrostimulation training, training based on technique and games, and training combined (CT) . The combined training is that system where two types of training are combined during the same training session or week. This method also It is known as complex training, which aims to develop and increase the linear power of athletes (2). Research has reported significant improvements in speed, strength, power and agility in subjects participating in a combined training protocol (WT + PT), compared with subjects participating in these training protocols separately (3).

METHODS: Objective.- Determine the effects of a 9-week Combined Strength Training on the vertical jump in female adolescent volleyball players.

A total of 8 teenage volleyball players (age: 16.4±0.12) at an amateur level participated in a personalized training program with a duration of nine weeks, that consists of two training sessions per week that combined strength training (weights) with plyometric training in a single exercise session, assessing body composition by bioimpedance and vertical jump with force platform (countermovement jump, blocking jump and attack jump) at baseline and after the exercise intervention. Statistical significance was $p < 0.05$.

RESULTS: At the end of the training, significant improvements were obtained in the height (BVJ from 26.3±3.9 cm to 30.1±3.78 cm, CMJ from 26.9±4cm to 28.3±4.7 cm), flight time in seconds (BVJ from 0.46±0.03 to 0.49±0.03, CMJ from 0.46±0.03 to 0.5±0.03 and the SPJ from 0.5±0.03 to 0.52±0.04.) and power in kgm/s (BVJ from 634±87.3 to 682±88.4, CMJ from 644.8±93 to 692.8±90.1 and the SPJ from 689.6±96.4 to 737.3±87.1); General body composition did not show any significant difference.

CONCLUSION: A 9-weeks CT improved the vertical jump in female adolescent volleyball players, increasing the vertical covered distance, flight time and muscle power of the athletes. A small Increment on lower limbs muscle mass seems to explain these functional adaptations, although, neural activity and technique may also be involved.

1. Reeser JC, et al. (2017)

2. Chu D, et al. (1996)

3. Shafeeq VA, et al. (2010)

**TRAINING LOAD VARIATIONS IN FEMALE COLLEGIATE RHYTHMIC GYMNASTS: INSIGHTS FROM SESSION-RPE MONITORING**

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INTRODUCTION: Rhythmic gymnastics (RG) is an aesthetic sport that requires a fusion of beauty and advanced technique, and athletes need flexibility, a sense of balance, precision of movement, and artistic ability. During competition preparation, routine repetitions "run-throughs" and weight management often lead to increased physiological and psychological stress in RG athletes. The session-RPE (sRPE) method has been widely used for evaluating internal load (ITL), yet its application in collegiate RG athletes, who must balance academics and sports, remains unclear. This study aimed to monitor ITL variations during competition preparation period using sRPE method in association with body composition and menstrual cycle in female RG athletes.

METHODS: Seven RG athletes in individual events were monitored for 17 weeks leading up to the All-Japan Championships. Athletes recorded their training duration, sRPE, and ITL daily, and ACWR, Monotony, and Strain were calculated weekly. Additionally, body composition was measured by the InBody system every three weeks. The relationship between weight fluctuations, menstrual cycle, and ITL was analyzed.

RESULTS: Training load fluctuated throughout the competition preparation period, with a notable increase observed during the training camp in Week 6, where ITL peaked at 13,860 AU and ACWR reached 1.93. A similar trend was also observed in Week 16, just before the All-Japan Championships, with ITL and Monotony levels rising to 10,011AU and 1.7. A significant correlation was confirmed between training duration and sRPE, although the relationship was weak (r=0.24-0.58) and varied between individuals. Regarding weight management, participants who lost more than 3% of their body mass exhibited higher sRPE. In contrast, no significant differences in sRPE were observed between menstrual and non-menstrual phases, although sRPE were slightly higher during menstrual phase.

CONCLUSION: This study found that training load in collegiate RG athletes spikes during competition prep, especially in off-academic training camps with intensive "run-throughs." These workload surges may increase fatigue and injury risk, highlighting the need for gradual load adjustments. A weak correlation between training duration and sRPE suggests that longer sessions may elevate perceived exertion, but assessing training content and intensity is also crucial for effective load management. Pre-competition weight loss may further increase ITL, emphasizing the importance of sustainable weight management. While menstrual cycle effects on sRPE were unclear, individual differences should be considered. These findings support sRPE as a valuable tool for monitoring training load in time-constrained RG athletes.

**EXPLORING THE RELATIONSHIP BETWEEN HAND GRIP STRENGTH AND ANTHROPOMETRIC CHARACTERISTICS IN COLLEGIATE LACROSSE PLAYERS**

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INTRODUCTION: Lacrosse is a dynamic sport where players' positions are influenced by grip strength (1, 2). This study analyzes the relationship between Hand Grip Strength (HGS) and various anthropometric measures, including body composition (BMI), limb lengths (arm and forearm length), and hand size in collegiate lacrosse players.

METHODS: A total of 48 participants (22 males and 26 females, age 20.2 ± 1.47 years) were assessed in a single session. Hand grip strength was measured using a handheld dynamometer. Height and weight measurements were recorded to calculate BMI. Limb lengths such as arm and forearm lengths were also documented. Hand size was assessed using a measuring tape.

RESULTS: Correlation analysis revealed a strong positive relationship between HGS and both arm length and forearm length arm length ($r = 0.625$, $p < 0.001$; $r = 0.508$, $p < 0.001$ respectively), while moderate correlations were noted for BMI ($r = 0.491$, $p < 0.001$). In contrast, hand size weakly correlated with HGS ($r = 0.279$, $p = 0.055$). Linear regression analysis showed that these four factors together explained 55.6% of the variance in HGS.

CONCLUSION: These findings emphasize the importance of considering the anthropometric characteristics of lacrosse players for training regimens in this sport. Understanding how these factors impact grip strength can help coaches tailor training programs to enhance performance and reduce injury risk among athletes.

**SWEAT LACTATE RESPONSE DURING CLASSICAL ROLLER SKIING AT INTENSITY ZONE 4**

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INTRODUCTION: Roller ski training is an effective summer conditioning program for improving cross-country skiing performance. Monitoring metabolic responses during training is crucial, and blood lactate concentration serves as a key marker of exercise intensity. However, limited research has investigated lactate behavior during roller skiing, particularly in classical technique at high intensities. Recently, a non-invasive, real-time method for monitoring sweat lactate has been developed. This study aimed to analyze sweat lactate dynamics in junior cross-country skiers during classical roller skiing at high intensity (Zone 4).

METHODS: Five junior cross-country skiers (2 males: 15–18 years, height: 170–175 cm, weight: 52–60 kg; 3 females: 15–17 years, height: 153–162 cm, weight: 41–55 kg) participated in this study. A sweat lactate sensor was affixed to the left upper arm and secured with a bandage, with data transmitted to a wearable device. Heart rate was recorded using the bipolar induction method, and distance and speed were measured via GPS. The training protocol included two 5-minute bouts of classical roller skiing at intensity Zone 4 (80–90% HRmax), with a 2-minute rest interval. Sweat lactate responses were analyzed throughout the session.

RESULTS: The skiers covered a total distance of 6.37 ± 0.12 km at an average speed of 8.09 ± 0.72 km/h. Heart rate ranged from 166–197 bpm in the first Zone 4 bout, dropped to 137–155 bpm during the rest interval, and increased to 178–201 bpm in the second Zone 4 bout. Sweat lactate levels were 3.0–4.0 μA in the first Zone 4 session, 2.6–4.0 μA during the rest period, and 3.5–5.8 μA in the second Zone 4 session.

CONCLUSION: The progressive increase in sweat lactate suggests rising metabolic demand. Individual variations were noted, particularly between male and female athletes, indicating potential sex-based differences in metabolic response. These findings highlight the potential of sweat lactate as a non-invasive biomarker for monitoring training intensity in roller skiing. The observed fluctuations in heart rate, speed, and pacing align with metabolic stress markers. Further studies with larger sample sizes are needed to establish more definitive trends.

Sweat lactate concentrations increased during high-intensity classical roller skiing, reflecting metabolic stress. These findings support the feasibility of sweat lactate monitoring as a non-invasive tool for assessing training intensity in endurance sports.

**THE INFLUENCE OF REPRESENTATION ON POSTURAL CONTROL**

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INTRODUCTION: We have analyzed the mechanisms of postural control during movement, focusing on factors such as plantar pressure distribution and hip joint strategies. Our objective was to quantify postural control during walking movements in gradient transition tasks, particularly by examining center-of-gravity movement trajectories.

In this study, we used a custom-made adjustable slope device. Participants performed stepping movements while experiencing slope changes imposed under instructor-guided gradient transition tasks, allowing us to examine postural control patterns. Participants received prior information about slope changes, leading to the hypothesis that they would respond predictively by adjusting their posture based on spatial mental representations. However, discussions on the applicability of this approach in actual exercise instruction settings remained insufficient.

Therefore, this study aimed to investigate whether gait analysis incorporating image processing could serve as an effective assessment method in exercise instruction settings. Additionally, we report on how quantitatively capturing participants' adaptation to the changing slope and providing them with feedback can assist in instructional guidance.

METHODS: The study involved four healthy university students (both male and female). A treadmill was used to create a setting where the slope gradually increased. Participants walked on the treadmill while experiencing gradual slope changes. Their vision was obstructed with an eye mask during walking.

Two trials were conducted:

- Trial 1: Slope set to 0°
- Trial 2: Slope set to 10°

Each trial consisted of a 30-second measurement period, which was divided into three phases:

- Phase 1: First 10 seconds
- Phase 2: Middle 10 seconds
- Phase 3: Final 10 seconds

The walking movements under changing conditions were recorded using video analysis.

RESULTS: The influence of mental representation on walking under treadmill slope changes was observed. In Trial 1, no significant posture changes were detected. However, in Trial 2, clear postural changes were identified.

A one-way repeated measures ANOVA confirmed significant posture changes in Trial 2 across the three phases. Motion capture analysis showed posture changes at different body points:

- Acromion (shoulder joint): Postural changes were observed across all phases.
- Knee joint: Postural changes were observed across all phases.
- Heel: Postural changes were observed across all phases.

CONCLUSION: This study aimed to investigate predictive postural control based on human sensory information. Such predictive postural control is carried out by utilizing mental representations of body and environmental information.

The findings highlight the importance of examining how inaccurate mental representations or the absence of predictive postural control affect human movement and posture. These results contribute to a deeper understanding of the role of mental representations in human sensory and motor functions and may aid in the development of methods for treating sensory and movement disorders.

**GWAS APPROACH TO IDENTIFYING CANDIDATE GENES FOR THE ELITE ATHLETIC PHENOTYPE IN LITHUANIAN POPULATION**

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INTRODUCTION: A comprehensive understanding of the genetic factors influencing elite athletic performance is a key to optimizing training strategies and integrating precision-based approaches in sports medicine. This pilot genome-wide association study (GWAS) aimed to identify genetic markers associated with physical performance phenotype of Lithuanian elite athletes.

METHODS: The study included 96 Lithuanian elite athletes (55 males, 41 females participating in endurance and sprint/power sports) and 424 non-athlete controls (healthy unrelated 211 males, 213 females). Each elite athlete underwent anthropometric and functional assessment of physical performance (grip strength, vertical jump and stair climbing test and maximal oxygen consumption - VO2max). Whole-genome genotyping was performed using Illumina Infinium OmniExpress-24 and Global Screening Array-48 Kits. Chi-squared tests and logistic regression analysis of case/control data were performed using PLINK-1.9 to evaluate the genetic association between 77607 single nucleotide polymorphisms (SNPs) and athletic traits.

RESULTS: Endurance athletes exhibit significantly higher $VO_2$max values compared with the sprint/power athletes ($p < 0.05$), whereas sprint/power athletes demonstrate greater explosive muscle anaerobic power in a single repetition, a higher muscle mass percentage, elevated body mass index (BMI), and increased right- and left-hand grip strength. GWAS results did not reveal any statistically significant associations between SNPs and elite athlete status or phenotypic characteristics ($p > 5\times10^{-8}$). Nonetheless, eight SNPs demonstrated suggestive significance for elite athlete status ($p < 5\times10^{-5}$), including three intergenic variants (rs10957507, rs9453403, rs4359550), three intronic variants (rs12485289, rs16873417, rs1347756), one non-coding transcript exon variant (rs2001078) and one missense variant (rs3213445, CPT1B:c.196A>T (p.Ile66Phe)). The CPT1B gene encodes carnitine palmitoyltransferase 1B, a key enzyme in the β-oxidation of long-chain fatty acids within muscle mitochondria—a fundamental aerobic metabolic pathway essential for energy production during endurance-based activities.

CONCLUSION: Phenotypic analyse confirmed expected physiological differences between elite endurance and sprint/power athletes, reinforcing the importance of muscle metabolism, aerobic capacity, and anaerobic power in athletic specialization. However, further investigations with larger cohorts are required to validate suggestive genetic markers and their implications for performance optimization in elite Lithuanian athletes.

**RELIABILITY AND CRITERION VALIDITY OF THE CONCEPT 2 SKIERG™ TO ASSESS 1-KM ON-SNOW, TIME TRIAL PERFORMANCE – A CASE STUDY.**

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INTRODUCTION: Cross-country skiing is a physically demanding sport, requiring whole body strength and power and high and sustained aerobic energy turnover. However, standardised testing for cross country skiing performance can be challenging due to unpredictable snow conditions. Specificity of an exercise test to actual field performance is an important concept in sport performance assessment. The Concept 2 SkiErg™ ergometer has been developed to simulate on-snow double poling performance. However, the test-retest error (reliability) and capability of the Concept 2 SkiErg™ to discern genuine intervention effect from random error and the criterion validity to assess on-field snow performance has not been reported. Therefore, this studies objective is to determine Concept 2 SkiErg™ reliability and criterion validity to assess on-snow performance.

METHODS: Ten members, 5 males and 5 females of a national cross-country ski team participated in this study (20.4±3.8 yrs, 179.8±9.7 cm, 70.0±10.5 kg). Informed consent was provided during an on-snow training camp held over 4 days at an elevation of 1200 metres. Athletes completed two 1-km Concept 2 SkiErg™ tests in a temperature-controlled room (18˚C) in random, counter-balanced sequence. On a separate day, athletes completed a 1-km maximal flat terrain (±5 m altitude change) effort time trial on-snow using the classical double poling technique. Athletes used their own equipment and ski waxing products and procedures were standardized. All on-snow testing was completed within a 45-min period and environmental conditions were stable (air temperature 12±1˚C; no precipitation and high visibility). Athletes wore an accelerometer and GPS unit (MinimaxX, Catapult, Australia) to record poling cadence and completion time was recorded. Reliability of Concept 2 SkiErg™ test was determined and reported as typical error and coefficient of variation. The average of the two Concept 2 SkiErg™ trials was compared to the 1-km time trial on the snow time trial to determine the Concept 2 SkiErg™ validity.

RESULTS: There was a strong positive correlation between the Concept 2 SkiErg™ and the on-snow test time trial (mean r= .99), although on-snow performance was significantly slower than performance on the Concept 2 SkiErg™ (254.1±38.6 v 235.9±24.5 s). The typical error was 6.95 s (coefficient of variation = 2.5%). The reliability assessment of the Concept 2 SkiErg™ showed a typical error of 3.75 s (1.5 %, r = 0.98). There was a significant decrease in time from test 1 to test 2 (238.3±26.1 v 233.4±23.9 s).

CONCLUSION: The findings of our case study suggest that the Concept 2 SkiErg™ performance has strong criterion validity despite a slight bias for faster times than on-snow performance, suggesting that it can be used as a tool to assess cross

country skiing performance indoors. Furthermore, the Concept 2 SkiErg™ is a very reliable test and should have sufficiently sensitivity to detect genuine and meaningfully changes in performance.

**A NEW REACTIVE STRENGTH INDEX FOR TRACK AND FIELD SPRINTING: DIFFERENCES BETWEEN AGE GROUPS.**

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INTRODUCTION: The Reactive Strength Index (RSI) represents a commonly accepted measurement of the reactive strength, defined as the ability to perform fast stretch-shortening cycles (SSC). Track and field sprinting requires a fast SSC, especially during the maximum velocity phase. The RSI is usually assessed as the ratio between jump height (JH) and contact time (CT) in specific vertical jumps, but some studies suggest that an RSI calculated by a horizontal jump test may be a better predictor of sprint performance [1]. These studies, however, present some methodological limitations in the calculation of the RSI, such as the use of non-standardized horizontal jumps. Therefore, the aim of the present study was to assess a new RSI (RSI RUN) based on CT and stride length (SL) measured in sprint running and then to correlate this index with sprint performance.

METHODS: One hundred and five athletes, divided in three groups based on age (Group 1 [G1] elite and sub elite athletes [n=16, age 23.9 ± 3.6 y], Group 2 [G2] junior sprinters [n=22, 15.5 ± 0.6 y] and Group 3 [G3] youth athletes [n= 67, 12.6 ± 1.2 y]), performed a Vertical Stiffness test (VJ, 6 stiffed leg jumps ) and a 60-m sprint. Subsequent analysis considered the best RSI for VJ (RSIVJ), calculated as JH divided by CT, and the RSI for the sprint (RSIRUN), calculated as the average SL divided by the average CT of five steps performed at top speed.

RESULTS: A nearly perfect significant correlation was detected between RSI RUN and sprint performance in G1 and G2 (r=0.945 and 0.923, respectively) and a very large correlation was detected in G3 (r=0.754). No significant correlations were observed between RSIVJ and max speed in the three group. Combining the three groups, RSIRUN showed a nearly perfect correlation with performance (r=0.902). In addition, RSIVJ showed a moderate correlation with performance (r=0.481).

CONCLUSION: The new horizontal-based RSIRUN showed a greater correlation with sprint performance in athletes of different age compared to vertical-based RSI. On the contrary, RSIVJ calculated by the stiffness test, was moderately correlated with max speed when the whole sample was considered, but not when each group was separately analyzed. In conclusion, the RSIRUN is a better predictor of sprint performance than the stiffness test and the calculation of this parameter may help coaches and sport scientists to assess the characteristics of the athletes, to identify talents and to monitor the influences of training on CT and SL.

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**EFFECTS OF ISOMETRIC AND ISOTONIC COMPLEX TRAINING ON STRENGTH AND VERTICAL JUMP PERFORMANCE IN FOLK DANCERS**

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INTRODUCTION: The implementation of isometric and isotonic complex training in folk dancers can significantly enhance their performance through mechanisms such as post-activation potentiation (PAP). PAP refers to the phenomenon where the force exerted by a muscle increases following a prior contraction, which can be particularly beneficial in dance, where explosive movements are frequently required. This training approach not only improves strength and power but also aids in injury prevention, a critical aspect for dancers who are prone to musculoskeletal injuries due to the physical demands of their art. This study aims to investigate the effects of isotonic and isometric complex training on the muscular strength and jumping abilities of folk dancers.

METHODS: The study groups were randomly formed as isometric complex training (ICTG) and isotonic complex training (ISCTG) groups. 43 male folk dancers participated in the study voluntarily. ICTG=age:20,14±1.35years; body weight:74,7±6.03kg; body height:177.58±1,.08cm, N=23; ISCTG=age:20,02±1,55years; body weight:73.81±9.87kg; body height:174.5±6.13cm, N=20.Participants participated in complex exercise sessions determined 3 days a week for 4 weeks before their routine folk dance training. ICTG group completed the mid-thigh pull exercise 3x10s, and the ISCTG completed the back squat exercise 3x3 with 1RM 90%. As a pre-test and post-test, counter movement jump, squat jump, back squat and isometric mid-thigh pull values were evaluated. Mixed design anova was used to test the time x group interaction.

RESULTS: According to the pre-post test results, time x group interactions were found as follows; Counter movement jump height= (ηp2:0.032; p:0.248), squat jump height= (ηp2:0.016; p:0.424), back squat 1RM= (ηp2:0.382; p:0.04). isometric mid-thigh pull=(ηp2:0.166; p:0.007), percentage of improvement in each training session=(ηp2:0.118; p:0.024),respectively.

CONCLUSION: The findings of this study suggest that both isometric and isotonic complex training can enhance muscular strength and performance in folk dancers, particularly in movements requiring maximal force production.

**PHASE-SPECIFIC MUSCLE ACTIVATION IN ONE STRIDE CYCLE DURING A SIMULATED 400 M SPRINT TREADMILL**

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INTRODUCTION: This study aimed to analyze the changes in phase-specific muscle activity in one stride cycle during simulated a 400 m sprint running on a treadmill.

METHODS: Two male track and field athletes (A: 35 years, 180 cm, 68 kg; B: 24 years, 177 cm, 70 kg) participated in this experiment. Muscle activity was measured while running on a treadmill. The treadmill speed gradually increased to 25 km/h over 10 seconds at a 0 % incline, and then the 400 m sprint started the moment this speed (25 km/h) was reached. The treadmill speed was adjusted in increments of 0.1 km/h according to the subjects position on the treadmill or their intention, maximizing their 400m performance. After completing 400 m, the speed was reduced.

Kinematic data were collected using a marker-based motion capture system (sampling rate 100 Hz, BTS Bioengineering, SMART-DX EVO, Italy). Based on the method of Aurélien et al. (2021), the following gait events were identified: initial contact (IC), Mid-stance (Mid), Toe-off (TO), and maximum knee flexion (MKF). The stride cycle was divided into four phases: Braking (IC to Mid), Propulsion (Mid to TO), Recovery (TO to MKF), and Pre-activation (MKF to the next IC). EMG signals were recorded from eight muscles of the right leg: gastrocnemius (GAS), soleus (SOL), tibialis anterior (TIB), biceps femoris (BF), vastus lateralis (VL), rectus femoris (RF), tensor fasciae latae (TFL), and gluteus maximus (GMax) (sampling rate 1000 Hz, BTS Bioengineering, FREEEMG, Italy). The root mean square (RMS) values were calculated for the entire stride cycle and for each phase duration.

RESULTS: The 400 m sprint times were 54.0 seconds for participants A and 60.0 seconds for participants B. The maximum speeds reached were 27.8 km/h for A and 25 km/h for B. Post-sprint blood lactate levels were 16.8 mmol/L for A and 16.6 mmol/L for B. Participants A showed a decrease in RMS values of the GAS and SOL during the Braking phase as the running distance increased. Additionally, most muscles exhibited an increasing trend in muscle activity during the Pre-activation phase. For participants B, the TIB decreased during the Braking phase, while it increased during the Propulsion phase as the running distance increased. Additionally, the BF showed an increase in RMS values during the Pre-activation phase. Participant B showed increased muscle activity during both the Propulsion and Pre-activation phases.

CONCLUSION: The results of this study suggest that muscle activity during a 400 m sprint changes with the increase in running distance, depending on the phase of the stride cycle. Future research should increase the number of subjects to enhance the reliability of the data.

Aurélien et al. (2021) Initial contact and toe off event identification for rearfoot and

non-rearfoot strike pattern treadmill running at different speeds

Howard et al. (2017) Muscle activity in sprinting: a review

**CONSTRUCT VALIDITY OF TWO NEW RPE SCALES TO ASSESS PSYCHOLOGICAL AND PHYSICAL LOADS IN ÉLITE SOCCER ATHLETES DURING TRAINING AND COMPETITIONS**

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INTRODUCTION: Recently, two new rating scales of perceived exertion (RPE) have been developed and validated: the Mental RPE (M-RPE), designed to assess the psychological load experienced by athletes during training and competition, and the Physical RPE (P-RPE), aimed at evaluating the subjective physical load (1, 2). This study aims to assess the construct validity of the P-RPE and M-RPE scales in a field setting by examining whether they can effectively differentiate between training sessions with varying physical and mental loads.

METHODS: Four youth teams of elite soccer players (n = 38 U20, n = 45 U18, n = 38 U17, n = 18 U16) were monitored for two consecutive competitive seasons 2023/2024 and 2024/2025) for a total of 337 training sessions and 89 matches (7934 total records). Athletes completed RPE assessments (Overall, Physical, and Mental) 30 minutes after each training session or competition. The linear mixed model analysis compared P-RPE and M-RPE scores across different sessions categorized using the match day (MD) minus days formula. Session type was included in the model as a fixed effect, while players were included as random effects to consider the intra-individual variability. Separate models were created for each RPE scale as the dependent variable. The P-RPE values were compared between the most intense training session of the week, usually the MD-3, and the pre-match session in which the players are not overloaded before the match. For the M-RPE values, the MD-3 was compared with the recovery session performed by the players on the first day after the match, the MD-5.

RESULTS: The analysis of variance (ANOVA) from the linear mixed model revealed a significant main effect of session type for the P-RPE, $F(1, 64.20) = 139.006$, $p < .001$. Thus, post hoc analysis between the specified contrast was run and a significant difference ($p < .001$) was found between MD-1 and MD-3 training sessions for the P-RPE scale. Similarly, a significant main effect of session type was found in the ANOVA from the linear mixed model for the M-RPE scale, $F(5, 83.98) = 31.622$, $p < .001$. Post hoc comparisons revealed a trend toward statistical significance ($p = .059$) for M-RPE scores between MD-5 and MD-3 training sessions.

CONCLUSION: Accordingly with literature (1), in the present study P-RPE scale effectively discriminates between training sessions with different physical loads in elite soccer players. Regarding M-RPE scale, while the findings were not statistically significant, they approached significance and suggested a potential effect to differentiate between training sessions

with varying mental demands. The present research highlighted the utility of differentiated RPE-based scales for monitoring both physical and mental training loads, though further research is needed.

**INFLUENCE OF TESTING PROTOCOL ON THE RELATIONSHIP BETWEEN PHYSIOLOGICAL VARIABLES AND PERFORMANCE IN MOUNTAIN RUNNING**

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INTRODUCTION: The assessment of aerobic capacity is crucial in mountain running performance. However, the most appropriate testing protocol for evaluating athletes remains unclear. This study aimed to analyze whether the type of protocol used for physiological assessment (flat vs. slope) influences its relationship with race performance in mountain runners.

METHODS: Twenty-eight amateur mountain runners (39.9±6.6 years) who competed in a mountain race of two different distances (26 km and 42 km) underwent physiological assessments in two laboratory sessions. They performed incremental tests to exhaustion and submaximal running economy tests under two conditions: flat (1% gradient) and slope (10% gradient). VO2max, ventilatory thresholds, heart rate, running economy, and perceived exertion were recorded. Additionally, anthropometric measurements and jump tests were conducted to assess leg stiffness and lower limb strength. Statistical analyses examined the correlation between race performance (finish time) and physiological variables obtained from each protocol.

RESULTS: Significant correlations were found between race performance and VO2max ($r = -0.68$, $p<0.05$), ventilatory thresholds ($r = -0.71$, $p<0.05$), and running economy ($r = -0.54$, $p<0.05$). The slope protocol was more sensitive in distinguishing performance levels, particularly in the 42 km race, where VO2max measured in the slope test showed a stronger relationship with race time ($r = -0.75$, $p<0.01$) compared to the flat test ($r = -0.62$, $p<0.05$). Additionally, running economy assessed in the slope protocol correlated more strongly with performance ($r = -0.54$, $p<0.05$) than in the flat protocol, suggesting greater specificity for mountain running demands. However, both protocols provided reliable physiological markers for training prescription.

CONCLUSION: The slope protocol proved to be a more suitable method for assessing aerobic capacity in mountain runners, as it showed stronger relationships with race performance, particularly in long-distance events. These findings suggest that using a gradient-based protocol may enhance the precision of physiological evaluations and training recommendations in mountain running.

**TECHNICAL TESTS IN YOUNG FEMALE HANDBALL ATHLETES: VALIDITY AND RELIABILITY ANALYSIS**

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INTRODUCTION: The accuracy and consistency of technical skill tests form a significant aspect of research methodology in young athletes' evaluation. This study aimed to evaluate in female adolescent handball athletes the validity and reliability of three technical handball tests: - passing-receiving, dribbling, and shooting accuracy - using expert judgment and statistical analysis.

METHODS: A total of 15 female handball athletes (age: 13.84 ± 0.64 y) participated in the study. The study assessed the validity and reliability of three technical handball tests (Sullivan, 2011): passing – receiving (as many successful passes as possible against the wall from 2m distance within a 30-second timeframe), dribbling (time during a 15-meter slalom) and shooting accuracy (10 shots on goal from the penalty line, evaluated with different points depending on the target area). Descriptive statistics were used to analyze the characteristics of the sample. Logical validity was ensured by working with an experienced handball coach to examine if the tests accurately measured performance. The content validity of the technical tests was assessed by three handball experts who evaluated the test structure and scoring procedures (7-point scale). Reliability was assessed using Pearson correlation and intra-rater reliability analysis of data collected in two assessments a week apart. All statistical analyses were performed in R using JASP software and the level of significance was set at $\alpha=0.05$.

RESULTS: The requirements for logical validity have been met. The high average scores given by the experts (passing: 5.37±.66, dribbling: 5.28±.77, shooting: 5.35±.63) indicated strong content validity. Reliability was assessed using Pearson correlation coefficients and intraclass correlation coefficients (ICCs), both of which showed excellent consistency. Passing - receiving showed a correlation of $r = .961$ ($p < .001$) and an ICC of 0.945, dribbling showed almost perfect reliability with $r = .991$ ($p < .001$) and an ICC of 0.989, and shooting accuracy showed strong reliability with $r = .936$ ($p < .001$) and an ICC of 0.935.

CONCLUSION: The study demonstrated strong validity and reliability for the three technical handball tests, passing - receiving, dribbling and shooting accuracy in adolescent female handball players. These findings suggest that the assessment tools examined are robust and suitable for the reliable assessment of performance in young female handball players.

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**EFFECT OF GPS-DERIVED FOOTBALL MATCH ACCELERATIONS AND DECELERATIONS ON JUMP HEIGHT AND LEG STIFFNESS IN YOUTH FEMALE ACADEMY ATHLETES**

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INTRODUCTION: Increased ACL injury risk in female youth football (1) may be linked to exercise-induced fatigue (2). Studies have found negative changes in knee neuromuscular control in response to simulated match-play in adult (3) and youth (4) female footballers. Biomechanical studies suggest ACL risk factors include changes of direction (CoDs) involving deceleration and acceleration efforts (5) with 80-100 CoDs occurring per match (6). Due to limited data on the topic, the study aimed to analyse neuromuscular response to match-play in U16 female footballers.

METHODS: Twenty-eight U16 female footballers completed 95 player-sessions of ≥75 of 80 minutes in a match. Relative accelerations and decelerations (ACCEL and DECEL, n/min) were determined by GPS analysis (GPSports HPU system). Players completed neuromuscular response (NMR) testing pre- and post-match involving mean-of-3 countermovement jump height (CMJ) (7) and relative leg stiffness (LS) using submaximal hopping (SmartJump, Fusion Sport) (8). Paired t-tests compared pre- and post-match responses. NMRs were converted into a z-score (z-score = participant test score – group mean score)/SD, and differences (post – pre) were calculated. Pearson's correlation analysed the relationship between Z-score difference of NMRs with ACCEL and DECEL, respectively.

RESULTS: There was no significant change ($p>0.05$) in CMJ from pre-match (27. 9 ± 3.4 cm) to post-match (27.6 ± 3.8 cm). LS was significantly lower post-match (30.6 ± 10.1) vs. pre-match (35.4 ± 9.2), ($p<0.001$, $d = 0.49$). A small negative correlation was found between CMJ z-score difference and DECEL ($r = -0.231$, $p <0.05$), but not ACCEL. No significant correlation was found between LS z-score difference and either ACCEL or DECEL.

CONCLUSION: Results showing a decrease in LS post-match align with previous research on simulated matches in female youth football (4), suggesting a negative alteration in lower limb neuromuscular control from repetitive stretch-shortening cycle loading (9). However, changes in LS were not shown to be related to ACCEL or DECEL, suggesting LS is altered by match-play without effect from specific high-intensity efforts. A negative correlation between changes in CMJ and DECEL may be related to the energy costs of decelerations (10) and subsequent decrease in jump height which may indicate a reduction in neuromuscular performance (11). This study shows negative neuromuscular response due to match-play, warranting further study of ACL injury risk in female youth football.

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**THE DIFFERENCE AND CORRELATION BETWEEN FUNCTIONAL THRESHOLD POWER AND VENTILATORY THRESHOLD POWER IN RECREATIONAL TRIATHLETES**

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INTRODUCTION: The relationship between Functional Threshold Power (FTP) and the metabolic threshold defined in graded exercise test is an essential topic in sports science. However, existing research is limited and contradictory, possibly due to differences in study populations and fitness levels. Some researchers suggest FTP is a good indicator of the anaerobic threshold and is valuable for training and performance monitoring [1]. However, further validation is needed regarding the factors influencing FTP and its comparability to the ventilatory threshold (VT1 and VT2). This study aims to explore the differences and correlations between FTP and pedaling power at the ventilatory threshold in recreational triathletes in Taiwan.

METHODS: This study recruited 22 recreational triathletes (13 males, 9 females) and conducted FTP and cycling-graded exercise tests on separate days to calculate FTP value and determine the ventilatory threshold and corresponding power. All power data were normalized by body weight. The Shapiro-Wilk test was used to assess the normality of the data. If the data followed a normal distribution, the Pearson correlation test was employed; if not, the Spearman correlation test was used. The difference in pedaling power was performed using the Kruskal-Wallis H test with Dunn's post-hoc test.

RESULTS: In the overall and male groups, the relative power output at FTP (All: 2.56 ± 0.49 W/kg; Male: 2.67 ± 0.49 W/kg) was significantly higher than at VT1 (All: 1.61 ± 0.29 W/kg, $p < 0.001$; Male: 1.55 ± 0.34 W/kg, $p = 0.014$) and lower than at

VT2 (All: 3.42 ± 0.51 W/kg, p = 0.005; Male: 3.56 ± 0.45 W/kg, p = 0.039). In the female group, FTP (Female: 2.42 ± 0.47 W/kg) was higher than VT1 (Female: 1.68 ± 0.22 W/kg, p = 0.044), but no significant difference was found between FTP and VT2 (Female: 3.25 ± 0.53 W/kg, p = 0.119). Additionally, FTP and VT1 showed no significant correlation, while a strong correlation was found between FTP and VT2 (All: γ= 0.788; Male: γ= 0.755; Female: γ= 0.795). These findings align with previous studies on elite athletes, where FTP and VT1 showed similar relationships, but no significant difference was observed between FTP and VT2 [2]. This suggests that FTP may underestimate VT2 in the overall and male groups but may better represent VT2 in female athletes.

CONCLUSION: It is suggested that the training level of participants is a key factor influencing the differences between FTP and the ventilatory threshold. The recreational male athletes FTP values may significantly underestimate the VT2, though this may not be the case for female athletes. Therefore, caution is required when applying FTP values to avoid misjudging an athletes true capacity.

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**EFFECTS OF MENTAL FATIGUE ON 400-M FRONT-CRAWL SWIMMING PERFORMANCE IN ELITE ATHLETES**

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INTRODUCTION: This study aimed to investigate the effects of mental fatigue on 400-meter front-crawl swimming performance in elite athletes.

METHODS: Ten elite swimmers (FINA points = 725 ± 74) participated in a crossover, randomized, and counterbalanced study design. The study consisted of three experimental visits over three weeks. Participants were familiarized with the testing instruments and procedures during the first visit. In the second and third visits, swimmers underwent two experimental conditions in a randomized order: control (CON) and mental fatigue (MF). Following the intervention, participants performed a 400-meter front-crawl maximal effort test. Mental fatigue was assessed using the Brunel Mood Scale (BRUMS), physiological and psychological parameters, including heart rate (HR), lactate (La), and rating of perceived exertion (RPE), were evaluated during the assessments.

RESULTS: Manipulation Check

• BRUMS-Fatigue: A significant interaction was found ($X^2(1,18) = 5.60$, p = 0.018). Fatigue significantly increased following the MF intervention [PRE = 9.7 (8.3 to 11.1) a.u.; POST = 12.1 (9.7 to 14.6) a.u.; CI95%diff = -2.43 (-4.03 to -0.82); p = 0.018], while the CON condition remained unchanged [PRE = 9.0 (5.8 to 12.1) a.u.; POST = 0.35 (-0.76 to 1.46) a.u.; CI95%diff = -10.20 (-12.50 to -7.95); p = 1.00].

400-Meter Performance

• Performance: A significant condition effect was observed ($X^2(1,9) = 117.14$, p < 0.001). Participants performed better in the CON condition than in the MF condition [CON = 277.0 (270.0 to 283.0) s; MF = 288.0 (281.0 to 294.0) s; CI95%diff = 10.89 (8.92 to 12.86); p < 0.001].

• RPE: An interaction effect was observed ($X^2(1,27) = 48.29$, p < 0.001). RPE values were higher in the MF condition during pre-measurements [CON = 8.56 (8.12 to 9.00) a.u.; MF = 10.45 (9.97 to 10.93) a.u.; CI95%diff = -9.68 (-10.32 to -9.03); p = 0.001]. Post-measurement RPE values were similar between conditions [CON = 18.24 (17.48 to 18.99) a.u.; MF = 18.54 (17.95 to 19.22) a.u.; CI95%diff = -0.30 (-1.10 to 0.50); p = 0.465].

• Heart Rate: No interaction was found ($X^2(1,18) = 0.422$, p = 0.516).

• Lactate (La): Significant interaction was observed ($X^2(1,18) = 36.2$, p = 0.001). Post-measurement La levels were higher in the CON condition compared to the MF condition [CON = 10.24 (9.16 to 11.32) mmol/L; MF = 9.02 (7.93 to 10.10) mmol/L; CI95%diff = 1.22 (0.81 to 1.63); p < 0.001].

CONCLUSION: The findings demonstrate that mental fatigue significantly impairs 400-meter front-crawl swimming performance in elite athletes. The MF condition led to increased perceived fatigue, higher RPE values, and reduced performance compared to the CON condition. These results highlight the importance of managing mental fatigue in elite swimmers to optimize performance. Future research should explore strategies to mitigate the negative effects of mental fatigue in competitive swimming.

**CORRELATION BETWEEN PHASE ANGLE AND STRENGTH PERFORMANCE IN HIGH-LEVEL SPRINT RUNNERS.**

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INTRODUCTION: In high-performance sports, monitoring body composition is important to develop athletes and improvement performance. Body composition-BC can be estimated using several methods, including adipometry, bioelectrical

impedance-BIA, dual-energy X-ray absorptiometry-DXA. Specifically in relation to BIA, it has been used in this context, due to its easy application, time, and reduced costs. The assessment includes four parameters: resistance, reactance, impedance, and phase angle, which estimate body composition through equations. The phase angle-PA is a parameter obtained from the relationship between resistance-R and reactance-Xc measurements, and has been related as an important marker of cellular and muscle integrity, in addition occurrence of some diseases. The objective of the present study is to associate, in high-performance athletes, muscle strength parameters, through one maximum repetiton-1MR tests, PA values and body fat percentagem-BF obtained by BIA.

METHODS: Athletics sprinters participated in national and international competitions, with results corresponding to 88.42% of the world records of their events, were selected to participated in a tetrapolar bioimpedance tests-50kHz to obtain PA, percentage of BF and skeletal muscle mass, in addition tests of 1MR in the bench press and half squat. From these tests, the mean and standard deviation of all values were obtained and the Graphpad Prism v. 8.0.1 was used to obtain the correlation between the measures.

RESULTS: 11 athletes (men=7, women=4), aged 23.00±3.95, were evaluated. The mean PA obtained was 8.19°±1.08, a study [1] with similar population found a higher mean value than the untrained population. The moderate strong negative correlation between PA and BF percentage r = -0.71 indicates that individuals with lower fat percentage tend to have higher PA values. The moderate positive relationship between PA and skeletal muscle mass r = 0.61 suggests that higher values of this parameter are associated with a greater amount of muscle mass, an essential factor for sports performance. The results found regarding muscle strength and BC, PA proved to be an important indicator in the sports context. In addition, the relationship between PA and muscle strength was significant. A strong positive correlation was observed with the load lifted in the bench press r = 0.81 and moderate strong correlation with the half squat r = 0.64. Indicates that athletes with higher PA perform better in maximum strength and muscle power.

CONCLUSION: Phase angle monitoring can be a useful tool in monitoring the evolution of training, helping to optimize body composition and improve sports performance. Its use can be relevant for sports that require strength and power, as in the case of speed tests in athletics, proving to be an important marker in the periodization of sports training.

1. Campa F. et al, Reference Percentiles for Bioelectrical Phase Angle in Athletes. Biology 2022 Feb 8;11(2):264

**MONITORING TRAINING LOAD IN YOUNG FEMALE TABLE TENNIS PLAYERS DURING THE PRE-COMPETITION PERIOD**

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INTRODUCTION: Muscle fatigue can impair velocity, accuracy, and motor control in racket sports [1]. Managing fatigue is crucial for injury prevention and optimal training adaptations [2]. Higher training volumes enhance performance and strength, but they also increase injury risk [3]. Most research focuses on male athletes, yet young women exhibit distinct physiological, psychological, and maturational responses affecting training loads [4]. This study aimed to characterize the training model of young female Brazilian table tennis elite players during pre-competition period, and examine associations between external and internal loads, performance, and maturation.

METHODS: Seven female players participated in the study (16.4±1.8 years; 53.2±6.9 kg; 156.1±8.8cm; 3.0±1.1 maturity offset), all selected to compete in the Brazilian Table Tennis National Youth Team (U15 and U19). The following procedures were performed: 1. anthropometric and maturation assessments [5]; 2. a sport-specific test to obtain performance variables [6]; and 3. completing a questionnaire for monitoring and diagnosing external and internal loads during the training week. Internal load was calculated using the Rate of Perceived Exertion (RPE) scale, which was also used to calculate monotony and strain (7). Pearson's correlation coefficient was used to analyze associations between external and internal training loads, performance parameters, and maturation indicators. Significance was set at $P<0.05$. Data are presented in mean±SD.

RESULTS: Performance variables were 44.5±4.3 for ball velocity (km/h); 46.6±9.9 for error (%); 24.0±4.4 for consistency (%); 28.8±14.5 accuracy (%); 37.0±10.6 accuracy score and 15.3±4.3 for the performance index. External loads were 18±7 in weekly training volume/h and 5±1.7 in weekly training frequency/days. Internal loads were 4.2±1.2 for average weekly RPE; 5895.5±4397.1 for strain and 1.7±0.4 for monotony . Weekly frequency showed positive product-moment correlations related to consistency (%) (R=0.79, p=0.03); accuracy (%) (R=0.76, p=0.04); accuracy score (R=0.80, p=0.03) and performance index (R=0.84, p=0.01). Moreover, it was inversely related to error (%) (R=-0.79, p=0.03). Weekly volume correlated with monotony (R=0.77, p=0.04) and maturation (R=0.82, p=0.02); strain was also related to maturation (R=0.78, p=0.03).

CONCLUSION: Training frequency correlated to performance while volume correlated to monotony, suggesting that more frequent, shorter training may be optimal for this population. Moreover, maturation seemed to be a key factor to monitor, as it correlates with internal and external load parameters. Triangulating monitoring parameters is essential for coaches. Additionally, maturation in young female athletes affects body development and hormonal changes, impacting performance and recovery.

1. Alba-Gimenez et al. (2022) 2. Lechner et al. (2022) 3. Dudley et al. (2023) 4. Hunter et al. (2023) 5. Moore et al. (2015) 6. Le Mansec, et al. (2016) 7. Foster et al. (2001)

**MUSCULAR ENDURANCE AND SPRINT INTERVAL SWIMMING TRAINING ADAPTATIONS FOLLOWING CONCURRENT TRAINING**

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INTRODUCTION: A session of dryland muscular endurance training (ME) deteriorates sprint interval swimming performance (SIT) [1]. However, applying ME sessions concurrent to SIT for a period of several weeks may facilitate adaptations and reverse the previously induced swimming performance impairment. It remains unclear whether different dryland training characteristics (i.e. ME or maximum strength: MS) concurrent with SIT will induce adaptive responses facilitating acute performance maintenance and long-term performance improvement. The present study examined the effects of different dryland training characteristics on SIT performance before and after a 6-week concurrent ME and SIT training period.

METHODS: Eight competitive swimmers (15.9±2.0 years) participated in concurrent dryland ME training (2 sets x 20 repetitions @55% of one repetition maximum: 1RM) applying three exercises: bench press, seated pulley rowing, and half squat 20 min before SIT (2 sets x 4 x 50 m and 1 x 100 m swimming sprints), three times per week during a 6-week period. Before (T1) and after (T2) the training period all swimmers completed three experimental conditions: i) Muscular endurance (ME, @55% of 1RM), ii) MS, @90% of 1RM, and iii) control (CON, no dryland). Twenty minutes following ME, MS, and CON, swimmers performed a 10 s tethered swimming sprint, 4x50 m and 1x100 m front crawl sprints. Performance time, blood lactate (BL), stroke rate (SR), and stroke length (SL) were measured during 4x50 m and 100 m. Hand grip strength (HG) and shoulder isometric extension (ISO) were measured after each session.

RESULTS: Performance time in 4 x 50 m and 100 m was decreased (indicating improvement) in all conditions at T2 compared to T1 (4X50 m: 2.5-4.1%, 100 m: 4.3-4.4%, p=0.01). Performance decrements in the 2nd, 3rd, and 4th repetitions of 4x50 m were similar in all conditions before and after the 6-week training period (p=0.03). At T2, ISO was increased in MS and ME conditions compared to CON (p=0.03), while TF was increased in all conditions (p=0.01). BL was higher in ME session compared to CON in T1 but not in T2 (T1: 5.±3.2 vs. T2: 4.1±1.9 ,p=0.04). SR, and SL were similar between conditions before and after the 6-week period.

CONCLUSION: Applying dryland endurance training (ME) concurrent to SIT may improve performance following a 6-week training period. Moreover, ME sessions attenuated metabolic perturbation within a training unit preceding SIT at T2 following six weeks of concurrent ME and SIT training. This may be attributed to specific adaptations occurred over the six-week training period.

1. Arsoniadis et al. (2024)

**TIME-COURSE CHANGES IN CONTRACTILE PROPERTIES OF KNEE EXTENSOR MUSCLES FOLLOWING ECCENTRIC EXERCISE ASSESSED BY TENSIOMYOGRAPHY.**

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INTRODUCTION: Fatigue influences athletic performance and can also increase the risk of injury in sports, and most of the methods to evaluate it require an additional voluntary effort. Recently, tensiomyography (TMG) has received attention as a non-invasive assessment of muscle contractile properties. TMG is independent of motivation or volitional effort. For this reason, TMG has been investigated as a means to assess muscle contractile properties after fatigue. However, previous studies have not clarified the time-course changes in the contractile properties of the knee extensor muscles after eccentric exercise (ECC). Therefore, this study aimed to investigate the early and recovery-phase changes in the contractile properties of the knee extensor muscles following ECC using TMG.

METHODS: Fourteen healthy males (mean ± standard deviation [SD] age: 21.1± 0.8 years; height: 173.1± 6.9 cm; weight: 72.1± 6.4 kg) participated in this study. Participants performed five sets of 20 maximal eccentric contractions of the knee extensor muscles. The contractile properties of the rectus femoris (RF), vastus medialis (VM), and vastus lateralis (VL) were assessed using TMG. Maximal voluntary isometric contraction (MVC) torque and muscle contractile properties (TMG parameters: maximum displacement [Dm] and velocity of deformation [Vd]) were assessed before, immediately and 1–4 days after exercise.

RESULTS: MVC torque decreased immediately (-21.4± 9.1 %, $p < 0.05$) and 1 day (-19.5± 9.1 %, $p < 0.05$) after exercise, but returned to baseline at 2-day post-exercise. Dm in RF decreased immediately after exercise and remained lower than the baseline at 1 day (-21.6 ± 18.0 %, $p < 0.05$), 2 day (-19.2 ± 9.1 %, $p < 0.05$), 4 day (-10.5 ± 11.3 %, $p < 0.05$) after exercise. Vd in RF decreased ($p < 0.05$) -20.3± 13.7% from 211.2 ± 33.7 mm/s (baseline) to 166.6 ± 28.1 mm/s (immediately after exercise) and remained lower than the baseline ($p < 0.05$) for 4 days after exercise. Dm and Vd of VM were significantly decreased 1 day (Dm: -20.9 ± 17.5 %, Vd: -23.4 ± 16.7 %, $p < 0.05$) of after exercise, but returned to baseline 3 days of after exercise. Dm and Vd of VL were significantly decreased immediately (Dm: -19.5 ± 15.1 %, Vd: -18.0 ± 15.9 %, $p < 0.05$), 1 day (Dm: -22.1 ± 11.8 %, Vd: -24.8 ± 12.5 %, $p < 0.05$) and 2 days (Dm: -12.6 ± 11.4 %, Vd: -14.1 ± 11.2 %, $p < 0.05$) after exercise compared to baseline.

CONCLUSION: In conclusion, the TMG parameters of the knee extensor muscle (RF, VM and VL) after eccentric exercise showed different changes over time. These results are particularly important to understand how TMG parameters are modified with the type of muscle and indicate that TMG can be highly sensitive in detecting fatigue-induced changes and its recovery.

**CONCURRENT DRYLAND MAXIMUM STRENGTH AND SPRINT SWIMMING TRAINING: ADAPTIVE RESPONSE FOLLOWING A 6-WEEK TRAINING PERIOD**

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INTRODUCTION: Applying dryland maximum strength training (MS) concurrent to sprint interval swimming training (SIT) is well-accepted by competitive swimmers. It has been seen that a MS followed by SIT order does not acutely impair swimming performance [1]. Moreover, the concurrent application of MS with high-intensity training can enhance swimmers' performance after a period of training [2]. It is unclear whether such improvement in performance, following a period of training, is facilitated by adaptation to a dryland training specific modality. Swimmers are likely getting adapted to the dryland training specific characteristics they regularly apply concurrent to swimming training (i.e. maximum strength or muscular endurance concurrent to SIT). The present study examined the effects of various dryland training characteristics on SIT performance before and after a 6-week concurrent MS and SIT training period.

METHODS: Eight competitive swimmers (17.0±2.6 years) participated in concurrent MS and SIT training consisted of 3 sets x 4 repetitions @90% of one repetition maximum (1RM) applying three exercises: bench press, seated pulley rowing, and half squat 20 min before SIT (2 sets x 4 x 50 m and 1 x 100 m swimming sprints), three times per week during a 6-week period. Before (T1) and after (T2) the training period all swimmers completed three experimental conditions: i) Muscular endurance (ME, @55% of 1RM), ii) MS, @90% of 1RM, and iii) control (CON, no dryland session). Twenty minutes following ME, MS, and CON, swimmers performed a 10 s tethered swimming sprint, 4x50 m and 1x100 m front crawl sprints. Performance time, decrement score (DS), blood lactate (BL), stroke rate (SR), and stroke length (SL) were measured during the 4x50 m and 100 m sprints. Hand grip strength (HG) and shoulder isometric extension (ISO) were measured after each session.

RESULTS: Performance time in 4 x 50 m and DS were similar between ME, MS, and CON (p=0.68-0.88) in T1 and T2 (p=0.07), whereas performance time improved in the 100 m for all conditions (ME, T1: 72.5±5.6 vs. T2: 70.0±4.7 s; MS, T1: 72.6±6.2 vs. T2: 69.7±4.3 s; CON, T1: 72.2±5.3 vs. T2: 69.2±5.2 s, p=0.01). HG and ISO were increased in all conditions after the 6-week period (p=0.01). TF increased in all conditions (p=0.01), while swimmers managed to increase TF to a higher extent in MS compared to CON (3.2±2.4%) in T2 compared to T1 (p=0.01). BL, SR, and SL were similar between conditions before and after the 6-week period.

CONCLUSION: A concurrent application of MS and SIT may increase specific in-water force. This finding suggests a potential enhancement in muscle activation following MS training relative to the absence of dryland training in the CON condition. Such improvements may be attributed to neuromuscular adaptations induced by the 6-week concurrent training program.

1. Arsoniadis et al. (2024); 2. Aspenes et al. (2009)

**THE EFFECTS OF FATIGUE ON REACTION SPEED IN BASKETBALL: VISUAL STIMULI RESPONSE IN COGNITIVE TESTS OF DIFFERENT COMPLEXITY**

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INTRODUCTION: Basketball is a clear example of open skill sport where changes of direction are often performed, and the player is required to continuously respond to various stimuli from the environment. Reactive agility is one of the key factors of a basketball players performance, therefore unhindered scanning of information must be at a high level, considering that the player is simultaneously handling the ball while also moving on the court. The role of cognitive components related to decision-making during the game, which also include visual scanning, anticipation and recognition of certain patterns, is increasing, and nowadays more attention is given in the training process to tasks that require its involvement. To determine player's level of reactive agility, the applied testing protocols must contain some external stimuli that will then "load" the player's visual system and visual scanning abilities in general, as well as anticipation and decision-making abilities. Fatigue, especially as the game progresses, further challenge this process by potentially impairing visual scanning, decision-making, and reaction speed, highlighting the need for training and testing protocols that account for its effects. The main aim of this research is to determine whether a fatigue affects player performance in a reactive agility test at three levels of complexity.

METHODS: The sample of participants consists of Faculty of Kinesiology students who have successfully finished the mandatory course of Basketball. For testing purposes in this research, three variations of a cognitive reaction agility test were performed using Witty SEM system (Microgate). As a fatigue protocol, 300 meters shuttle run test was carried out.

RESULTS: A mixed model ANOVA was performed, and a statistically significant difference was determined between the various levels of test complexity, but there was no statistically significant difference between the test results depending on whether it was conducted under the influence of fatigue ($p > 0.05$). Results indicated that, regardless of whether players were fatigued, in the second and third variation (higher complexity levels) of the test the participants had issues with recognizing the correct stimuli, which in turn resulted in a slower reaction. In the first variation (lower complexity) of the test the results were significantly faster when compared to other two variations ($p<0.01$).

CONCLUSION: Although no significant differences were found in test results before and after physiological load, indicating that fatigue did not negatively impact players performance, it is essential to emphasize the importance of such assessments in the training process. The development of decision-making ability is crucial for player performance, and incorpo-

rating cognitive tests can provide valuable insights for optimizing training strategies. It is possible that the application of a more specific fatigue protocol would have yielded different results, highlighting the need for further research.

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